Quantifying Fiscal Policy's Role in U.S. Inflation*

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March 28, 2024

Abstract

The surge of inflation following the 2020-2021 COVID-19 pandemic, preceded by historically large fiscal deficits, has reignited an old-standing debate about the fiscal policy responsibility in inflationary outcomes. This paper sets out to contribute to that debate by empirically assessing the role that policy had on the post-pandemic inflation spike, disciplined by the requirement that such contribution had to be consistent with the U.S. experience for the entire 1960-2022 period, as inspected through the lens of a well-established model of the U.S. economy. To that end, the paper incorporates a fiscal block in the Smets and Wouter's model (2007) that overcomes the limitation that the active monetary-passive fiscal policy regime assumed by that paper does not let fiscal debt policy have any effect on inflation, other than "passively" validating the inflation "actively" controlled by the monetary authority. The augmented model makes it possible to postulate an alternative passive monetary-active fiscal policy configuration that allows "Non-Ricardian" orthogonal shocks to contemporaneous U.S. Federal primary budget deficits to be an independent source of unanticipated inflation or deflation. The paper finds that such shocks contributed to roughly one-third of the 2021-2022 post-Covid increase in inflation, and that they played yet a more significant role during the 1970s and 1980s, when their contribution to the rise and fall of inflation was roughly 50%. From a more historical perspective, the results of this paper suggest that non-Ricardian fiscal shocks have been a non-negligible source of U.S. inflation, accounting for 25% of the one-year-ahead inflation forecast error variance and for 64% of the unconditional variance in inflation over the period 1960-2022.

JEL Classification: E31, E62, E66

KEY WORDS: Inflation, Fiscal policy, budget deficit, primary surplus

*We are grateful for useful comments on this paper from participants at a 2022 Federal Reserve Bank of Dallas Fed seminar and at the 2023 Southern Economic Association meetings.

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1 Introduction

Following on the heels of record high fiscal deficits, inflation rates in 2021-2022 surged to levels not seen since the 1970s, naturally renewing interest in the old standing question of the inflationary consequences of fiscal policy. As demonstrated in the seminal paper by Wallace (1981), Friedman's well-known assertion that *"inflation is always and everywhere a monetary phenomenon"* requires the complicity of fiscal policy.

Interpreting inflation as a "monetary phenomenon" or as a "fiscal phenomenon", however, depends on which policymaker ultimately decides how much of the government debt is not "backed" by future primary surpluses and, therefore, on the extent to which the government debt valuation equation will be balanced with unexpected inflation or deflation.

Many models in the New Keynesian tradition, such as the one estimated by Smets and Wouters (2007), assume that that decision is made by monetary policy. From this perspective, there is no need to model fiscal policy explicitly: budgeted primary surpluses are expected to adjust as needed to validate whatever unexpected inflation is induced by monetary policy. Exogenous shocks to the primary surpluses have no impact whatsoever on inflation, because they do not introduce any innovation to the expected present value of budgeted primary surplus. This corresponds to the "active" monetary policy/"passive" fiscal policy regime taxonomy originally proposed by Leeper (1991). However, such an interpretation of the data is implicitly or explicitly challenged by commentators, scholars, and policymakers, who have been attributing to fiscal policy the ultimate responsibility for the surge of inflation during the pandemic and its aftermath.

In this paper, we examine that alternative interpretation that US inflation is a "fiscal phenomenon", driven by fluctuations in Federal budget deficits and surpluses. We do so through the lens of the prototypical New Keynesian model estimated by Smets and Wouters, but augmented with a fiscal block in which Fiscal policy (specifically, surpluses) is dominant or "active". We estimate the active fiscal/passive monetary policy version of Smets and Wouters by Bayesian methods. The estimated model is used to decompose inflation fluctuations that occur as a result of structural shocks in the original Smets and Wouters model, as well as to exogenous shocks to Federal budget deficits.[1]

To that end, the paper considers two types of fiscal policy shocks. The first we call "non-Ricardian", in the sense that economic agents do not expect a shock to a current period primary surplus to be undone by future surpluses. In response to a non-Ricardian surplus shock, the government debt valuation equation can only by satisfied by an unexpected change in the aggregate price level that dilutes or increases the market value of government debt in real terms. The other exogenous stochastic fiscal shock is "Ricardian", in the conventional sense that it is expected to be completely offset by changes in subsequent primary surpluses. Ricardian shocks do not alter the market value of existing government debt which means there is no need to satisfy the government debt value equation with an unexpected change in the aggregate price level. This type of fiscal shock has no effect on macroeconomic activity in the standard representative agent New Keynesian model.[2]

We find that a non-Ricardian surplus shock in the Smets and Wouters New Keynesian model looks like a traditional aggregate demand shock; both inflation and output growth increase in response to a negative non-Ricardian surplus shock. We also find that non-Ricardian surplus shocks have persistent effects on inflation; the inflation response peaking several years after the initial shock. In the benchmark model, monetary shocks have very muted effects on inflation–in fact, after a very small negative response initially, inflation rises in response to a contractionary monetary shock.

These so-called non-Ricardian surplus shocks are also an important source of inflation fluctuations. Our empirical analysis attributes close to 17% of the one-year-ahead inflation forecast error variance and 64% of the unconditional variance in inflation to non-Ricardian surplus shocks. As to historical fluctuations in inflation, We find that non-Ricardian fiscal budget shocks played a significant role in the rise and fall of inflation in the 1970s and 1980s. Our analysis also suggests that non-Ricardian primary surplus shocks were behind the rather

[1] We do not test if the data for the U.S. favor an active monetary policy/passive fiscal policy configuration or a passive monetary policy/active fiscal policy configuration. Cochrane (2023) points out the futility of such tests as the two frameworks are observationally equivalent. Rather, the paper assumes the latter policy regime and proceeds to identify its inflationary impact on US inflation since 1960.

[2] As noted by Cochrane (2022c), Ricardian surplus shocks can be very helpful for any empirical inquiry that wishes to reproduce the s-shaped pattern of U.S. primary surpluses seemingly present in the data.

subdued inflation that the U.S. experienced during the roughly quarter of a century spanned by the mid-1990s to the beginning of the COVID-19 pandemic.

Surprisingly, given the large fiscal shocks during the Covid pandemic, the contribution of fiscal budget shocks to the outburst of inflation post-Covid was relatively modest, accounting for roughly one-third of the 2021-2022 increase in inflation relative to its pre-pandemic expectation. The main contributors to the surprise inflation in the wake of the pandemic were Smets and Wouters' wage and price mark-up shocks. This result contrasts with the recent paper by Bianchi, Faccini, and Melosi (2023), who find that unfunded transfer payment shocks account for virtually all of the inflation, not only during the pandemic, but throughout US history since 1960.

The benchmark results are, furthermore, pretty robust to changes in specification of the fiscal rule, to the estimation period, and to how surpluses are measured. For completeness, we also re-estimate the Smets and Wouters model with their active monetary/passive fiscal policy configuration, but with the data at annual frequency used in this paper. We find that under that configuration, much like in the original Smets and Wouters paper estimated with quarterly data, mark-up shocks to wages and prices are largely responsible for fluctuations in inflation.

2 Government budget flow constraint

As in Cochrane (2022b), the analysis starts with the government budget flow equation:

$$V_{t-1}R_t^V = P_tS_t + V_t. \tag{1}$$

The left hand side of this equation represents the nominal government debt outstanding at the end of period t-1 valued at period t, rather than at period t-1 prices, that must be financed or repaid in period t. V_{t-1} is the value of debt at t-1 while R_t^V is the gross nominal return on government debt in time period t. In other words, the period t-1 market value of debt outstanding at the end of that period is updated to its period t market value by taking into account the change in the value of the outstanding debt between those two periods. The right hand shows how that debt obligation is financed by retiring debt with a period-t nominal primary surplus P_tS_t (where S_t is the real primary surplus) and/or by rolling over the difference with newly outstanding debt with period t market value V_t. A key insight from the Fiscal theory of the price level is that this equation should more properly be conceived as an equilibrium condition rather than a budget constraint, Cochrane (2022c).

For subsequent analysi, it is convenient to represent the elements of the government flow equation as fractions of nominal GDP. To that end, divide both sides of the budget flow equation by nominal GDP, P_tY_t, to obtain

$$\frac{V_{t-1}}{P_{t-1}Y_{t-1}}\frac{R_t^V}{\Pi_t G_t} = \left(\frac{S_t}{Y_t} + \frac{V_t}{P_tY_t}\right) \tag{2}$$

where Π_t is gross inflation rate and G_t is the gross growth rate in real GDP. Substituting recursively forward and taking expectations:

$$\frac{V_{t-1}}{P_{t-1}Y_{t-1}}\frac{R_t^V}{\Pi_t G_t} = \frac{S_t}{Y_t} + \sum_{i=1}^{\infty}\mathbb{E}_t\left(\prod_{j=1}^{i}(R_{t+j}^V)^{-1}\Pi_{t+j}G_{t+j}\right)\frac{S_{t+i}}{Y_{t+i}} \tag{3}$$

The right hand side of (3) is the present value of current and future real primary surpluses (relative to GDP) discounted by the real return on government debt, diminished or augmented by GDP growth, $\frac{R_t^v}{\Pi_t}/G_t$.

Equation (3) identifies the potential fiscal origins of inflation. Given existing debt to GDP ratio ($\frac{V_{t-1}}{P_{t-1}Y_{t-1}}$), the gross real return on debt relative to GDP, $\frac{R_t^V}{\Pi_t G_t}$, responds to the expected present value of current and future primary surpluses. A deficit (or negative surplus) shock that will eventually be undone, in present value terms, by future primary surpluses (in present value terms) will have no effect on $\frac{R_t^V}{\Pi t G_t}$. A deficit shock that is not offset in present value terms by increases in future surpluses will affect $\frac{R_t^V}{\Pi t G_t}$. Furthermore, for this type of deficit shock the relationship between inflation and debt-to-GDP is likely to be negative. Since the current (end-of-period) debt to GDP ratio, $\frac{V_t}{PtYt}$, is equal to the present value of future surpluses, a deficit shock likely to be reversed will result in an increase in the debt to GDP ratio but have no impact on $\frac{R_t^V}{\Pi t G_t}$. On the other hand, a deficit shock that will not be paid back need not result in an increase in the debt to GDP ratio and, in fact, might be accompanied by a decline in that ratio if the deficits are to persist into the future. Inflationary deficit shocks, in general, are those in which debt-to-GDP ratio on the right-hand side of equation (3) does not rise enough to offset the increased deficit.

When we log linearize equation (2) as in Cochrane (2022c) and Cochrane (2023), the flow equation implies:

$$v_{t-1} + r_t^v - \pi_t - g_t = s_t + \rho v_t \tag{4}$$

where v_{t-1} is the logarithm of the debt to GDP ratio, r_t^v is the realized rate of return on government rate, π_t is the inflation rate, g_t is the growth rate of real GDP, s_t is a function of surpluses relative to GDP and ρ is a constant that depends on the ratio of nominal surplus to nominal debt in steady state.[3] Solving this equation forward yields the present value budget equation in terms of v_t:

$$v_t = \mathbb{E}_t \sum_{i=1}^{\infty} \rho^{(i-1)} \left(s_{t+i} - r_{t+i}^v + \pi_{t+i} + g_{t+i} \right) \tag{5}$$

The implications of the government budget constraint for the effect of a deficit shock (shock to s_t) depends on expectations of present value of future surpluses through ρv_t. If a deficit shock is offset by increases in the present value of future surpluses, then the change in the right hand side of (4) is zero and the flow budget constraint implies no change in $r_t^v - \pi_t - g_t$. If the shock to s_t is not offset by ρv_t, the flow budget constraint requires $r_t^v - \pi_t - g_t$ to change. In our analysis below, we will label $-(s_t + \rho v_t - v_{t-1})$ the change in the stance of fiscal policy.

[3]Formally, $\rho = \frac{V}{S/Y+V}$ where V, S, and Y are steady state values. We take the value of $\rho = .9999$ reflecting the fact that over our sample primary surpluses were slightly negative. This value is similar to that employed by Cochrane (2022b), Cochrane (2022b), and Cochrane (2023). Our results are robust to slightly higher or lower values of ρ. In our empirical analysis. we take s_t to be the residual in equation (4), given data on real debt-to-GDP and the real rate of return on government debt. Note also, we suppress the intercept terms in equations (4) and (5)).

Combining equation (4) and equation (5) at time t and t-1,

$$r_t^v - \pi_t - g_t = s_t + \rho v_t - v_{t-1} \tag{6}$$

$$= \mathbb{E}_{t-1}\left(r_t^v - \pi_t - g_t\right) + \Delta\mathbb{E}_t\left[\sum_{i=0}^{\infty}\rho^i s_{t+i} - \sum_{i=1}^{\infty}\rho^i\left(r_{t+i}^v - \pi_{t+i} - g_{t+i}\right)\right] \tag{7}$$

The value $s_t + \rho v_t - v_{t-1}$ is expected real rate of return on debt-to-GDP (at t-1) plus the unexpected change in present value of current and future primary surpluses from time period t-1 to t. If present value of current and future surpluses are low relative to previous period expectations, then fiscal policy has become stimulatory—π_t and g_t tend to rise and r_v tends to fall. How the individual components, r_t^v, π_t, and g_t, respond requires further information about the economy.

As pointed out by Cochrane (2023), Ch 4, the connection between fiscal policy and U.S. inflation is far from obvious from time series plots. Figure 1 displays a measure of inflation (GDP deflator), along with the log of the market value of government debt-to-GDP ratio and fiscal primary surpluses, measured as described below. Take, for example, the year 2009, when under the effects of the "subprime" mortgage crisis, both the fiscal deficit (decrease in primary surplus) and the market value of the government debt to GDP ratio increased dramatically, with no change in inflation. By contrast, during the 2021-2022 COVID pandemic, deficits and inflation rose while the market value of the government debt to GDP declined.

Formal statistics do not suggest obvious relationships between those variables either. The simple correlation between inflation and the debt-to-GDP ratio is -0.65, which suggests a negative relationship between debt-to-GDP and inflation, while the correlation between surpluses and inflation is -0.21, which points to a small positive relationship between deficits and inflation. Why do some episodes of large deficits coincide with bouts of inflation and other episodes do not? In the analytical framework proposed by the fiscal theory of the price level, deficits that are not expected to be paid back (in the form of present value of future primary surpluses) have qualitatively different effects from deficits that are expected to be repaid. That is, deficits that are not expected to be paid back will have inflationary consequences while deficits that are expected to be paid back do not.[4]

3 Smets and Wouters with active fiscal policy

To draw out the empirical implications of fiscal policy for inflation, we must first make a stand on what determines the path of current and future of future surpluses. Second, one needs to determine how a change in the stance of fiscal policy would be allocated to changes in r_t^v, π_t, and g_t. In this section, we describe a simple model that allows fiscal policy to be characterized by different deficit shocks, one that will be noninflationary and another that will be inflationary. We will abstract away from the effects of (distortionary) taxes and expenditure and focus only on primary surpluses (s_t). We allow government debt to have a maturity structure so that changes in monetary policy interest rate has an effect on the current realized nominal return of government debt (r_t^v). We use the estimated New Keynesian model of Smets and Wouters (2007) to specify the rest of the economy. The original Smets and Wouters model contains frictions such as habit formation, wage and price stickiness, time varying wage and price mark-ups, capital adjustment costs, and monetary policy inertia. The Smets and Wouters model does not allow for deficits to have an effect on the economy, and, a result, we add the government flow constraint (log-linearized) described by equation (4) above and allow for fiscal policy to be active.[5]

The original Smets and Wouters model had seven structural shocks: TFP, risk premium shock, price mark-up shock, wage mark-up shock, exogenous expenditures shock, investment specific technology shock, and monetary policy shock. We add two more structural shocks: Ricardian and non-Ricardian deficit (surplus) shocks. To the seven observables in the original Smets and Wouters model (real GDP growth, consumption growth, investment growth, log

[4]One of the main motivations of the fiscal theory of the price level is to identify the class of nonrepaid deficits that determine uniquely the price level in the context of a general nonlinear model. Given the linearization technique adopted in this paper to solve the model, it is not possible to establish the global uniqueness of the equilibrium and as such we only consider equilibrium that are locally unique.

[5]Smets and Wouters do allow for exogenous expenditures, which would include government purchases of goods and services, to affect the economy through the resource constraint. They assume that tTaxes are lump sum and fiscal policy is passive (there are only Ricardian deficit shocks).

of hours worked in the private sector, real wage growth, inflation, and interest rate), we add as observables the surplus series from the linearized flow constraint and the market value of government debt relative to nominal GDP. We describe our version of the Smets and Wouters model in detail in Appendix A.

3.1 Realized return on nominal government debt

As the flow budget constraint includes realized return on nominal government debt, we need to add to the Smets and Wouters model how the nominal return on government is determined. The maturity structure of government debt plays an important role in that determination, captured by assuming, as Cochrane (2022b), the expectations theory of the term structure so that:

$$\mathbb{E}_t r^v_{t+1} = r_t, \tag{8}$$

where r_t is the short-term policy rate set by the monetary authority. The realized (log) return on government debt is then given by:

$$r^v_t = \omega q_t - q_{t-1}, \tag{9}$$

where q_{t-1} is the log of the price of government debt in $t-1$ and ω reflects the maturity structure of government debt, with average maturity given by $\frac{1}{1-\omega}$. Combining equations (8) and (9) implies that realized returns are given by:

$$r^v_t = r_{t-1} - \Delta \mathbb{E}_t \sum_{i=0}^{\infty} \omega^i r_{t+i} \tag{10}$$

Equation (10) suggests that the realized return on debt depends on changes in expectations about future short-term interest rates. The longer maturity of the debt (higher values of ω), the more sensitive is the nominal return on government debt. In our benchmark model, we set $\omega = 0.8$, which implies an average duration of five periods. In the empirical analysis below, we take a period to be a calendar year (instead of a quarter, as in the original Smets and Wouters paper).

3.2 Active fiscal policy

The government flow constraint, while linking inflation and fiscal policy, says nothing about their causal relationship. Economic causality depends on one's view of how fiscal policy is determined.

Consider the two types of fiscal policy stances studied by Leeper (1991): active vs passive. The standard New Keynesian macro model assumes passive fiscal policy. Current and future deficits are chosen (think s_t and ρv_t) to validate monetary policy's choice of r_t^v, π_t, and g_t. This is why the government flow equation has no implication for standard New Keynesian macro model. With active fiscal policy, the path of current and future surpluses are not constrained by equation (4) and a deficit shock, to the extent that it is not offset by future surpluses, will have an effect on economic activity and unexpected inflation through the government flow equation. Another key difference between the original Smets and Wouters and the Smets and Wouters with active fiscal policy is that monetary policy is now passive, in the sense that it passively validates the unexpected inflation determined in the fiscal block of the mode (typically, the corresponding coefficient on inflation in the monetary rule is less than one).

We make the distinction between surplus shocks that have no implications for macroeconomic activity and those that do. Specifically, we consider that some surplus shocks are going to be offset by future surpluses, in such a way that they will not introduce innovations to expected discounted present value of surpluses (the right hand side of equation (5)). In the absence of such innovation, the government valuation equation is satisfied by budgeted primary surpluses, without the need to dilute or reflate the real value of the government debt with surprise inflation or deflation. Other surplus shocks may not be offset by future surpluses and, hence, change the present value of current and future surpluses. Given the resulting innovation to the present value of expected primary surpluses, the government debt cannot be redeemed in real terms at the pre-shock price level. The government debt valuation equation can then only be satisfied by a change in the price level, that is, by unexpected inflation.

By distinguishing between surplus shocks that are not expected to be entirely repaid from those that are, one can capture periods where large deficits were accompanied by an increase in the real value of the debt (as in the case of a repaid deficit shock) and other periods where large deficits are accompanied by a decrease in the real value of the debt (as might occur in the case of a non-repaid deficit shock). Also, distinguishing between these two types of deficit shocks allows deficits to have an effect on economic activity in some periods and not in others. Deficits that are expected to be repaid (for unchanged output growth and real interest rate path) imply greater future surpluses that raise the total value of debt and the net effect on the fiscal stance is negligible. Deficits that are not expected to be paid pack are not accompanied by an increase in the total value of debt and result in a fiscal stance that is expansionary (inflationary) (the right hand side of (5) falls). Whether the expansionary fiscal policy results in a decline in the nominal return on government debt and/or in an increase inflation (and a decline in real value of the debt) depends on monetary policy and the maturity structure of the debt.

Formally, in our model, actual surpluses are a combination of two components:

$$s_t = s_t^r + s_t^n \tag{11}$$

where s_t is total observed "surplus", broken into surpluses with Ricardian exogenous shocks, s_t^r, and surpluses that are non-Ricardian, s_t^n.

We assume that the surplus component with a Ricardian shock evolves according to:

$$s_t^r = \theta_\pi^r \pi_t + \theta_y^r y_t + \alpha_v v_{t-1}^r + u_t^r \tag{12}$$

where v_t^r is the present value of future surpluses that will ultimately be repaid and u^r is a shock to the fiscal rule, assumed to follow an AR(1) stochastic process. As in Cochrane (2023), we allow this surplus component to be procyclical (θ_y^r) and for surpluses to respond to inflation (θ^r_π).

As demonstrated in Appendix B, the presence of the term $\alpha_v v^r_{t-1}$ ensures that the Ricardian shock element of the rule s^r_t will not bring about any innovations to the expected present value of budgeted primary surpluses and will not have, therefore, inflationary consequences. The value of repaid debt is given by

$$v^r_{t-1} = \rho v^r_t + s^r_t \tag{13}$$

This equation, along with equation (12), ensures that a shock to s^r_t will result in the accumulated value of future surpluses ρv^r_t to change. Together, these two equations imply, as shown also in Appendix B, that the surplus process s^r_t is unexpected-inflation neutral, or unexpected-inflation Ricardian, in the sense that s^r_t, in and by itself, doesn't add or subtract to the unexpected inflation originating from other sources.[6]

We assume that the non-Ricardian component of the surplus evolves according to:

$$s^n_t = \theta_m s^n_{t-1} + \theta^n_\pi \pi_t + \theta^n_y y_t + u^n_t \tag{15}$$

where u^n_t is an exogenous AR(1) stochastic process. In our benchmark model, we assume that $\theta^n_\pi = 0$ and $\theta^n_x = 0$, so that one can think of s^n_t as a strictly exogenous surplus process.

[6]To avoid semantic misunderstandings, by the criterion adopted by Cochrane (2023), Ch. 4, this surplus component completely offsets changes to the expected present value of the surpluses originated in the Ricardian shock, but not in the other structural shocks of the model. Adapted to the notation of this paper, the condition for surpluses to fully repay the debt according to Cochrane is:

$$0 = -\alpha_{s^r}(\rho) - \alpha_g(\rho) + \alpha_r(\rho), \tag{14}$$

where the first term on the right-hand side of the expression, $\alpha_{s^r}(\rho)$, is a polynomial that summarizes the innovation to the present value of s^r induced by some of the structural shocks in the model, making abstraction of the impact that the shock under consideration may have had on the real discount factor and output growth, captured by the other two other two polynomials, $\alpha_g(\rho)$ and $\alpha_r(\rho)$. In Cochrane's words, *"The term $\alpha_r(\rho)$ expresses the important idea that a government that repays its debts must also raise surpluses when there is a rise in the interest costs of its debt."*

By construction, the debt repayment condition, as stated by Cochrane, is satisfied in the present paper only by the Ricardian shock to s^r. For all the other structural shocks in the model, equation (13) implies only that $\alpha_{s^r}(\rho) = 0$. Unexpected inflation is introduced then in the model through the channel $0 \neq \alpha_r(\rho) - \alpha_g(\rho)$. It follows that the surplus s^r can be interpreted as ex-post Ricardian, in the sense that $\alpha_{s^r}(\rho) = 0$ holds after the current surplus has incorporated the response to the unexpected inflation originated in the non-zero innovation $\alpha_r(\rho) - \alpha_g(\rho)$ to the expected present value of budgeted primary surpluses.

3.3 Passive monetary policy

The form of the monetary policy rule governing the path of the nominal interest rates was kept unchanged with respect to that assumed by Smets and Wouters. Where the analysis in this paper departs from theirs is in that the value of θ_π is set to that needed to render monetary policy passive. It turns out that in Leeper (1991) and Cochrane (2023), $\theta_\pi > 1$ in the presence of an active fiscal policy results in an explosive model solution. This required us to modify the priors for the monetary policy parameters assumed by Smets and Wouters.[7] In practice this means that we imposed conditions on the parameters so that Blanchard and Kahn (1980) conditions for a locally unique, stable solution holds when fiscal policy is active.

3.4 Data

Because surpluses and market value of government debt exhibit very strong seasonal patterns, rather than using quarterly data we estimate the model using annual data from 1959 to 2022. Real GDP and the implicit GDP deflator are from the Bureau of Economic Analysis. When estimating the model, we use GDP less Federal government expenditures as our output variable. This helps lessen the possible correlation between the surplus series and total GDP due to inclusion of Federal government expenditures as a component of GDP. Also, by using private GDP, we can use the original Smets and Wouters framework without having to model explicitly government expenditures, transfers, and tax receipts individually.[8]

Like the original Smets and Wouters model, we allow for exogenous expenditures to enter into the resource constraint. For the short term interest rate, r_t, we use the three month Treasury Bill rate. The nominal market value of US government debt is updated to 2022

[7] As repeatedly pointed out by Sims (1994, 2011), Leeper and Cochrane implicitly rule out the resulting hyperinflation as an equilibrium outcome, an assumption not necessarily warranted by the evidence that economies manage to produce output even with virtually zero real money balances during hyperinflationary periods.

[8] We considered breaking up surpluses into taxes net of transfers and government purchases of goods and services. Government purchases would enter into the economy wide resource constraint, while taxes net of transfers and government purchases would enter the surplus series. We decided to write the model in terms of surpluses to keep the analysis as close as possible to the original Smets and Wouters model and to focus on a simple version of active fiscal policy rule, rather than introduce distortionary taxes, expenditures, and transfers into the model.

from the data in Hall and Sargent (2022). The nominal market value of US debt includes Federal government debt in private hands plus Federal Reserve liabilities such as reserves and, more recently, reverse repurchase agreements less the private assets held by the Federal Reserve. The nominal return on government debt, R_t^v through 2022, is also from Hall and Sargent and adjusted for Fed interest payments on reserves. Given the nominal value and the gross rate of return on government debt as well as inflation and output growth, the surplus series is just the residual in logs calculated from the fiscal flow constraint, equation (4).

4 Empirical results

4.1 Posterior distribution of parameters

We estimate this simple model using Bayesian methods, with algorithms available from Dynare 5.3. As our data is annual and spans a slightly different time period from that in Smets and Wouters, our prior and posterior distribution are slightly different from theirs too. That notwithstanding, for the most part our annual version of Smets and Wouters yields parameter estimates similar to those in the original Smets and Wouters paper.

The exception, of course, is the inflation parameter in the monetary rule which was restricted to be passive in order for the standard Blanchard and Kahn conditions hold. This parameter has a posterior mean of 0.864 and a [10%, 90%] interval of [0.784, 0.933]. This suggests that monetary policy, while passive, still responds fairly aggressively to inflation.

Table 1 displays the parameters for the fiscal rules of the benchmark model. As expected, constant discount rate Ricardian surpluses respond positively to existing levels of debt (parameter α) and to real GDP (θ_y^r). The standard deviation of the Ricardian surpluse shocks are a factor of ten greater than standard deviation of shocks to non-Ricardian shocks which suggests that the bulk of the fluctuations in surpluses are due to fluctuations in Ricardian surpluses. As a result, fiscal surpluses will look Ricardian most of the time and the relationship between surpluses (deficits) and government debt will be negative (positive).

4.2 Impulse response analysis

Figure 2 displays the impulse responses implied by the active fiscal policy version of Smets and Wouters for a non-Ricardian deficit shock. A non-Ricardian deficit shock has quantitatively important positive effects on output growth (and other measures of economic activity not shown) in the initial period, but this effect dies out quickly (it is virtually zero by year three). A non-Ricardian deficit shock has a small negative, but noisy, effect on real wage growth on impact, offset by an increase in real wage growth in subsequent years. A non-Ricardian deficit shock has persistent positive effects on inflation, which peaks several years after the initial shock. Taken together these responses have the hallmark of a traditional aggregate demand shock whose dynamic effects on inflation are very persistent. Nominal interest rates rise in response to these non-fully repaid deficit shocks. This reflects the relatively high weight that inflation receives in the estimated monetary policy rule.

Turning to the fiscal variables, a non-Ricardian deficit shock results in a sharp but temporary increase (expansionary) in the "stance of fiscal policy". Recall that a change in the stance of fiscal policy as broken up into changes in π_t, g_t, and r_t^v, respectively. In the baseline model, a non-Ricardian deficit shock has large negative effects on the nominal return on government debt initially, followed in subsequent periods by an increase in the return on government debt (through increased interest rates). The increase in short-term rates combined with a relatively long maturity structure of the debt result in a large capital loss for government bond holders on impact in the face of a deficit shock. The effect is so large that an increase in the stance of fiscal policy results results largely in a decline in the return on government debt rather than an increase in inflation. The response of the real return on government debt is negative across all time horizons, not just on impact, as the increase in inflation overshadows the increase in nominal interest rates after horizon one.

A non-Ricardian deficit shock lowers the debt-to-GDP ratio. The present value of surpluses as a whole falls as a result of a non-Ricardian deficit shock, and, hence, the debt-to-GDP ratio falls accordingly. This implies in the face of a non-Ricardian deficit shock, the negative effect on the real value of existing government debt more than offsets the increase in the par value of new debt that is raised to finance the deficit. The total effect on the sum of future non-Ricardian surpluses $\mathbb{E}_t \sum_{i=0}^{\infty} \rho^i s^n_{t+i}$ is negative, given the negative surplus shock and the relative persistence of non-Ricardian surplus shocks. The response of total surpluses is mixed; while non-Ricardian surpluses fall, the constant discount rate Ricardian surpluses s^r rise, as they initially respond positively to the increase in output.

In contrast, the Ricardian shock to the s^r component of the surplus has no effect on non-fiscal economic variables (see Figure 3). This is true of the original Smets and Wouters model as well with surpluses/deficits hadving no separate effect after conditioning on government expenditures. While Ricardian deficit shocks lower the current surplus, they raise future surpluses. Thus, surpluses display the "S shaped" response that Cochrane (2022b) found in his examination of empirical surpluses. Indeed, by construction, the increases in future surpluses raise the market value of government debt so that $s_t + \rho v_t - v_{t-1}$, i.e. the stance of fiscal policy, is unchanged.

Figures 4 and 5 display the response of selected variables to price markup and wage markup shocks, respectively. With the exception of the response of real wage growth, price markup and wage markup shocks have similar impact on real GDP growth and inflation as well as on interest rates and the fiscal variables. Both price and wage markup shocks result in a decline in real GDP growth and increase in inflation. In contrast to non-Ricardian fiscal shocks, the inflation response is relatively short-lived and, in fact, becomes slightly negative after about three years. Price and wage markup shocks result in increases in interest rates and have a positive (expansionary) but short-lived effect on the fiscal stance. Price and wage markup shocks by construction have no effect on current and future non-Ricardian surpluses (hence, the response of $\mathbb{E}_t \sum_{i=0}^{\infty} \rho^i s^n_{t+i}$ is unchanged). Initially, the debt-to-GDP ratio is virtually unchanged suggesting the present value of surpluses is largely unaffected; the constant discount rate Ricardian surpluses fall initially and then rise in subsequent years.

Figure 6 displays the responses to a monetary policy shock. A monetary policy shock that raises the short-term interest rate has a contractionary effect on real economic activity; output and real wage growth declines. Keeping non-Ricardian surpluses unchanged, a contractionary monetary policy shock has virtually no effect on inflation on impact (similar to the neutral monetary policy shock in Cochrane (2023)) but becomes positive over time as the Fisher effect of increasing nominal rates and increasing inflation expectations kicks in at longer horizons. Debt-to-GDP falls initially as the nominal return on debt falls (due to the rise in short term interest rates); the increase in interest rates lowers the present value of future surpluses on impact. In the subsequent periods, the debt-to-GDP ratio rises as the constant discount rate Ricardian surpluses s^r turn positive.

4.3 Sensitivity analysis of response to non-Ricardian shocks

To help understand the role that various parameters play in determining the baseline model's dynamics, we calculate the impulse responses for the case where we alter key parameters from their benchmark values. Figure (7) displays the response to non-Ricardian shocks for various specifications. The benchmark response (evaluated at the posterior mode) is in black. When monetary policy reaction to inflation is small (.1 vs the .9 that was estimated), the inflationary effect of non-Ricardian deficit shocks, while on impact is similar to the benchmark model, but much less persistent (blue vs black lines). Interestingly, the effect on output is greater when the monetary rule has a low inflation weight.

When the duration of government debt is short (1.25 years versus 5 years in the benchmark model), non-Ricardian deficit shocks have much larger effects on inflation. On the other hand, the effect on the Fiscal stance on impact is quite similar across the four alternative specifications. With short duration debt, the effect on the nominal value of the debt is relatively small which requires a larger inflation and real GDP growth adjustments. With longer duration government debt, much of the impact of deficit shock is felt in a decrease in the nominal value of the debt rather than an increase in nominal GDP growth. Finally, we examine the effect of the persistence of a non-Ricardian shock given the shock that has the same cumulative effect on primary surpluses over time (in green). The persistence of a non-Ricardian deficit shock in and of itself has no effect on the macro variables and the fiscal stance; all that really matters is the cumulative effect on surpluses over time, $\mathbb{E}_t \sum_{i=0}^{\infty} \rho^i s_{t+i}^n$. However, the persistence of non-Ricardian shock does have implications for observable surpluses and debt-to-GDP, suggesting that these two observation variables have important roles in estimating the stochastic process for non-Ricardian deficits.

5 The fiscal contribution to economic fluctuations

In this section, we consider the contribution of fiscal (surplus) shocks to fluctuations in economic activity.

5.1 Variance decompositions

Table 2 displays one period (year) forecast variance decomposition (Panel A) and the unconditional variance decomposition (Panel B) for the benchmark model with active fiscal policy. For real GDP growth, the variance decompositions across the horizons are very similar (due to the fact that GDP growth is not persistent); the most important contributor to GDP growth variance is the risk premium shock. Non-Ricardian deficit shocks contribute little to the forecast variance of real GDP growth. This is true for other real variables in the model not listed in Table 2, such as consumption, investment growth, hours, and real wage growth. Ricardian deficit shocks by construction have no effect on the macro bloc variables.

Non-Ricardian deficit shocks are a more important contributor to inflation forecast variance, contributing to around 25% of the one-step-ahead forecast variance and close to 64% of the unconditional inflation variance. The persistent effect on inflation of shocks to non-Ricardian deficits, evident in the impulse response analysis, explains why non-Ricardian deficit shocks are such an important contributor to the unconditional variance of inflation. Price and wage markup shocks are also important contributors to the inflation forecast variance, particularly at one year forecast horizon, but their relevance diminishes as the forecast horizon increases.

Non-Ricardian deficit shocks are also an important contributor to the return on government debt, as well as to the stance of fiscal policy. On the other hand, non-Ricardian deficit shocks contribute only a small fraction to the forecast variance of surpluses themselves; the vast majority of fluctuations in surpluses are the result of Ricardian deficit shocks. This suggests that deficit surprises are largely Ricardian. Finally, non-Ricardian deficit shocks and risk premium shocks are two of the most important contributors to fluctuations in debt-to-GDP ratios, particularly at longer horizons. This suggests that while non-Ricardian deficit shocks are only a small contributor to overall surpluses, they have an important contribution to fluctuations in the debt-to-GDP ratio by affecting the market value of that debt.

5.2 One step ahead historical decompositions

One of the advantages of breaking up deficit shocks into Ricardian and non-Ricardian is that this allows deficits to have different effects across time depending on whether they are expected to be repaid or not. To determine the relative contribution of non-Ricardian deficit shocks to historical fluctuations in inflation, we examine the historical decomposition of one-step ahead forecast error for inflation.

Figure 8, panel(a), displays the historical decomposition of one-step-ahead forecast error for inflation in our benchmark model. We mark a few of the key dates to help the reader keep track of the time periods. Non-Ricardian deficit shocks appear to be an important contributor to several episodes of changes in inflation. For example, non-Ricardian surplus shocks contribute to surprise inflation in the early 1970s (in particular, in 1971 and 1975 and a lesser extent in 1977) along with price and wage markup shocks. Positive non-Ricardian surplus shocks in 1981, 1982 and again in 1984, 1985 were important negative contributors to one-step-ahead surprise inflation during the disinflation of the early 1980s. In 1995, the model generates a large non-Ricardian surplus shock that contributed to the disinflation in the 1990s. Interesting, non-Ricardian surplus shocks are not important contributors during the Financial crisis and only modestly contributed to one-step-ahead inflation surprises in the 2020-22 period.

Panel (b) of Figure 8 displays the implied stance of fiscal policy, $-(s_t + \rho v_t - v_{t-1})$. Higher values of this variable imply a more stimulative fiscal policy. The solid line in Panel (b), Figure 8 suggests that the stance of fiscal policy was on average expansionary starting in the late 1960s through the late 1970s, with big non-Ricardian deficit shocks in 1971 and 1975 helping to contribute the expansionary fiscal stance. Starting in the early 1980s through 2010, the fiscal stance was more contractionary than earlier in the sample. Non-Ricardian shocks were important contributors to this more contractionary stance in the 1980s and again the the mid-1990s. While the fiscal stance fell dramatically in 2020 largely due to the contribution of a risk premium shock (which affects the present value of future surpluses), the fiscal stance increases (become more expansionary) dramatically in 2021 and 2022.

As suggested above, changes in fiscal stance have implications not only for inflation but for real GDP growth and the nominal return on debt (recall, $\pi_t + g_t - r_t^v = -(s_t + \rho v_t - v_{t-1})$). Figure (9) Panel (a) displays the one-step-ahead historical decomposition of output growth. Here, shocks to the risk premium play a much more important role in contributing to output fluctuations than do fiscal shocks. Investment shocks are also an important contributor to output growth fluctuations. Panel (b) displays the nominal return on government debt. Here non-Ricardian fiscal shocks are an important contributor to fluctuations in nominal returns. In fact, non-Ricardian fiscal shocks have a greater effect on nominal returns than on inflation and output growth, suggesting that shocks to the present value of surpluses are reflected more in changes in the relative price of government debt rather than in the aggregate price level. In our model, the reason is that future short term rates are expected to rise in response to an expansionary fiscal shock which results in a decline in the value of long-term debt.

5.3 Historical decompositions of specific periods

Here we examine the forecast error decomposition starting at a particular date and then moving forward in time. The one-step-ahead forecast decompositions discussed in the previous section informed our selection of the dates.

5.3.1 The inflation of the 1970s and disinflation of the 1980s.

Figure 10 panel (a) displays historical decomposition of inflation, starting in 1970. The baseline model, based on information through 1970, forecasts relatively constant inflation going forward. Actual inflation rose in the 1970s relative to what was expected. The model suggests that expansionary fiscal shocks in the early 1970s contributed substantially to the increase in inflation (particularly in 1974 ad 1975). This suggests a substantial fiscal contribution to the inflation of the 1970s. Wage markup and price markup shocks also contributed to the higher inflation while TFP shocks mitigated the surprise increase in inflation. Recall, the one-step-ahead forecast error decompositions in Figure 8 suggested a large inflationary fiscal shock in 1971 and again in 1975. Figure 10 suggests that impact of these fiscal shocks builds over time. This interpretation of the historical decomposition is consistent with the narrative analysis of Cochrane (2022a), Cochrane (2024) and Sims (2024). Similarly, fiscal deficit shocks also contributed substantially to the disinflation of the early 1980s. Starting in 1980, the model predicted a slow increase in inflation over the next six years, yet actual inflation fell substantially starting in 1982 and through 1986. Contractionary fiscal shocks and to a lesser extent wage markup shocks are attributed to be the source of the surprise disinflation of the 1980s.

5.3.2 The disinflation of the 1990s

As of 1994, the model forecasts a steady increase in inflation through the second half of the 1990s (see Figure 11, panel (a)). However, actual inflation did not increase. The model attributes the failure of inflation to burst out over this time period largely to contractionary non-Ricardian fiscal shocks. Recall from Figure 8 above, the model suggests a large contractionary non-Ricardian surplus shock to inflation in 1995 (and lesser contractionary shocks in 1997 and 1999). The model suggests that these shocks altered the trajectory of inflation. One interpretation of this shock is that it reflects the fiscal aftermath of the 1994 mid-term elections in which the Republican party took control of the House of Representatives for the first time in over 40 years. The contractionary fiscal shocks implied by the model suggest an increase in future primary surpluses. Indeed, the 1996 welfare reform and the primary surpluses of the late 1990s seemed to validate those expectations.

5.3.3 The great recession of 2007-09

Despite the dramatic increase in fiscal deficits in 2009, the model implies that the fiscal impact on inflation was relatively small over the period 2008-12 (Figure 11, panel (b)). The large deficit in 2009 is attributed to mostly Ricardian surplus shocks that have no affect on inflation and the non-Ricardian deficits shocks in 2009-2010 were reversed in 2011. The offsetting non-Ricardian surplus shocks implied by the model might reflect the actual sequester debate and the "Tea Party" reaction to large deficits in 2008-09. Note also, debt-to-GDP increased dramatically in 2008 and 2009, characteristic of shocks to deficits that are Ricardian.

5.3.4 Covid pandemic: 2020-2022

From the perspective of 2019, the increase in inflation in 2021 and 2022 was a surprise; largely due initially to wage markup shocks but with a growing fiscal and price markup shock contributions (see figure 12). Disruptions to the labor market and the supply chain (as reflected in the model as wage and price markup shocks) during the Covid pandemic played a more important role than did fiscal shocks. The largest single contributor to surprise inflation in 2020-2021 was Smets and Wouters wage markup shocks. This is consistent with the notion that wage markup shocks reflecting disruptions in the labor market due to Covid shutdowns and price markup shocks reflecting supply chain disuptions (see Comin et al. (2023)). Even so, the effect of expansionary deficit shocks over this period contributed to the building inflation pressure in 2021-22, so that by 2022 nearly a quarter of the surprise inflation was due to fiscal shocks.

5.4 Inflation and non-Ricardian surpluses

Figure 13 overlays actual inflation with the cumulative non-Ricardian surpluses over the sample. We define cumulative non-Ricardian surpluses as:

$$\mathbb{E}_t \sum_{i=0}^{\infty} \rho^i s_{t+i}^n. \tag{16}$$

This is the direct contribution of non-Ricardian surpluses to the present value of current and future surpluses (keeping discount rates and output growth unchanged). Unlike the actual market value of government debt, which reflects the present value of both Ricardian and non-Ricardian surpluses, the cumulative contribution to non-Ricardian surpluses (for the benchmark model) shows a clear negative relationship between inflation and cumulative non-Ricardian surpluses.

Note that other shocks matter as well through their effect on discount rates which in turn affect the present value of discounted surpluses. Using the linearized, present value equation (3) above, we can decompose inflation into contribution of changes in expectations about future surpluses, future discount rates, and future output growth:

$$\Delta \mathbb{E}_t \pi_t = \Delta \mathbb{E}_t r_t^v - \Delta \mathbb{E}_t \sum_{i=0}^{\infty} \rho^i \left(s_{t+i}^n + g_{t+i} - \rho (r_{t+i+1}^v - \pi_{t+i+1} \right) \tag{17}$$

Figure 14 displays the contribution of surpluses, output growth, and discount rates ($\mathbb{E}_t \sum_{i=0}^{\infty} \rho^i (r_{t+i+1}^v - \pi_{t+i+1}$) to surprise inflation. Here we see that surpluses and discount rates often have large offsetting effects on inflation. Recall that the impulse response analysis suggesting that an exogenous, a negative non-Ricardian surplus shock lowers the expected future real return on debt which raises the present value of future surpluses and mitigates the inflationary consequences of the negative surplus shocks.

6 Robustness

In this section, we examine how sensitive the results are to changes in the specification of the model and the data used to estimate the model.

6.1 Feedback to non-Ricardian surpluses

Here, we allow economic activity (inflation and output) to affect non-Ricardian surpluses. Essentially, we re-estimate the model but allow the parameters θ_π^n and θ_x^n to be non-zero. It turns out that this specification does not change the main thrust of the benchmark model results. The variance and historical decompositions are quite similar to those in the benchmark model with the direct contribution of non-Ricardian fiscal shocks being slightly smaller. Figure 15 displays the one-step-ahead inflation decomposition and the decomposition of inflation starting in 2019 allowing for feedback to non-Ricardian surpluses. Allowing for feedback results in only small differences from the benchmark model.

6.2 Model with hand-to-mouth consumers

Here we modify the Smets and Wuters model to allow for credit constrained households who end up spending all their labor income and do not participate in credit markets. This results in "Ricardian" or repaid surpluses having non-neutral effects on economic activity.[9] Figure 16 displays the one-step-ahead historical decomposition and decomposition starting in 2019 for the model with hand-to-mouth consumers. Again, modifying the model in this way does not substantially change the decompositions relative to the benchmark model.

6.3 Model estimated using sample up to 2008

We estimate the baseline model using sample up to 2008 to avoid the zero lower bound period. We then take the estimated model and apply it to both the in-sample and out-of-sample data. Figure 16 contains the full sample one-step-ahead historical decomposition as well as the out-of-sample decomposition starting in 2019. As once can see, the figure implies much the same decomposition as the baseline model estimated with the entire sample.

[9] Specifically, we set aggregate consumption to be an weighted average of standard intertemporal households and hand-to-mouth households whose consumption is a function of surplus. In logarithms, aggegate consumption is: $c_t^{agg} = c_t - \theta_{htm} s_t$. This implies that both Ricardian and non-Ricardian surpluses affect hand-to-mouth consumers. We estimate the parameter θ_{htm} when estimating the entire model.

6.4 Alternative measure of primary surpluses

In our empirical analysis of the benchmark model, we took the surplus series to be the residual from observations on the government flow equation:

$$s_t^{obs} = v_{t-1}^{obs} + r_t^{v,obs} - (g^{obs} + \pi_t^{obs}) - \rho v_t^{obs} \tag{18}$$

where v_t^{obs} is observable debt-to-GDP ratio, $r_t^{v,obs}$ is the observed log of gross nominal return on government debt, with g^{obs} and π_t^{obs} the log of the gross growth rate of real GDP and GDP deflator, respectively. This implies that the variables in our benchmark empirical model impose the government flow equation in the estimation.[10]

Rather than take s_t^{obs} to be the residual in the government flow equation, alternatively we take observations for surpluses directly from observed federal primary surpluses. Specifically, we set

$$s_t^{obs} = log\left(\frac{(Tax_t^{obs} - Exp_t^{obs}) + V_t^{obs}}{P_t^{obs} Y_t^{obs}}\right) - \rho v_t^{obs} \tag{19}$$

where $Tax_t^{obs} - Exp_t^{obs}$ is the nominal primary surplus[11], V_t^{obs} is the nominal value of government debt while v_t^{obs} is the log of debt-to-GDP ratio. Figure 17 displays the values for s_t^{obs} for benchmark model as well as for the model where we use actual primary surpluses. For the most part, the two measures of surpluses overlap with the surplus based on actual primary surplus data showing slightly smaller fluctuations than the benchmark surplus measure.

Many of the previous results for the benchmark model hold up when using actual primary surpluses as an observable variable. The posterior distributions of the estimated parameters are similar and the implied forecast error variance decompositions are similar as well. Figure 18 displays the-one-step-ahead historical decomposition for inflation. As with benchmark model, many of the same episodes where shocks to non-Ricardian surpluses contribute to surprise inflation are present when actual primary surpluses are used in the analysis. In fact, the Figure 18 suggests a slightly larger role for fiscal shocks than that implied by the

[10]When estimating the model, we include s_t^{obs} but drop $r_t^{v,obs}$ from estimation. Adding $r_t^{v.obs}$ to the estimated model results in a stochastic singularity in estimation.

[11]We use Current Receipts and Current Expenditures net of interest payments from NIPA as they are available on a calendar year basis.

benchmark model. Panel (b) of Figure 18 shows the contributions to surprise inflation over the period 2020-2022 (based on information up through 2019). Here the contribution of fiscal shocks to inflation is larger than in the benchmark model, with non-Ricardian surplus shocks contributing to roughly half the surprise inflation in 2022.

7 Active versus passive fiscal policy

For comparison, we also examine the original Smets and Wouters model that assumes passive fiscal policy and active monetary policy. With passive fiscal policy the government flow constraint (4) still holds, but surpluses adjust so that changes in the expectations of current and future values of π_t, g_t, or r_t^v have implications for the present value of surpluses, as fiscal policy validates those macro effects. Specifically, current and future non-Ricardian surpluses satisfies

$$\Delta\mathbb{E}_t \sum_{i=0}^{\infty} \rho^i s_{t+i}^n = \Delta\mathbb{E}_t \left[\sum_{i=0}^{\infty} \rho^i \left(r_{t+i}^v - \pi_{t+i} - g_{t+i} \right) \right] \tag{20}$$

where the right hand side of equation (20) can be derived from the original Smets and Wouters model. We use the same seven observable variables as the original Smets and Wouters, but we use annual data to estimate and evaluate the model in order make the passive fiscal policy version comparable to the active fiscal policy model discussed above. The passive fiscal policy assumption means that we need not include observation equations on surpluses and debt-to-GDP when estimating the macro-block of Smets and Wouters. However, we do include the observation equation on the surpluses (s_t), so that we can evaluate the implications of the model for observed fiscal policy variable. Again, observed surpluses are the sum of Ricardian and non-Ricardian (see equation (11)) with Ricardian surpluses given by equation (12) and non-Ricardian surpluses given by:

$$s_t^n = \theta_m s_{t-1}^n + (1 - \rho\theta_m)\Delta\mathbb{E}_t \left[\sum_{i=0}^{\infty} \rho^i \left(r_{t+i}^v - \pi_{t+i} - g_{t+i} \right) \right]. \tag{21}$$

Equation (21 reflects the fact that with passive fiscal policy, non-Ricardian surpluses must adjust passively to validate the policy choices of the monetary authority.

Figure 19 displays the response to a monetary shock for the passive fiscal policy specification. Here a monetary policy shock triggers a decline in output that is qualitatively and quantitatively similar to that in the active fiscal policy model. In contrast to the active fiscal policy model, the inflation response to a monetary policy shock in the passive fiscal policy model is negative. The difference lies with the response of non-Ricardian surpluses which must adjust so that equation (20) holds. Here a monetary policy shock brings with it a fiscal contraction: the stance of fiscal policy becomes contractionary as the accumulated response of non-Ricardian surpluses ($\mathbb{E}_t \sum_{i=0}^{\infty} \rho^i s_{t+i}^n$) is positive.[12] For the benchmark model with purely exogenous non-Ricardian surpluses, a monetary shock had no effect on non-Ricardian surpluses and essentially no impact on inflation on impact. Here passive fiscal policy implies a contractionary fiscal response to a monetary shock and this fiscal contraction results in a decrease in inflation as well as a decrease in real economic activity.

Figure 20 displays the one period ahead historical decomposition for inflation from the passive fiscal policy model. Like the original Smets and Wouters model, most of the one-period-ahead inflation surprises are attributed to shock price and wage markup shocks. These markup shocks explain the vast majority of the one-step-ahead inflation innovations. Looking at specific episodes, the increase in inflation in the mid-1970s was a surprise (from the vantage point of 1970). The surprise inflation in 1974 and 1975 were due to the effects of wage and price markup shocks (see Figure 21). On the other hand, the disinflation of the 1980s was, according to the model, predictable in 1980, hence the contribution of various shocks to the disinflation is minimal.[13] Based on Figure 22, the lower than expected (as of 1994) inflation of the 1990s are attributable to largely disinflationary price markup shocks During the financial crisis of 2008-09, disinflationary risk premium and wage markup shocks offset inflationary price markup shocks so that actual inflation was lower than expected (as of 2007). Finally, the outburst of surprise inflation in 2021-22 according to the passive fiscal policy model was due to wage and price markups (see Figure 23). Interestingly, according to Figure 23 panel (b), the model implies a large decline in non-Ricardian surpluses in 2021 and

[12] Contrast this with actual surpluses which fall (after initially rising) due to the counter cyclical behavior of Ricardian surpluses.

[13] This feature of the Smets and Wouters' model seems quite implausible to us.

2022 that is largely attributed risk premium shocks. Recall that in the passive fiscal policy model, non-Ricardian surpluses adjust to validate the outcomes driven by active monetary policy. Thus, while the source of the increased inflation in 2021-2022 in the passive fiscal policy version of Smets and Wouter are markup shocks, there is still an expansionary fiscal policy response that, in part, validates the increased inflation.

8 Conclusion

The outburst of U.S. inflation toward the end of the COVID-19 pandemic and subsequent months has prompted the speculation that it could be traced to the historically large fiscal deficits. On the other hand, labor markets and supply chains were also severely disrupted during the pandemic. The contribution of fiscal policy to the post-pandemic inflation surge cannot be rigorously assessed, therefore, without accounting for other shocks that could effect inflationary outcomes.

The goal of this paper is to provide such an assessment, disciplined with the requirement that the findings have to be consistent with the U.S. experience for the entire period 1960-2022, as inspected through the lens of some existing model widely accepted as providing a good description of the role that a large variety of shocks have played in the U.S. economy over that period of time.

The often-cited model studied by Smets and Wouters (2007) seemed particularly well equipped for the task except that, in its original formulation, it assumes an active monetary policy-passive fiscal policy regime which denies any direct responsibility for inflation to fiscal policy. In fact, fiscal debt policy shocks are left out of that model's analysis, as they are implicitly assumed to be "Ricardian", in the usual sense that they have no consequence for real allocations and inflation.

For the purpose of this paper, the Smets and Wouters's model is augmented, therefore, with a fiscal block that overcomes that limitation. In the alternative passive monetary policy-active fiscal policy configuration of the model, shocks to contemporaneous Federal budget primary surpluses orthogonal to all the other shocks in the original Smets and Wouters's model cease to be Ricardian, because they are not undone by futures ones that would make it possible to still satisfy the government debt valuation equilibrium condition at an unchanged price level. As a result, shocks to government primary surpluses can become an independent source of unanticipated inflation or deflation.

The estimation of the model with Bayesian techniques suggests that such "non-Ricardian" fiscal policy shocks contributed to roughly one-third of the 2021-2022 post-Covid increase in inflation. The other two-thirds are mostly accounted for by the wage and mark-up shocks also present in the original Smets and Wouters model. These results contrast with those reported by Bianchi et al. (2023), whose estimation of their own alternative model attributes the bulk of the inflation surge in the aftermath of the pandemic to the non-Ricardian ("unfunded" in their terminology) component of fiscal policy, and very little to the other shocks they considered, including mark-up shocks.

Thus, while the augmented Smets-Wouters model studied in this paper attributes the high post-pandemic inflation largely to the lingering effects of the disruptions to supply chains and labor markets brought about by the pandemic, the Bianchi-Faccini-Melosi model traces it to fiscal profligacy. The different policy implications of these two distinct accounts of the ultimate causes of the post-pandemic inflation are too important to be ignored and should be the subject of further investigation. Research in progress by these authors is seeking to establish which features of the modified Smets-Wouters model and those of the Bianchi-Faccini-Melosi model are responsible for their rather different findings.

In any case, in line with the findings in Bianchi et al. (2023), the present paper attributes to fiscal policy a significant role in the inflationary outcomes observed during the 1970s and 1980s, when its contribution to the observed rise and fall of inflation was roughly 50%.

Finally, from a more historical perspective, according to the present paper, non-Ricardian fiscal shocks have been a non-negligible source of U.S. inflation, accounting for 25% of the one-year-ahead inflation forecast error variance and for 64% of the unconditional variance in inflation over the period 1960-2022.

Table 1: Prior and posterior distributions of fiscal parameters in benchmark model

		prior		posterior		
parameter	dist.	mean	st. dev.	mean	10%	90%
α_v	beta	0.400	0.200	0.292	0.215	0.367
θ_y^r	normal	1.000	1.000	1.076	0.783	1.362
θ_π^r	normal	0.000	1.000	-0.227	-0.767	0.340
θ_m^n	normal	0.000	0.500	0.926	0.898	0.949
AR(1) for u^r	beta	0.300	0.150	0.537	0.363	0.711
AR(1) for u^n	beta	0.300	0.150	0.205	0.076	0.357
sd for u^r	inv gamma	0.010	2.000	0.040	0.035	0.046
sd for u^n	inv gamma	0.010	2.000	0.004	0.003	0.005

Table 2: **Variance Decompositions: Active Fiscal Policy**

Panel A: One-step-ahead forecast variance

	shock:								
Variable	TFP (1)	risk premium (2)	exog exp. (3)	invest prod. (4)	monetary policy (5)	price markup (6)	wage markup (7)	Ricardian deficits (8)	non-Ricard. deficits (9)
GDP growth	3.20	56.84	7.88	18.07	5.30	2.18	0.54	0.00	5.99
Inflation	15.05	3.25	0.58	0.05	0.05	32.03	24.27	0.00	24.73
return on debt	7.92	7.15	1.17	0.04	14.78	0.09	0.06	0.00	68.78
debt-to-GDP	1.24	33.28	4.85	5.43	0.61	0.26	0.18	19.85	34.30
surplus	1.82	16.41	2.21	5.50	1.58	1.97	0.96	68.98	0.58
fiscal stance	4.93	24.46	3.69	2.20	3.52	0.28	0.73	0.00	60.20

Panel B: Unconditional variance decomposition

	shock:								
Variable	TFP (1)	risk premium (2)	exog exp. (3)	invest prod. (4)	monetary policy (5)	price markup (6)	wage markup (7)	Ricardian deficits (8)	non-Ricard. deficits (9)
GDP growth	3.63	51.11	6.58	16.07	5.76	4.74	5.34	0.00	6.77
Inflation	3.80	0.67	0.29	0.41	2.24	7.17	21.62	0.00	63.81
return on debt	4.42	2.79	0.51	0.35	6.37	4.82	16.29	0.00	64.45
debt-to-GDP	4.59	12.15	2.52	2.25	1.85	5.03	12.77	9.17	49.67
surplus	4.42	18.23	1.95	6.26	3.03	5.60	7.71	47.86	4.94
fiscal stance	4.68	25.20	3.48	3.01	6.19	0.65	1.25	0.00	55.54

Figure 1: Inflation, linearized surplus, and log debt to GDP

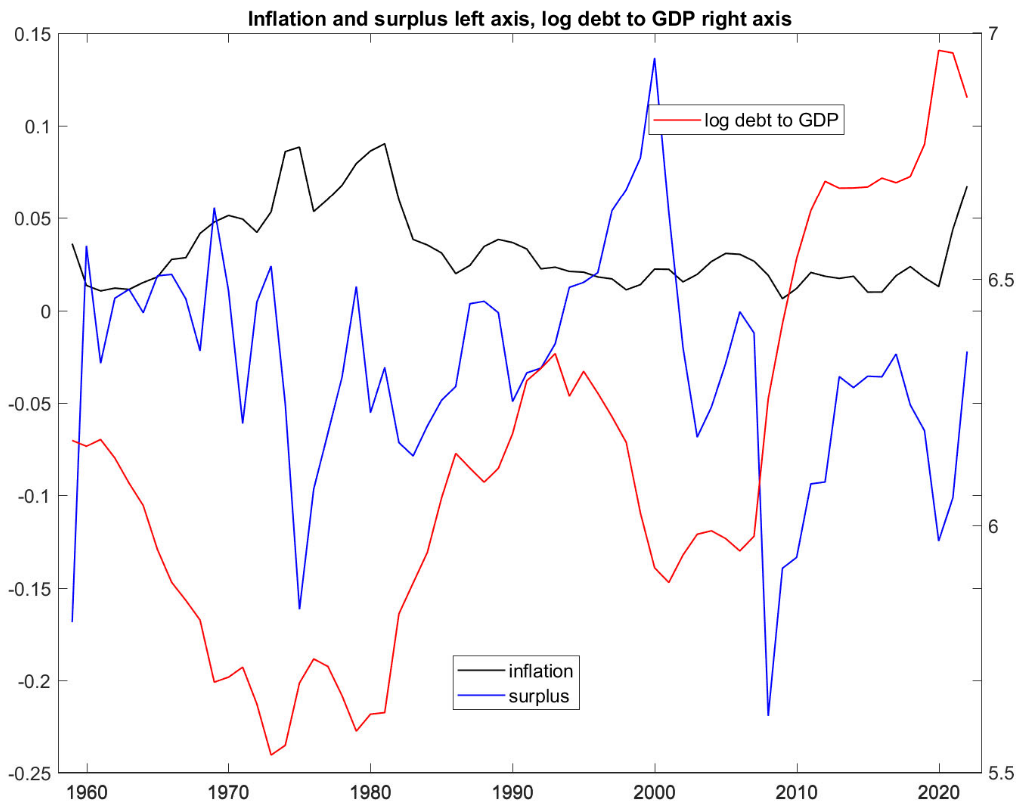


Figure 2: Responses to non-Ricardian deficit shocks in baseline model

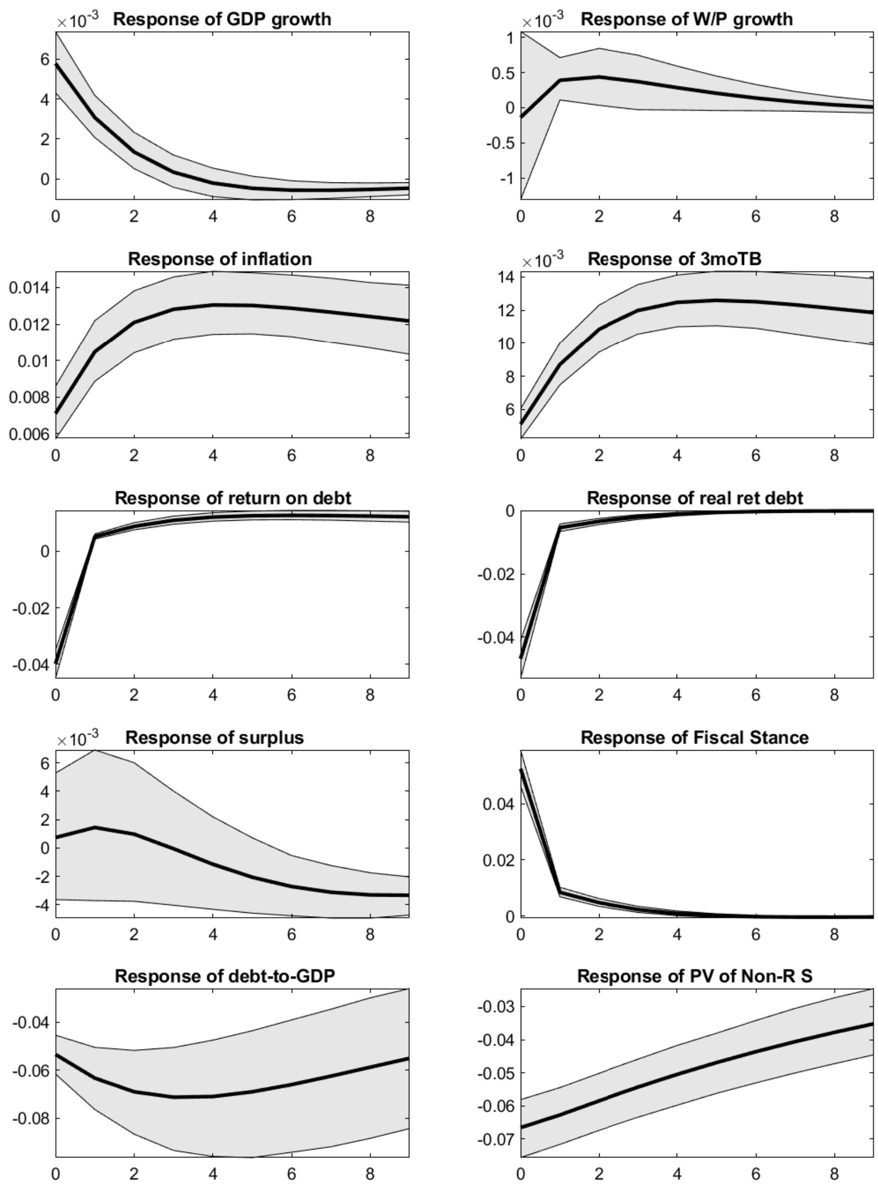


Figure 3: Responses to Ricardian deficit shocks in baseline model

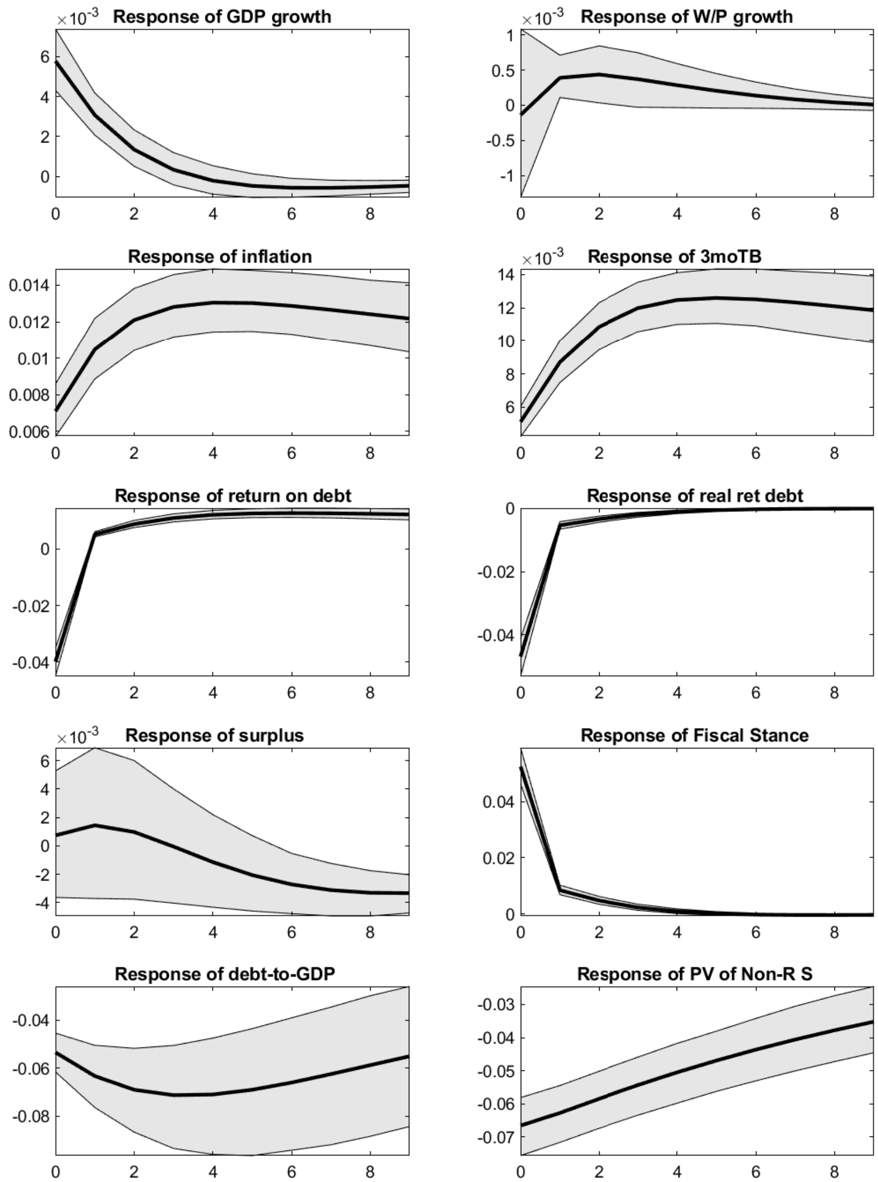


Figure 4: Responses to price markup shocks in baseline model

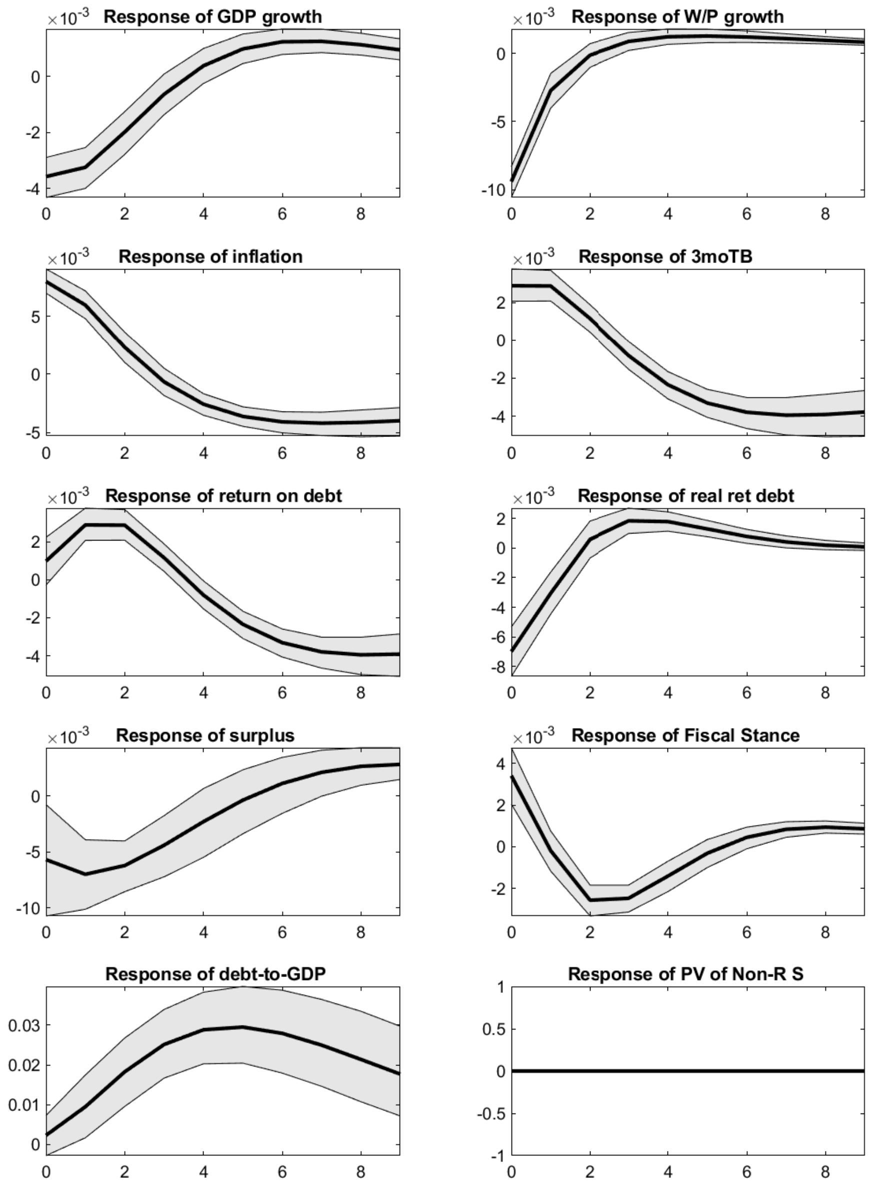


Figure 5: Responses to wage markup shocks in baseline model

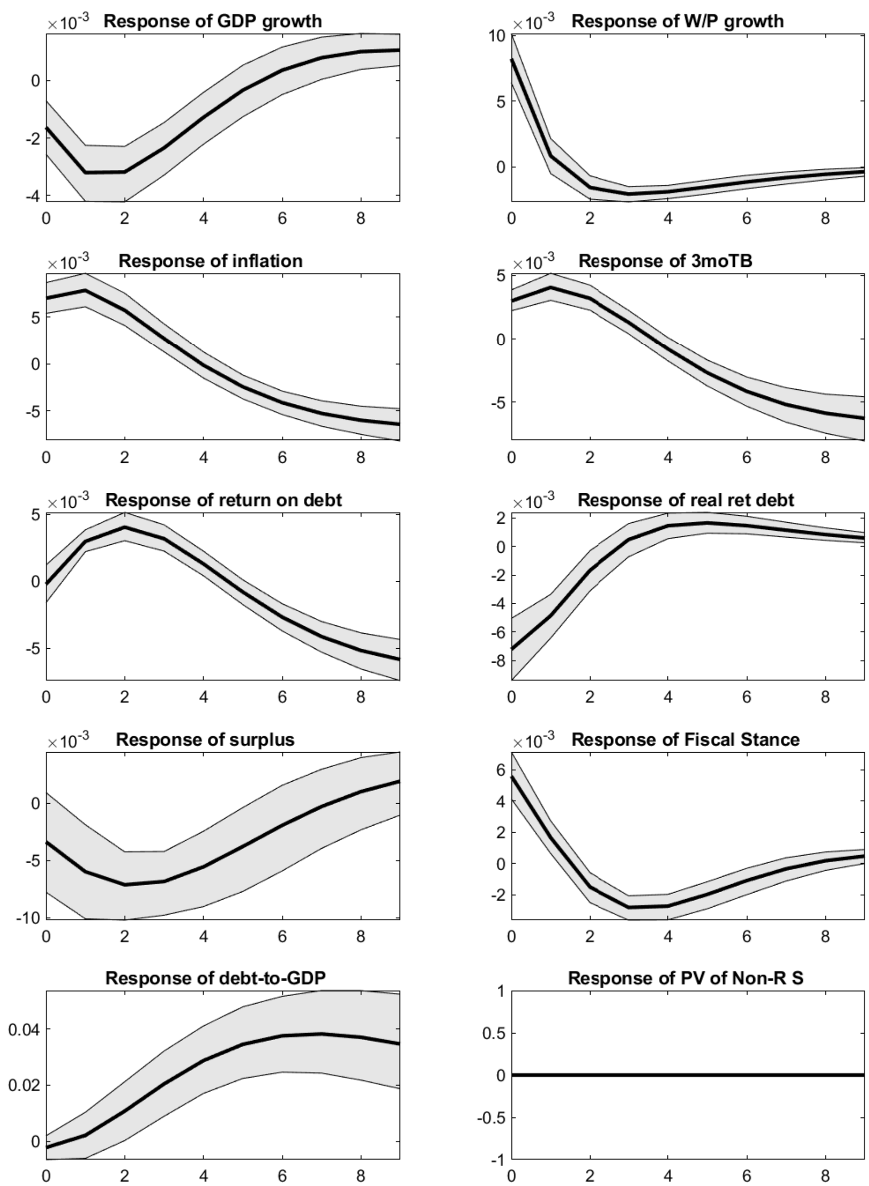


Figure 6: Responses to monetary policy shocks in baseline model

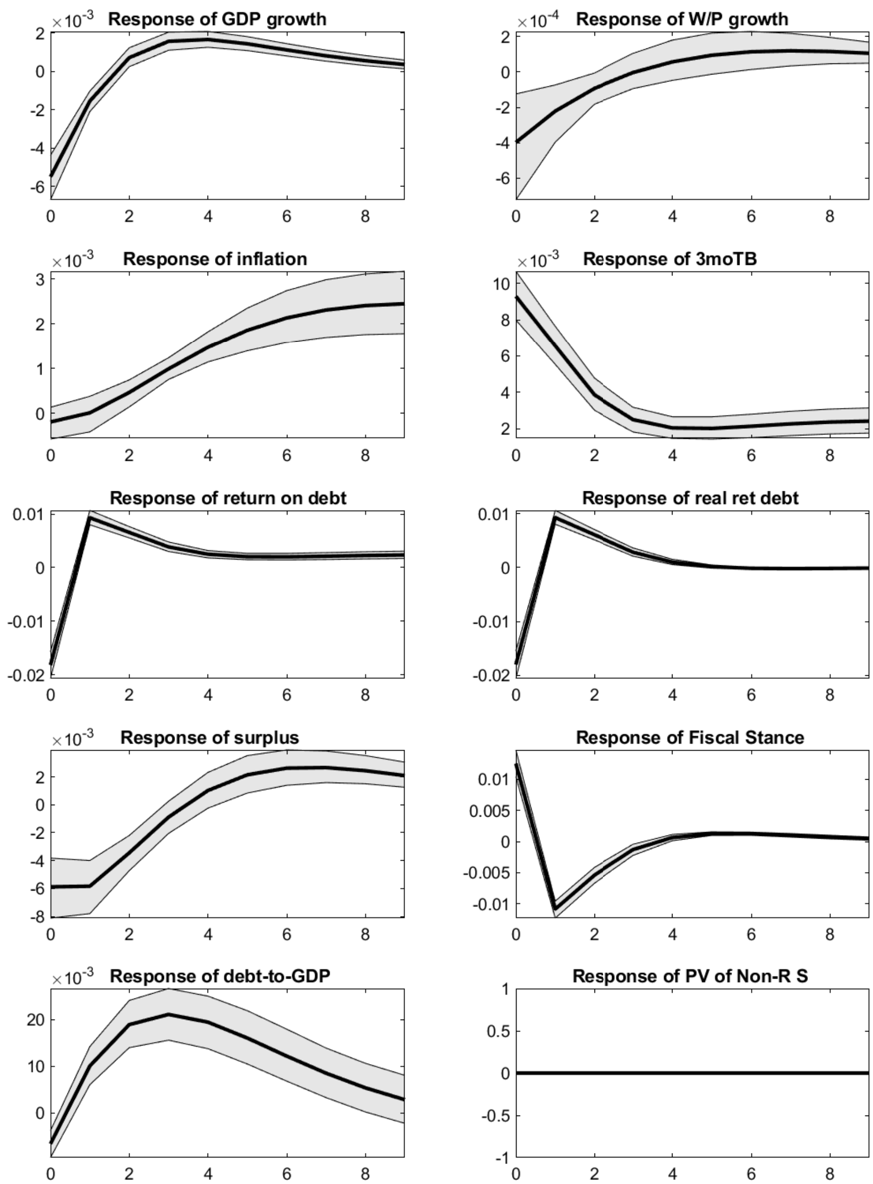


Figure 7: Alternative responses to non-Ricardian deficit shock

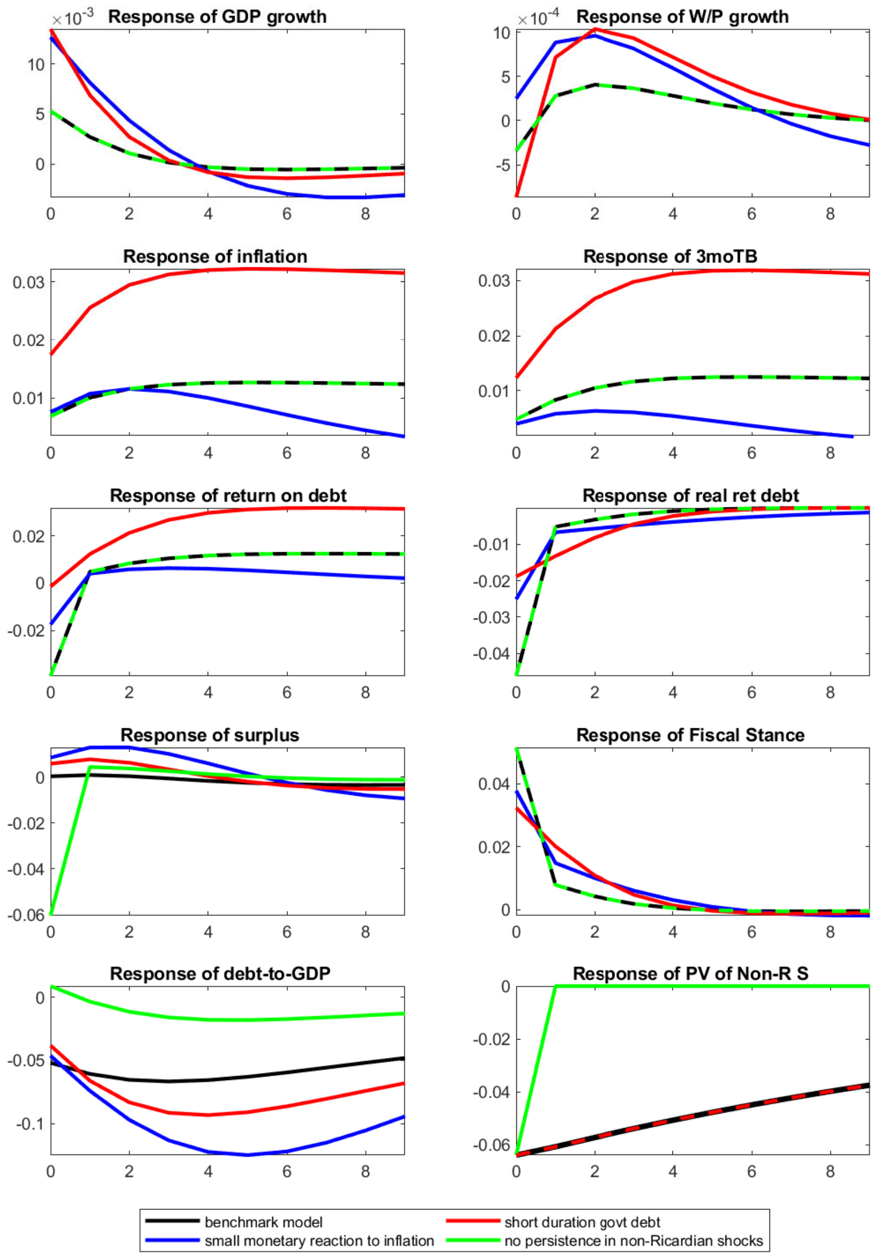
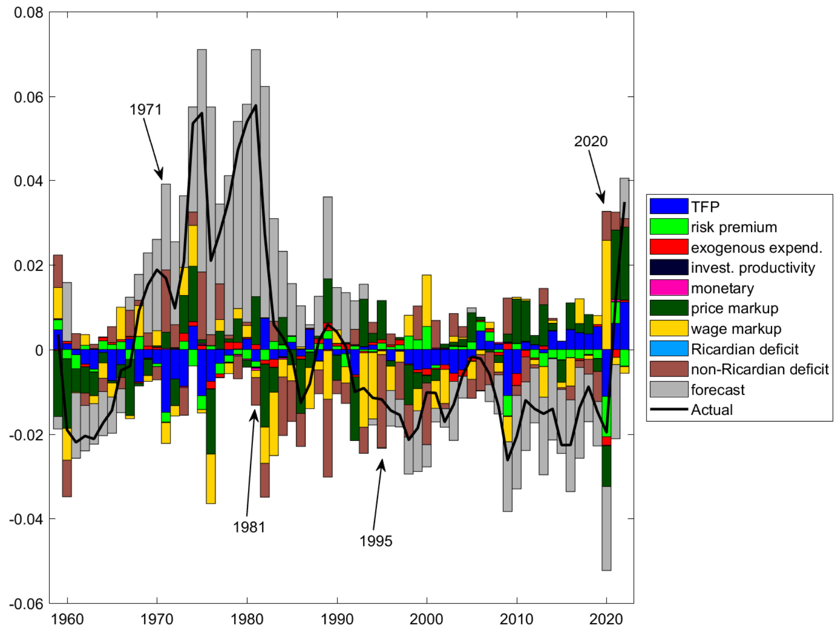


Figure 8: Historical decomposition of one-step-ahead forecast error
Baseline model

(a) Inflation



(b) Fiscal stance: -($s_t + \rho v_t - v_{t-1}$)

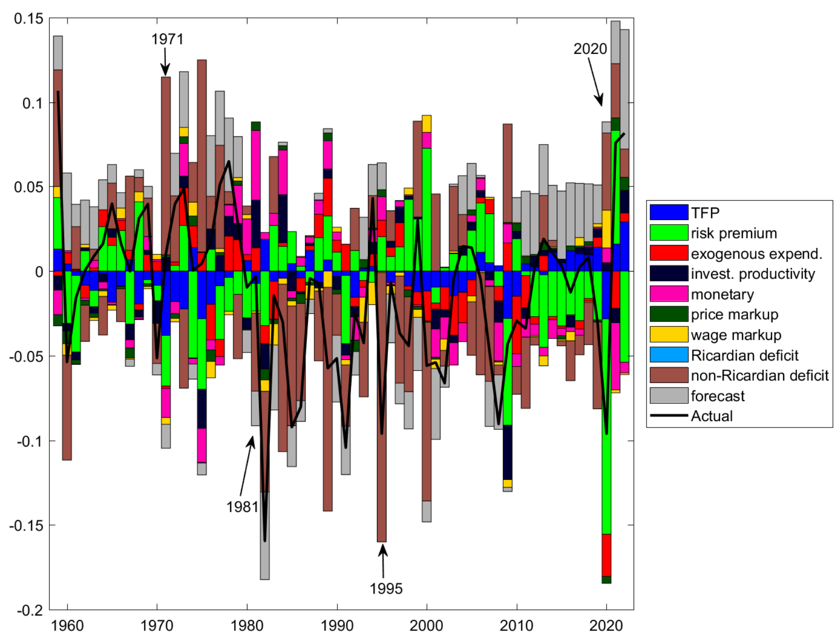
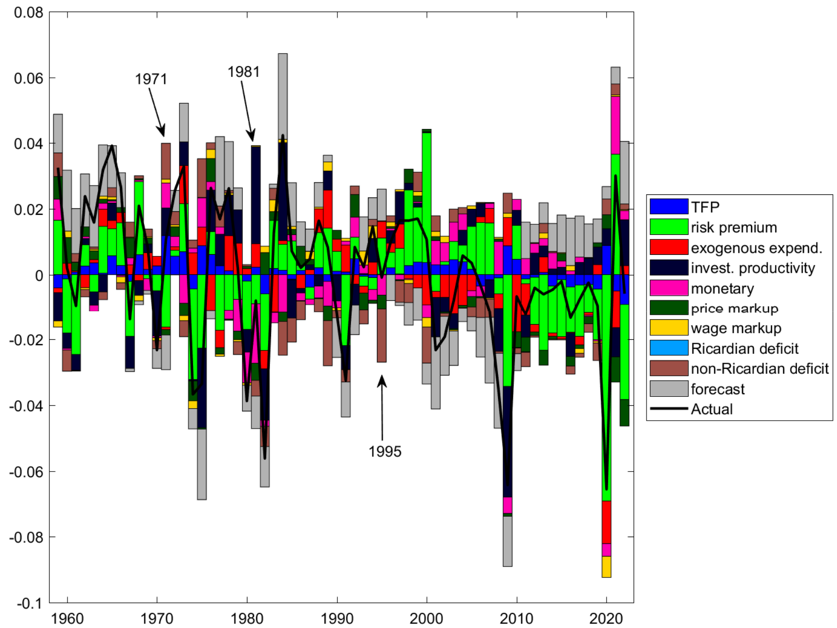


Figure 9: Historical decomposition of one-step-ahead forecast error
Baseline model

(a) real GDP growth



(b) Nominal return on Government Debt

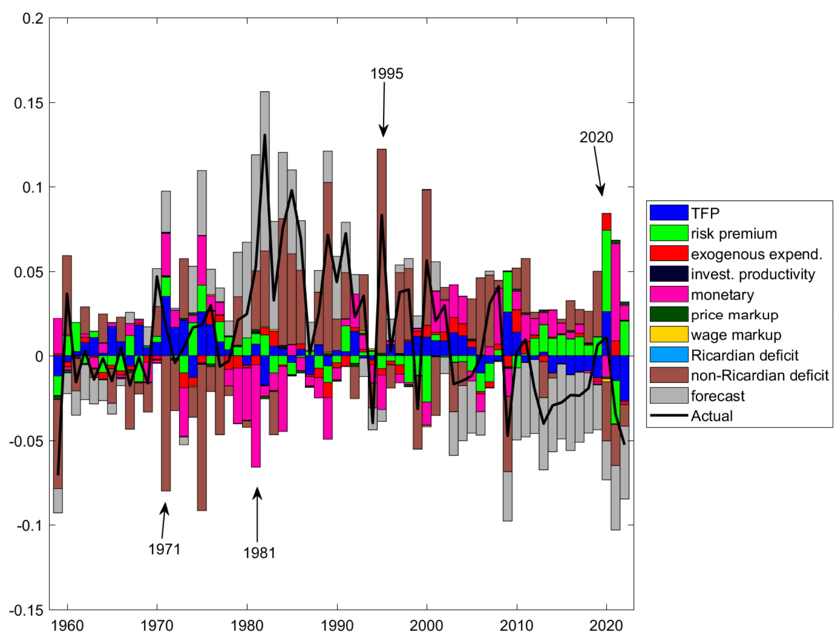
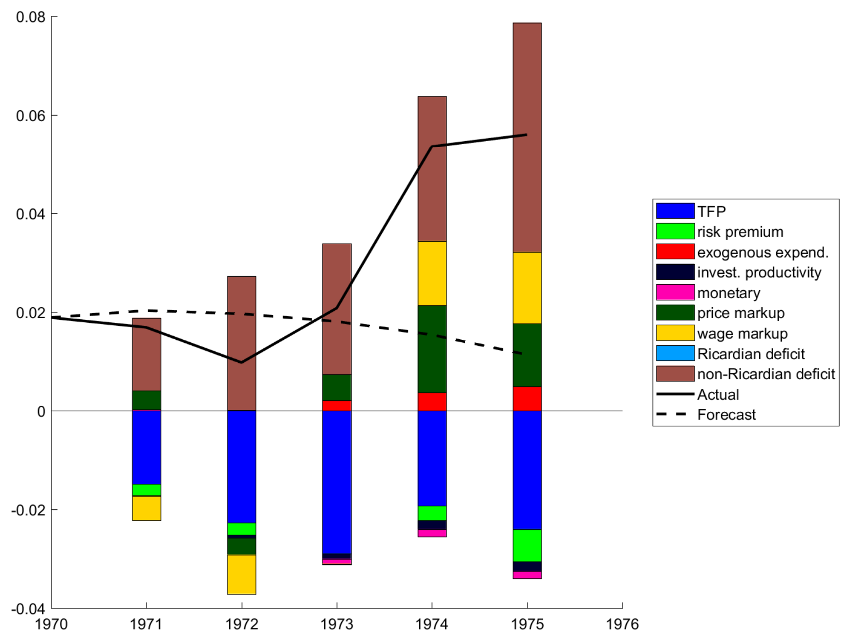


Figure 10: Historical decomposition of inflation

(a) Starting in 1970



(b) Starting in 1980

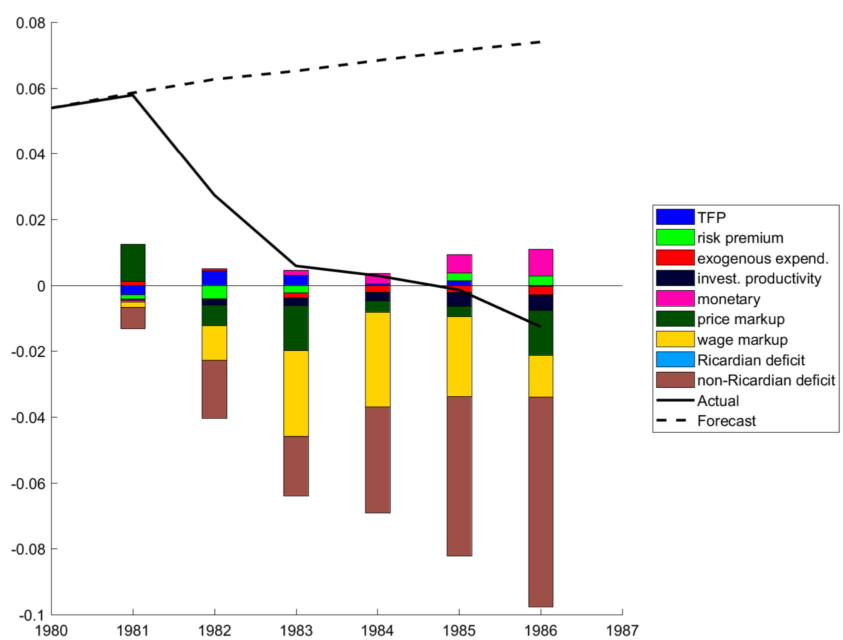
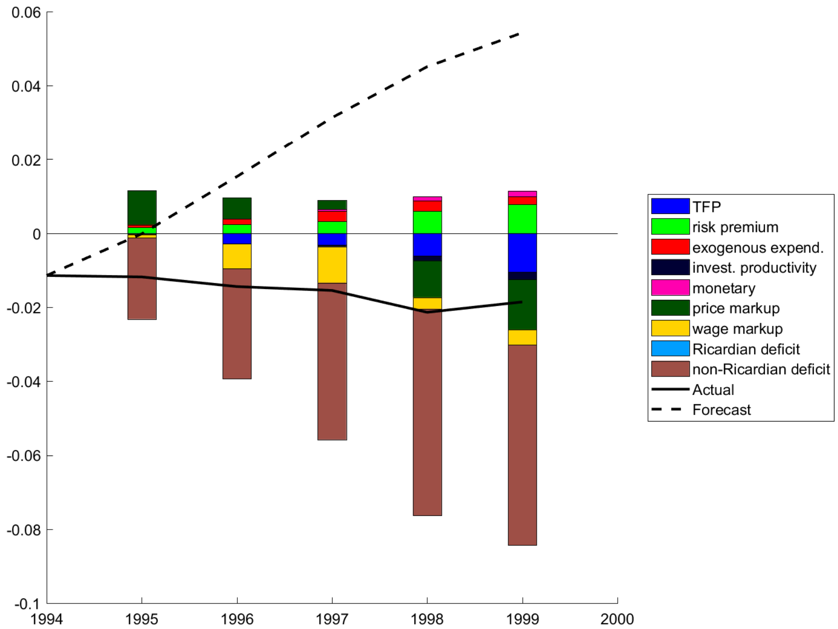


Figure 11: Historical decomposition of inflation

(a) Starting in 1994



(b) Starting in 2007

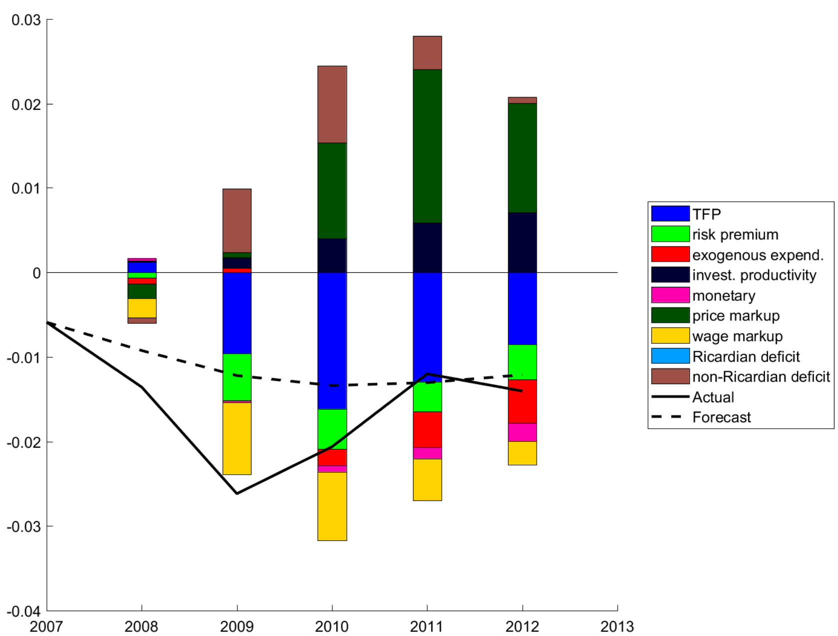


Figure 12: Historical decomposition of inflation starting in 2019

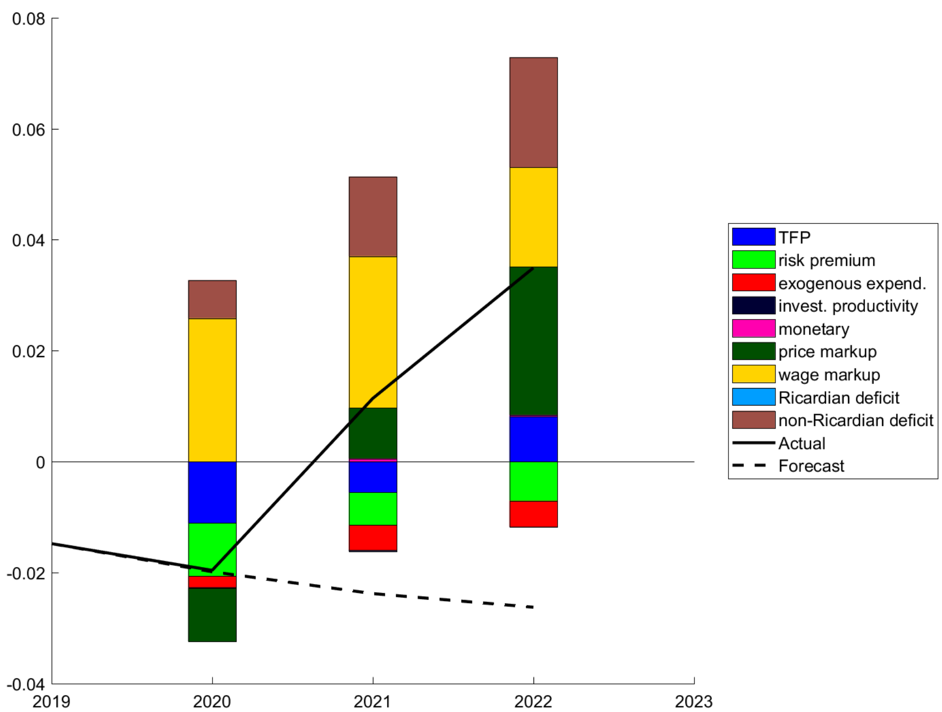


Figure 13: Inflation and implied present value of non-Ricardian surpluses

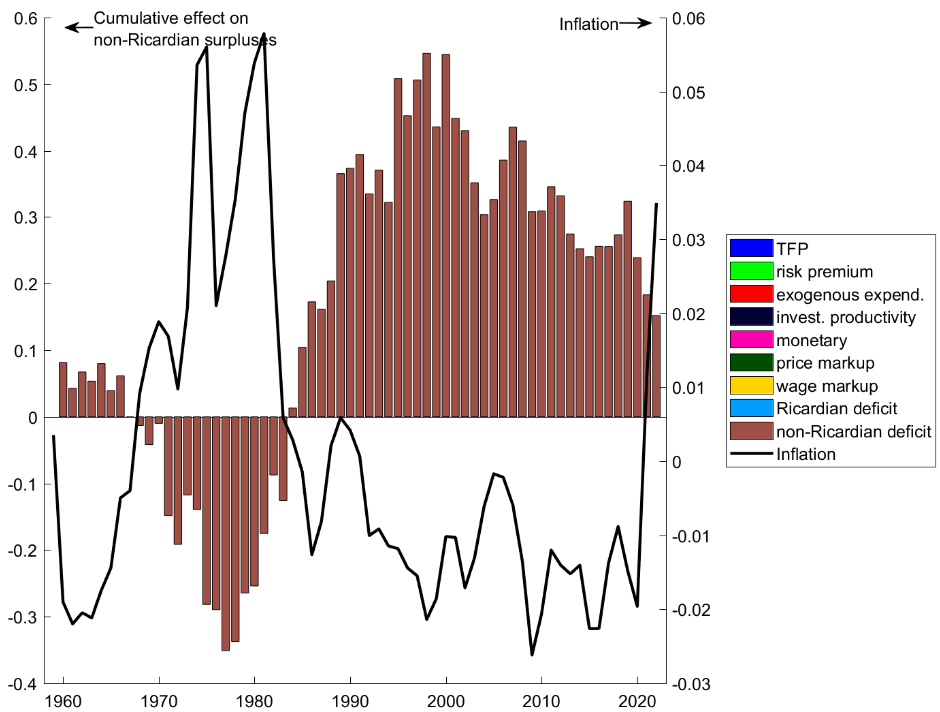


Figure 14: Decomposition of inflation due to changes in current and future surpluses, discount rates, and output growth.

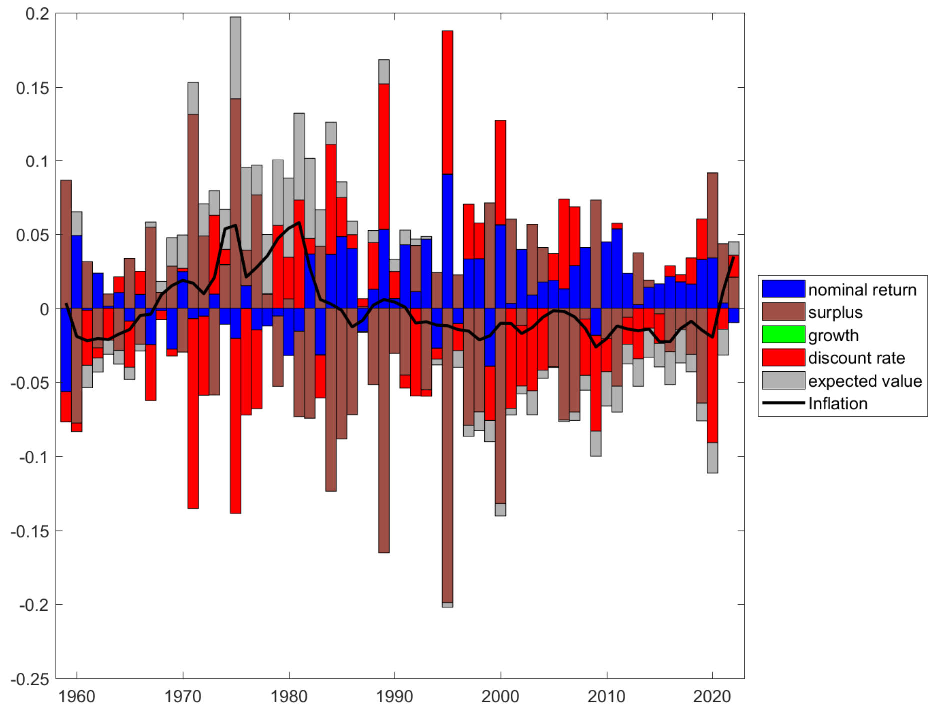
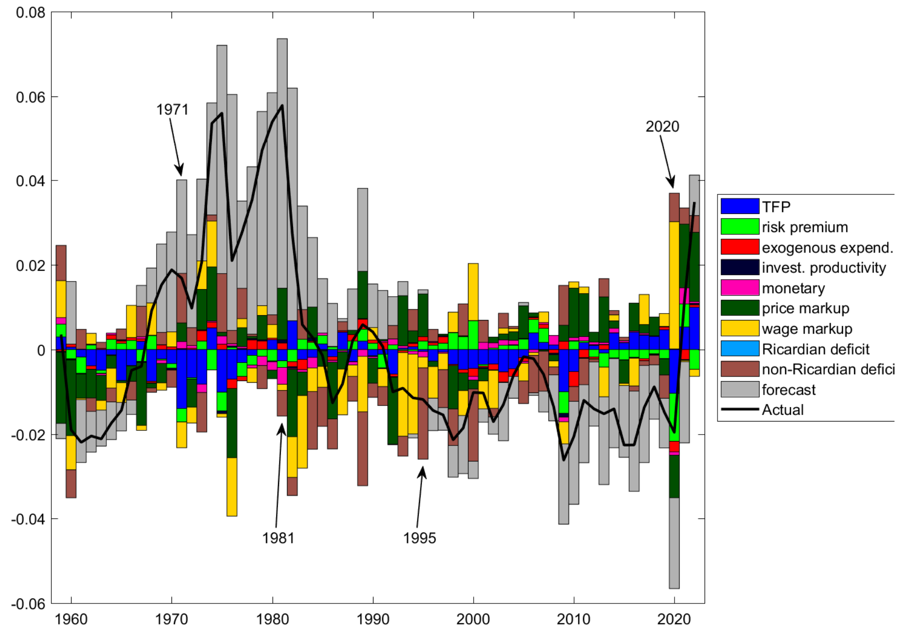


Figure 15: Historical decompositions of inflation
Model with feedback to non-repaid surpluses

(a) One-step-ahead historical decomposition



(b) Decomposition starting in 2019

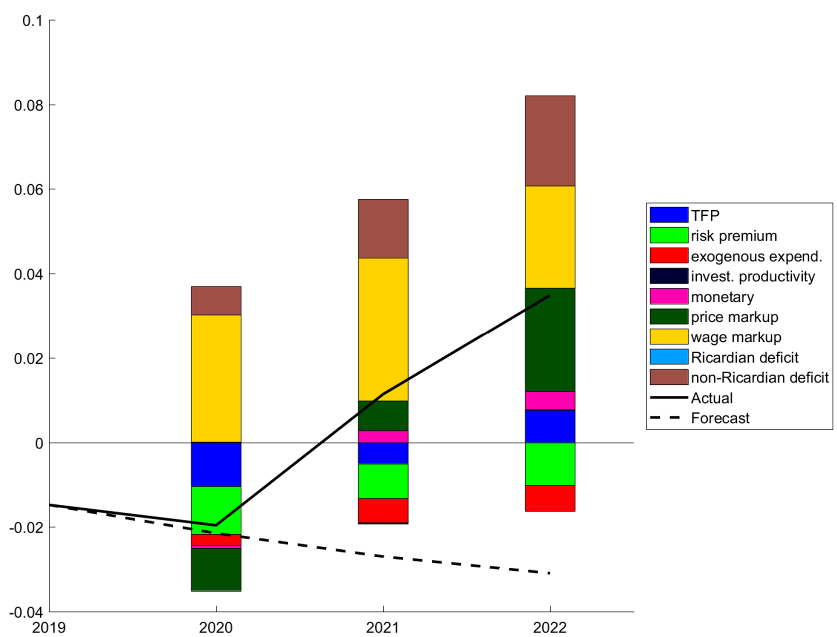
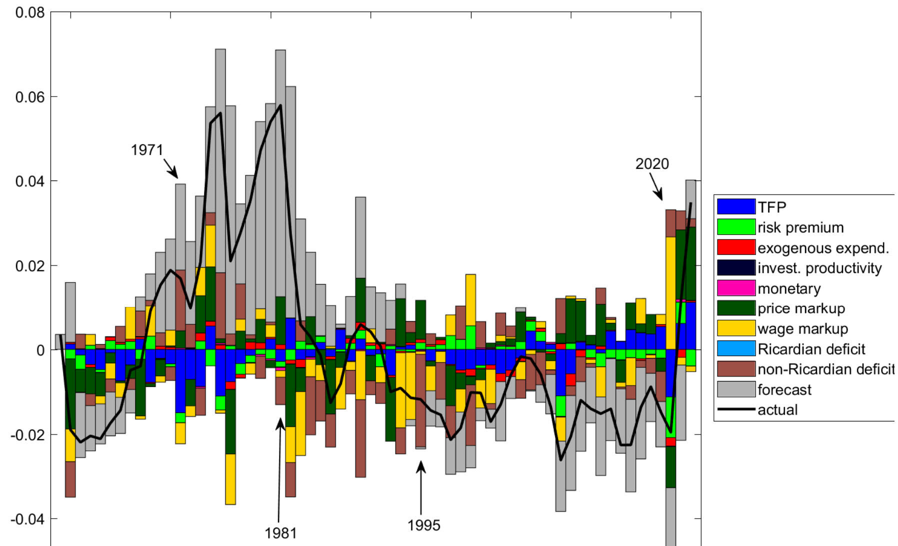


Figure 16: Historical decompositions of inflation
Model with hand-to-mouth consumers

(a) One-step-ahead historical decomposition



(b) Decomposition starting in 2019

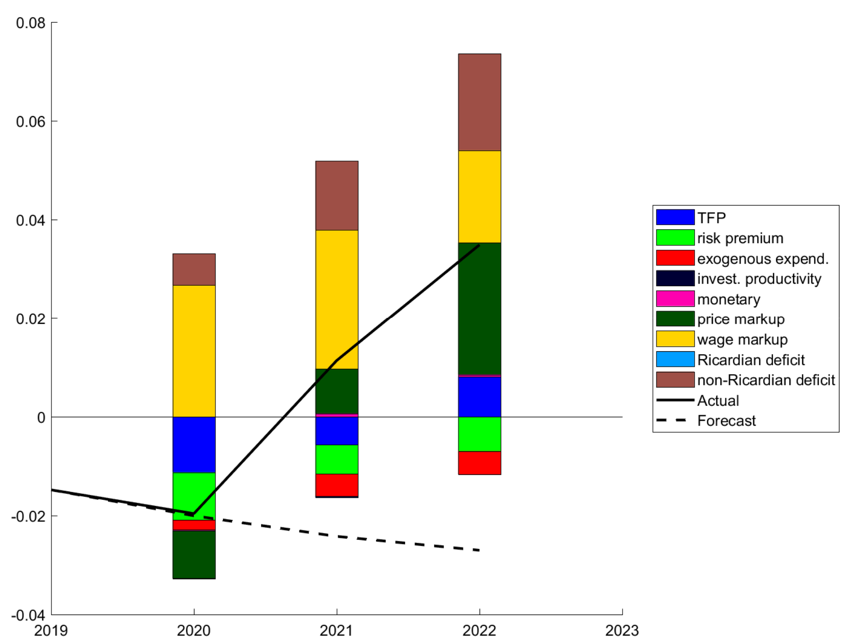


Figure 17: An alternative measure of surpluses

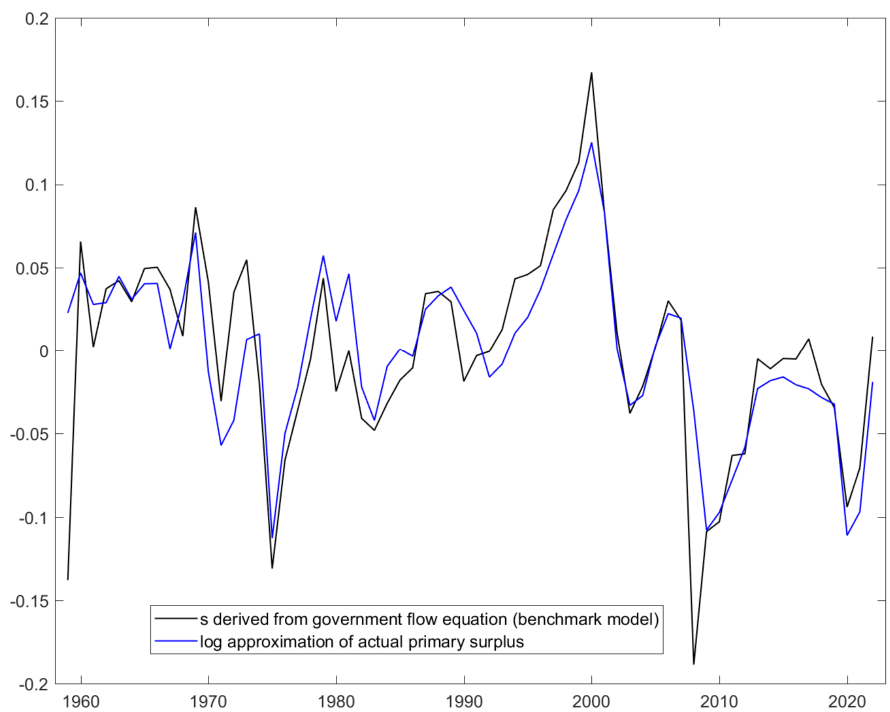
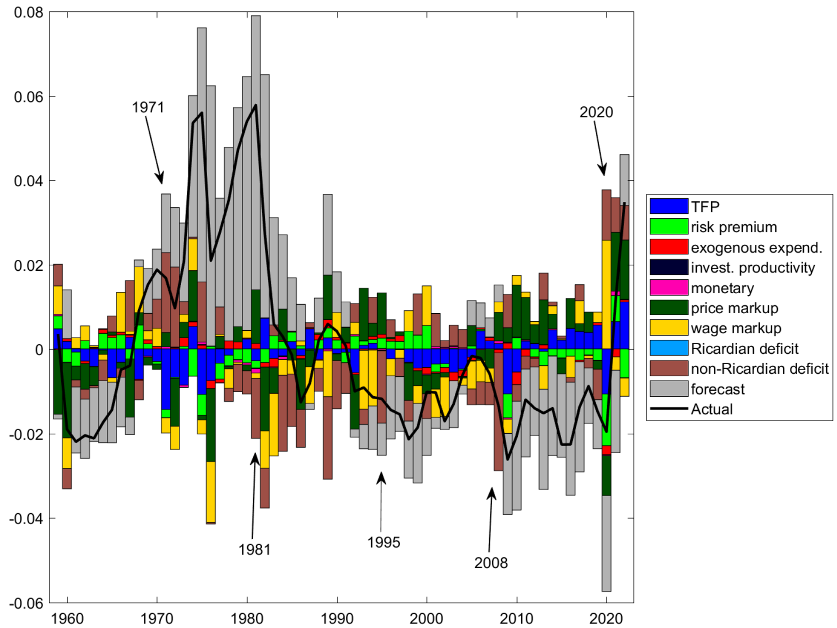


Figure 18: Historical decompositions of inflation
Model with approximated primary surpluses as an observable variable

(a) One-step-ahead historical decomposition



(b) Decomposition starting in 2019

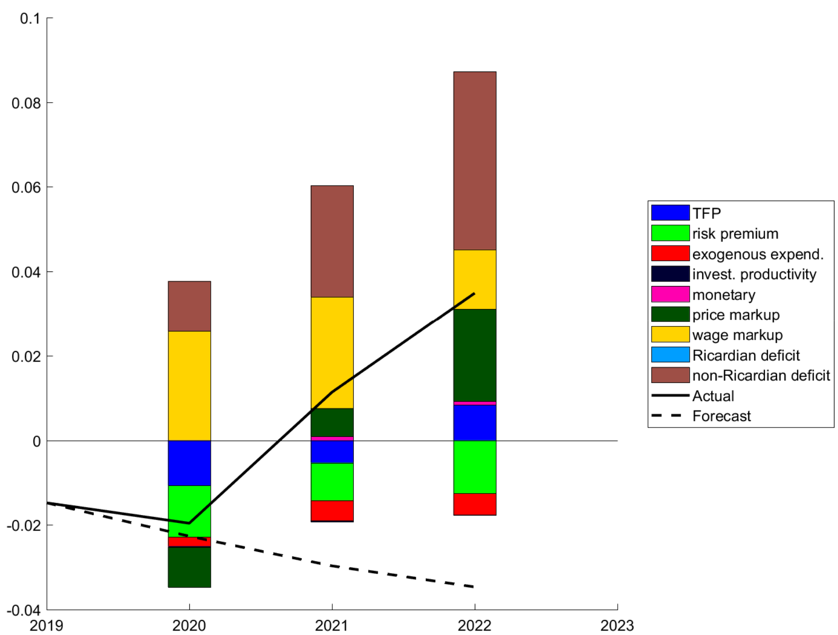


Figure 19: Response to a monetary shock for passive fiscal policy model

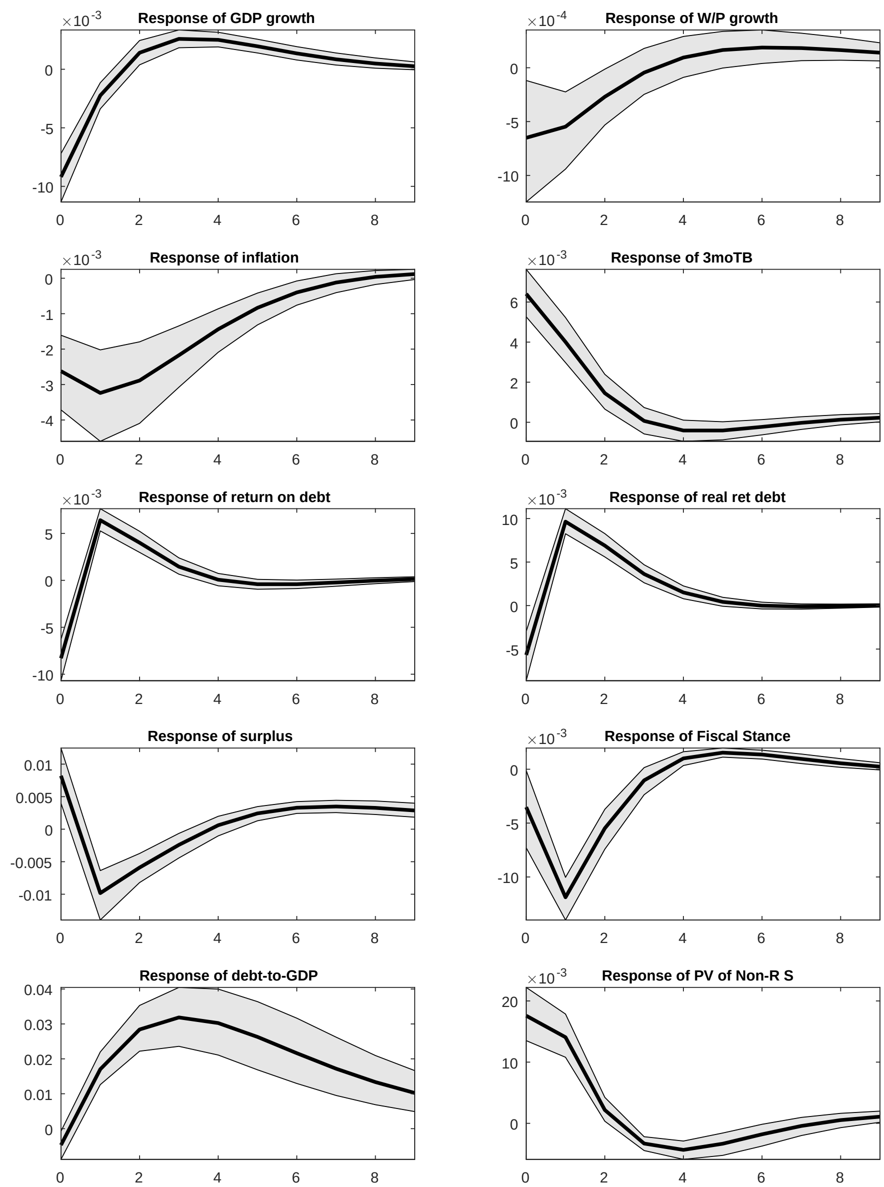


Figure 20: Historical decomposition of inflation for Smets and Wouters passive fiscal policy model

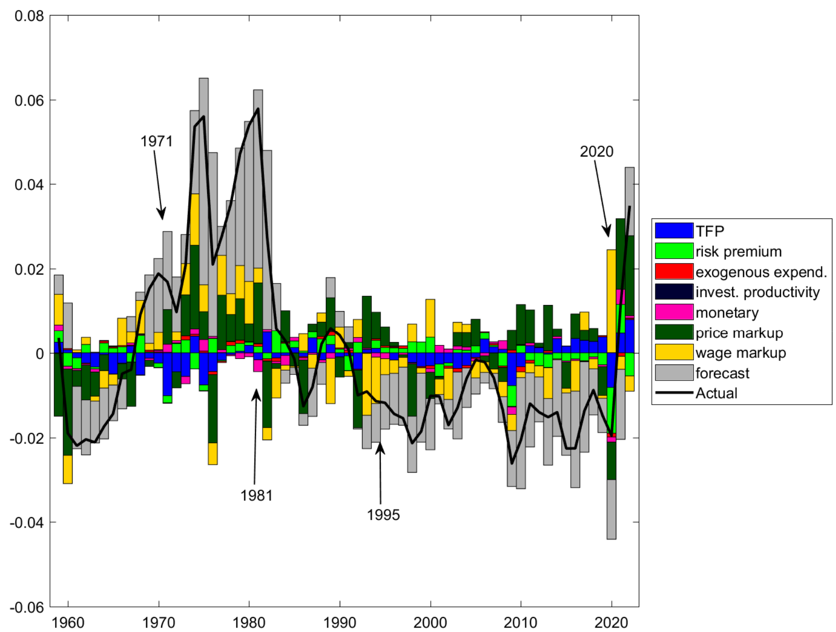
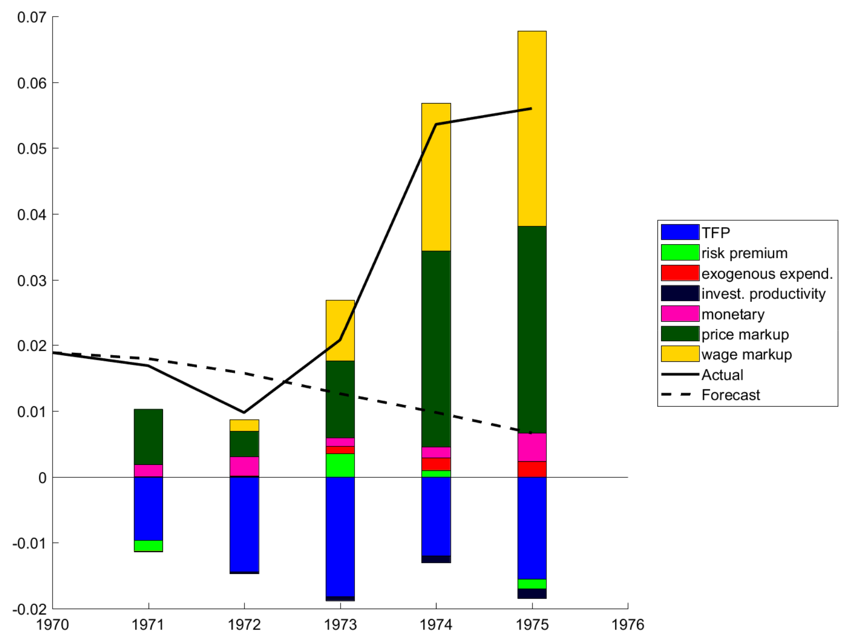


Figure 21: Historical decomposition of inflation for Smets and Wouters' passive fiscal policy model

(a) Starting in 1970



(b) Starting in 1980

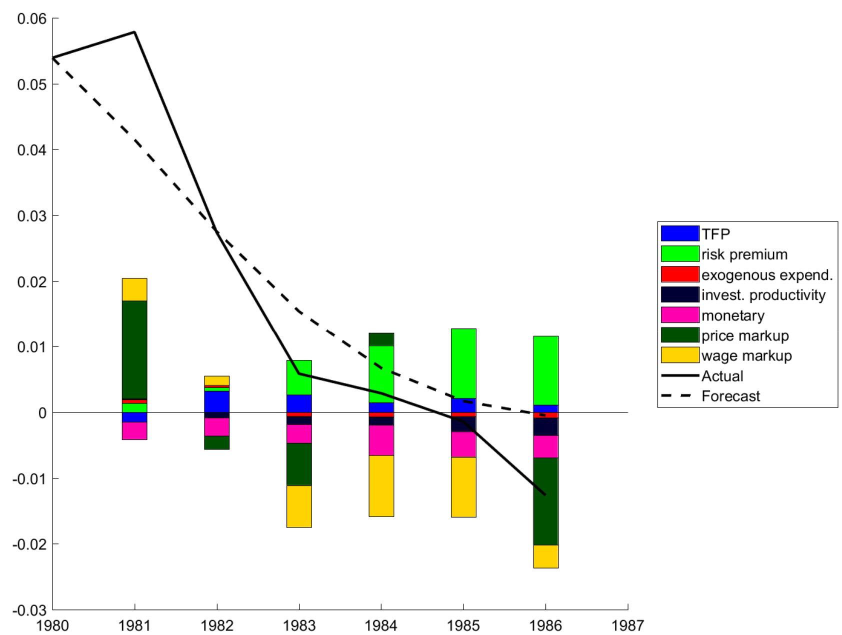
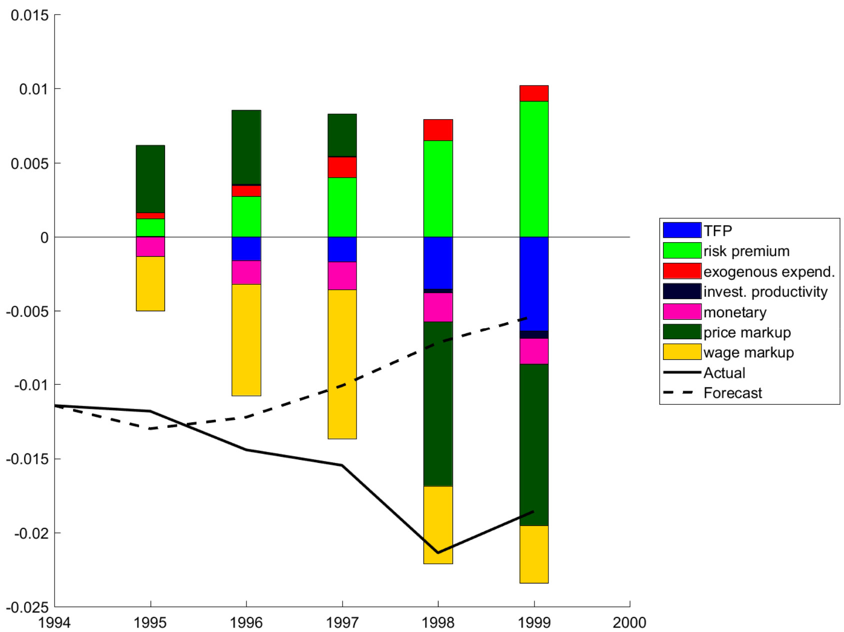


Figure 22: Historical decomposition of inflation for Smets and Wouters' passive fiscal policy model

(a) Starting in 1994



(b) Starting in 2007

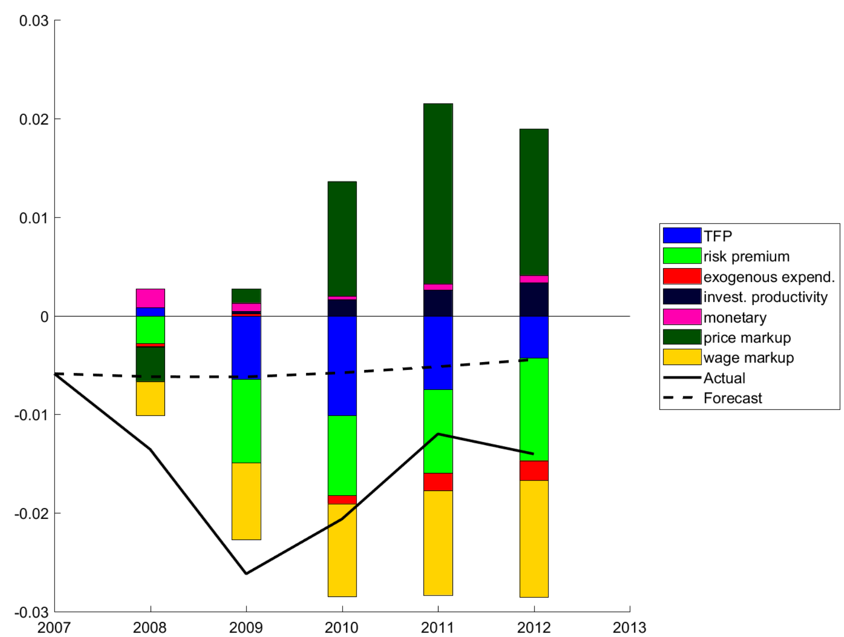
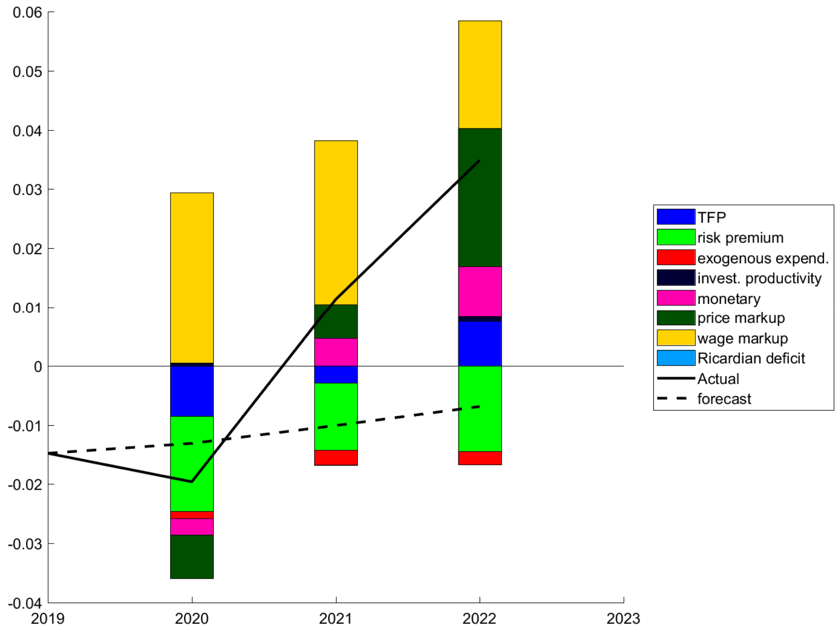
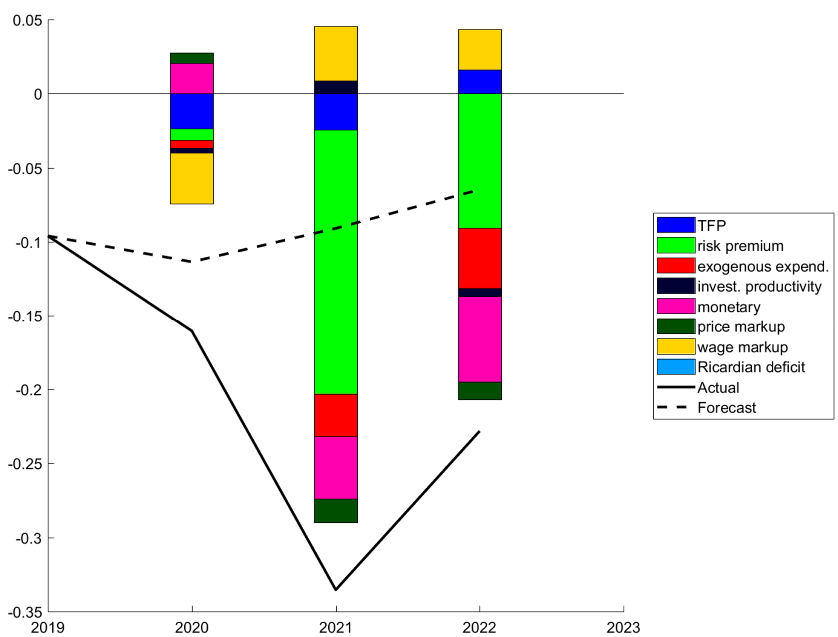


Figure 23: Historical decompositions for Smets and Wouters' passive fiscal policy model starting in 2019

(a) Inflation



(b) future accumulated non-Ricardian surpluses



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