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SHOULD MONETARY AND FISCAL POLICY PULL IN THE SAME DIRECTION?*

Drago Bergholt†, Øistein Røisland†, Tommy Sveen‡, and Ragnar Torvik§

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Abstract

There is a common view that if monetary and fiscal policy are to be used together for macroeconomic stabilization, they should pull in the same direction. We challenge this view by analyzing the optimal policy mix in a small open economy. We show that when the economy is hit by inflation shocks or exchange rate shocks, monetary and fiscal policy should pull in opposite directions. This policy mix makes more effective use of the exchange rate channel of monetary policy, allowing inflation to be reduced after a shock with lower costs in terms of unemployment. Only in the case of demand shocks, or if there are significant costs associated with the active use of the interest rate, should monetary and fiscal policy pull in the same direction. We then consider automatic stabilizers. As we show, for demand shocks, automatic stabilizers imply that monetary and fiscal policy pull in the same direction. For inflation and exchange rate shocks, on the other hand, automatic stabilizers imply that the two policy instruments pull in opposite directions. These policy interactions are all consistent with our results on the optimal policy mix. Strong automatic stabilizers could therefore serve as a substitute for optimal discretionary fiscal policy in open economies.

Keywords: Monetary Policy, Fiscal Policy, Coordination, Open Economy.
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1 INTRODUCTION

In recent years, most economies have experienced high inflation, partially due to supply-side shocks. Additionally, there has been a shift in foreign exchange markets, where the currencies of many small open economies have depreciated, contributing to higher imported inflation. This recent period of high inflation has ignited debates on the role of fiscal policy in stabilization efforts. A prevailing view is that, in a high inflation environment, it is crucial for monetary and fiscal policies to align, ensuring they do not pull in opposite directions. Fiscal policy should not exacerbate the inflationary pressures that monetary policy aims to mitigate. According to conventional wisdom, policy instruments should be *congruent*, meaning they should steer the economy in the same direction, rather than being *divergent* and pulling it in opposite directions.

In this paper we challenge this view. We show that when an open economy is hit by an inflation shock, the optimal policy mix is divergent. Policy goals are best achieved when a contractionary monetary policy is combined with an expansionary fiscal policy. We show that the same holds for a risk premium shock that depreciates the exchange rate. We also show that, in the simplest possible environment, a demand shock shall exclusively be counteracted by fiscal policy. In more realistic settings, however, both monetary and fiscal policies shall be used, and policies should be congruent. We also discuss to what extend automatic stabilizers in fiscal policy contribute toward the optimal policy mix. Automatic stabilizers, in a regime with flexible inflation targeting, have exactly the property that policies become divergent when inflation or exchange rate shocks hit, while they become congruent when demand shocks hit. Thus automatic stabilizers (in our model) always contribute in the direction of an optimal balance between monetary and fiscal policies.

The views on the division of roles between monetary and fiscal policies have changed over time. Going back to Mundell (1962), his key principle in policy design is that a policy instrument should be assigned to the goal it is more efficient in achieving. Mundell argued that monetary policy was better suited to the goal of external balance, while fiscal policy was best suited to the objective of internal balance. Over time, the view of fiscal policy as the main tool for stabilization policy became less optimistic. Of particular concern is that fiscal policy has longer implementation lags than monetary policy, that volatilities in taxes or the provision of public services are costly, and that political economy mechanisms induce a debt-bias. The view on the division of roles developed into one where monetary policy should have the primary responsibility for business cycle stabilization while fiscal policy should focus on sustainable public finances and efficient public service provision.

In recent years the division of roles between monetary and fiscal policies has gained renewed interest. The debate has also, to some degree, changed from discussing which policies should have what role, to a discussion on how monetary and fiscal policies should best be combined. At least three events has contributed to this development. First, the global financial crisis in 2007-2008 demonstrated that monetary policy is not always able to counter severe downturns because the policy rate is bounded from below. Even though many central banks used alternative measures such as large-scale asset purchases when they reached the policy rate's lower bound, there was still a need for expansionary fiscal policy in many countries.

Second, the pandemic in 2020-2021 made clear the need for active fiscal policy measures for additional reasons than supporting monetary policy at the lower bound. The policy programs implemented during the pandemic illustrated how fiscal policy can be micro-designed to address shocks which have highly heterogeneous effects. Fiscal policy can target specific groups or industries in a way monetary policy cannot.

Third, the recent experiences with high inflation made many observers argue that monetary policy should be supported by fiscal policy, or at least that fiscal policy should not pull the economy in the opposite direction from what monetary policy is trying to achieve. It is, first and foremost, to this debate that our paper contributes.

The view that it is important for fiscal and monetary policy not to work against each other has in particular been actively promoted by organizations such as OECD and IMF. OECD (2023, p. 53) is concerned that expansionary fiscal policy *"boosts aggregate demand at a time of high inflation. This adds to the challenges faced by monetary policy in bringing inflation back to target, and raises the risk that high underlying inflation will persist."* The IMF (2023, p. ix) states that *"[f]iscal policy can and should support monetary policy in bringing inflation back to target in a timely manner."* The reason for this is that (p. xi) *"A tighter fiscal policy - while providing targeted support to the most vulnerable - should complement efforts by the monetary authorities to bring inflation back to target, making it possible for central banks to increase interest rates by less than otherwise."* [1] We demonstrate, however, how monetary and fiscal policy leaning in different directions can better achieve objectives in response to inflation shocks or exchange rate shocks.

The basis of our analysis is that monetary and fiscal policy do not impact inflation in exactly the same way. While both monetary and fiscal policy affect inflation through the demand channel, monetary policy also directly influences inflation through the exchange rate channel. Therefore, by influencing the exchange rate, monetary policy affects inflation through an additional channel alongside the demand channel. As we will demonstrate, this has fundamental implications for the optimal interaction between monetary and fiscal policy.

We will focus on traditional business cycle management through fiscal policy, where fiscal policy can be expansionary or contractionary to varying degrees. We will abstract from disturbances that may require more targeted fiscal policy measures. The reason for excluding these factors is not because we consider them unimportant, but to limit the scope of the analysis.[2] Given the overall tightness/looseness of fiscal policy, there is nothing preventing targeted measures from being implemented through policy changes within a given budget. Therefore, our analysis complements, rather than conflicts with, any potential need for targeted measures beyond the impact of fiscal policy on aggregate demand. We also abstract from factors that may tend to make fiscal policy overly expansionary due to short-term considerations of voter support and various time inconsistency problems.[3]

[1] See also e.g. Calmfors et al. (2022, p.11) who have a similar assessment: *"Fiscal and monetary policy should normally pull in the same direction, i.e. be congruent."* (Our translation). Dao et al. (2023) discuss the recent high inflation episode and ask (p. 4): *"In such an environment, is there a role for fiscal policy in further reducing inflation? The textbook answer is an unambiguous "yes"!"*. They argue that quantitatively the effect of fiscal policy is small, however and (p. 5) *"Hence, although the textbook intuition is correct that fiscal tightening can support monetary policy in reducing inflation by compressing aggregate demand, the magnitudes of the effects through that specific channel appear to be small. This does not mean, however, that fiscal tightening is not needed or that a fiscal expansion would be harmless at the current juncture."* See also Bartsch et al. (2020).

[2] See e.g. Woodford (2022) and Auclert et al. (2021), who develop models that study this topic.

[3] See e.g. Persson and Svensson (1989) and Persson and Tabellini (2000) for different mechanisms that may permanently make fiscal policy too expansionary.

Such underlying and persistent imbalances in fiscal policy should be addressed through targeted institutional reforms, such as fiscal rules or debt targets. Therefore, our analysis can be interpreted as studying how the scope for fiscal stabilization within the institutional framework of fiscal policy can be best utilized, in coordination with monetary policy. We also assume that the interest rate does not have a lower bound and can thus be set freely, thereby limiting our analysis to studying monetary and fiscal policy in situations where monetary policy is not constrained.[4]

The paper most closely related to ours is Bilbiie et al. (2024), who study the optimal mix between fiscal and monetary policy in a TANK model where fiscal policy affects inequality and, through this channel, aggregate demand. In their setting inequality responds (inefficiently much) to variations in output. Monetary policy does not directly affect inequality, while fiscal policy does. When a cost push shock hits, then (p. 2) *"If tax incidence is progressive, a shock that otherwise generates a combination of recession and inflation calls for an expansion in government spending, because the ensuing transfer from unconstrained to constrained agents is the most effective way to stabilize aggregate demand."* This result resembles one of our main results, but for a different reason. Bilbiie et al. (2021) study a closed economy where monetary and fiscal policies differ in that fiscal policy directly affects inequality while monetary policy does not. In contrast, our result is the direct consequence of the difference between monetary and fiscal policy transmissions in the open economy: monetary policy has a direct effect on the exchange rate, while fiscal policy has not. This is the reason a cost push shock should be met with a contractionary monetary policy and an expansionary fiscal policy in our setting.[5]

Auclert et al. (2024) use the heterogenous-agent New Keynesian model in Auclert et al. (2021) to study fiscal and monetary policy responses to an energy shock. In economies dependent on energy imports, they find that even without a monetary policy response the shock causes a recession. The expansionary substitution effect increasing the demand for domestically produced goods is (under realistic parameter assumptions) dominated by a contractionary effect as higher prices of imported energy depress income and demand. Raising interest rates to such an inflationary shock does not limit inflation much, as the effect on world energy demand and prices is small. However, if the monetary tightening is coordinated with other countries, there are positive externalities since world demand for energy falls, reducing the stagflationary effects of the shock. Expansionary fiscal policy, on the other hand, and in particular energy subsidies, has negative externalities. It dampens the effect of the energy shock for each individual country, but does not reduce global energy demand. Our paper shares with Auclert et al. (2024) that we study an inflation shock, but they focus on international transmission effects of monetary and fiscal policy, as well as on energy subsidies, and thus have a different focus from us.

In the next section we construct the simplest reduced form static theory model we can think of, so as to initially communicate some of our arguments in the most transparent manner. We then develop a dynamic small open economy New Keynesian model in Section 3, and in Section 4 we employ this model to study optimal policy mix when the

[4]See e.g. Debortoli, Galí and Gambetti (2020) for a discussion of the relevance of the zero lower bound, and Gabaix (2020) and Mian et al. (2022) for models that study monetary and fiscal policy with limitations on how low the interest rate can be set.

[5]In Subsection 4.5 we extend the model to allow fiscal policy to have a direct effect on the exchange rate. This *strengthens* our result of policy divergence.

economy is hit by shocks. In Section 5, we extend the analysis by incorporating costs of adjusting the policy instruments. Section 6 replaces discretionary fiscal policy with automatic stabilization, and asks to which extend such a fiscal policy is in line with an optimal policy mix when monetary policy conducts flexible inflation targeting. Section 7 concludes. In the Appendix we undertake additional simulations as well as provide the results of various extensions and robustness analyses.

2 THE ARGUMENT

Before analyzing the policy mix in a medium-scale DSGE model, we will show the main argument in a very simplified model that enables us to provide some simple analytical expressions.

2.1 A SIMPLIFIED MODEL

We consider a small open economy that takes global market prices and interest rates as exogenously given. The demand for domestically produced goods and services is given by

$$y = y^e - \alpha_1 r + \alpha_2 e + g + v, \tag{1}$$

where y represents the output gap, which is the (logarithmic) deviation between actual output and potential output, y^e is the expected next-period output gap, and r denotes the real interest rate,[6] measured as the deviation from the neutral real interest rate. In this simple model, expectations (all variables with superscript e) are exogenous. Furthermore, e denotes the logarithm of the real exchange rate, which measures the deviation from the equilibrium real exchange rate. The real exchange rate is defined as the price of foreign-produced goods relative to the price of domestically produced goods, measured in the same currency. g represents the fiscal policy stance and is measured as a deviation from neutral fiscal policy. Lastly, v is a demand shock. The α parameters are assumed positive, and thus this simple model assumes that demand decreases with the real interest rate, increases with the real exchange rate, and is positively affected by government spending.

CPI inflation, π, is given by a simple Phillips curve:

$$\pi = \pi^e + \gamma_1 y + \gamma_2 e + u, \tag{2}$$

where π^e represents inflation expectations, and u represents an inflation shock. Inflation is increasing in the output gap and the real exchange rate.[7]

The real exchange rate is determined by risk-adjusted uncovered interest rate parity:

$$e = e^e - (r - r^*) + z, \tag{3}$$

[6] In the short run, the nominal interest rate, rather than just the real interest rate, can have an impact on demand due to cash flow effects for indebted households. However, we treat inflation expectations in the simple theory model here as exogenous, so that changes in the nominal interest rate are equivalent to changes in the real interest rate. When we develop the more fully specified New Keynesian model below we have endogenous expectations.

[7] A real depreciation leads to higher prices for imported consumer goods and inputs and thus higher inflation. For a derivation of the consumer price Phillips curve (7) from separate Phillips curves for domestic and imported inflation, see e.g. Røisland and Sveen (2018).

where e^e represents the expected real exchange rate next period, r^* is the foreign real interest rate, and z is an exogenous risk premium.

We analyse the optimal policy mix of monetary and fiscal policy by assuming that both instruments are used to minimize the following standard loss function:

$$L = \frac{1}{2}\left[(\pi - \pi^*)^2 + \lambda y^2\right]. \tag{4}$$

The optimal solutions for r and τ become:

$$r = \frac{1}{\gamma_2}\left[(\pi^e - \pi^*) + u\right] + (e^e + r^* + z), \tag{5}$$

and

$$g = \frac{\alpha_1 + \alpha_2}{\gamma_2}\left[(\pi^e - \pi^*) + u\right] + \alpha_1 (e^e + r^* + z) - (y^e + v). \tag{6}$$

The most interesting characteristic of the above reaction functions (5) and (6) is that when it is optimal to use both monetary and fiscal policy, then they shall *always* pull in opposite directions, i.e. be divergent. Fiscal policy should be expansionary (high g) when monetary policy is contractionary (high r), and vice versa. This is the exact opposite conclusion from what the standard policy advice discussed in the introduction suggests.

The intuition is as follows: assume that inflation increases due to an inflation shock ($u > 0$ in equation (2)). Suppose first that only monetary policy is used. Then, the optimal trade-off implies a negative output gap and a positive inflation gap. Suppose now that fiscal policy becomes expansionary, and that monetary policy neutralizes this expansionary effect on output by increasing the interest rate. Then, output is the same as before fiscal policy became expansionary. Inflation, however, is lower because of the higher interest rate and thereby a stronger exchange rate. Thus, the goal achievement is better. This also shows that, with a combination of expansionary fiscal policy and contractionary monetary policy, inflation can be reduced without affecting the output gap. By extension, one can also keep the output gap at zero and at the same time achieve inflation equal to target. The divergent policy composition allows the exchange rate channel to be more effectively utilized, enabling the simultaneous achievement of price stability and stability in the real economy. When an inflation shock occurs, monetary policy should be contractionary to fight higher inflation, while fiscal policy should be expansionary to fight lower output.[8]

The fact that one can achieve two goals with two instruments is not surprising, as it follows from the Tinbergen rule. What might be more surprising is that the two instruments should pull in opposite directions.

Another characteristic of optimal policy is that the demand shock, v, does not appear in the monetary policy reaction function. Within this simple framework, it is not optimal

[8]Further intuition for the divergence result can be contained as follows: consider a risk premium shock or an increase in the foreign policy rate. Such a shock causes the exchange rate to depreciate on impact. We can see from equation (5) that the optimal policy mix implies that the central bank should increase the policy rate by the same amount as the increase in the risk premium or foreign policy rate. The exchange rate equation (3) implies that the policy rate is set high enough for the exchange rate to remain at its initial level in absence of the shock. However, the increased policy rate, in isolation, would reduce the activity level in the economy. Fiscal policy can counteract this with an expansionary policy. Thus, optimal policy involves a higher interest rate, which counteracts the depreciation of the exchange rate, and an expansionary fiscal policy, which neutralizes the effect of the increased interest rate on the real economy.

for monetary policy to respond to demand shocks; instead fiscal policy should be solely responsible for offsetting them. The rationale is straightforward; if the central bank lowers the interest rate in response to a negative demand shock to prevent a reduction in y, inflation will become too high because the exchange rate weakens as a result of the lower interest rate. Consequently, in an open economy, monetary policy cannot simultaneously shield both the real economy and inflation from the effects of a demand shock. In contrast, expansionary fiscal policy can shield both the real economy and inflation from the effects of a demand shock because it does not directly affect the exchange rate. The mechanism is as simple as replacing lower private demand with higher demand induced by expansionary fiscal policy. This result hinges, however, on the assumption that the risk premium is exogenous. As we shall see in the model developed in the next section, where the risk premium is endogenous and depends on net foreign assets, a positive demand shock also implies a contractionary monetary policy, implying that the two policy instrument should pull in the same direction. Adjustment costs in fiscal policy, as we will consider in Section 5, also imply that both monetary policy and fiscal policy should be used, and they should pull in the same direction.[9]

Our result aligns with Mundell's (1962) recommendation that policies should target the variables they have a comparative advantage in influencing. In our framework, fiscal policy has a comparative advantage in affecting output, while monetary policy has a comparative advantage in influencing inflation. Consequently, one could implement a delegation scheme where monetary policy is assigned a strict inflation target and fiscal policy an output target.

2.2 A GENERAL REPRESENTATION

An implicit assumption in the derivation of the optimal policy mix above is that economic shocks are observable. In practice, however, only the outcomes of these shocks can be observed, and disentangling their sources involves considerable estimation uncertainty. This is exemplified by the ongoing debate over whether the recent surge in inflation was primarily driven by supply-side or demand-side shocks.[10]

An approach that does not rely on identifications of shocks is to evaluate the policy mix based on observed outcomes - specifically, the current combination of inflation and the output gap. This perspective is effectively illustrated using a "bullseye chart," a visualization popularized by the Federal Reserve Bank of Chicago.[11] As pointed out by Chicago Fed, optimal monetary policy avoids positioning the economy in the northeast or southwest quadrants of the chart, which would indicate overly loose or overly tight policy, respectively. In such cases, both inflation and output stabilization can be improved by adjusting interest rates. In contrast, the northwest and southeast quadrants reflect a trade-off: improving one objective necessarily comes at the expense of the other. However, if one

[9]It is also useful to compare our results to the results we would have obtained in the closed economy version of the model. The exchange rate channel would no longer be relevant, that is, we are in a special case of our model where $\gamma_2 = 0$. The implies that the two policies affect the output gap relative to the inflation gap in the exact same way, and the optimal policy mix is indeterminate. This result is consistent with results obtained in e.g. Gabaix (2020) and Wolf (2025), who study monetary and fiscal policy in closed economies.

[10]See Bergholt et al. (2025) and the references therein.

[11]See https://www.chicagofed.org/research/dual-mandate/the-bullseye-chart

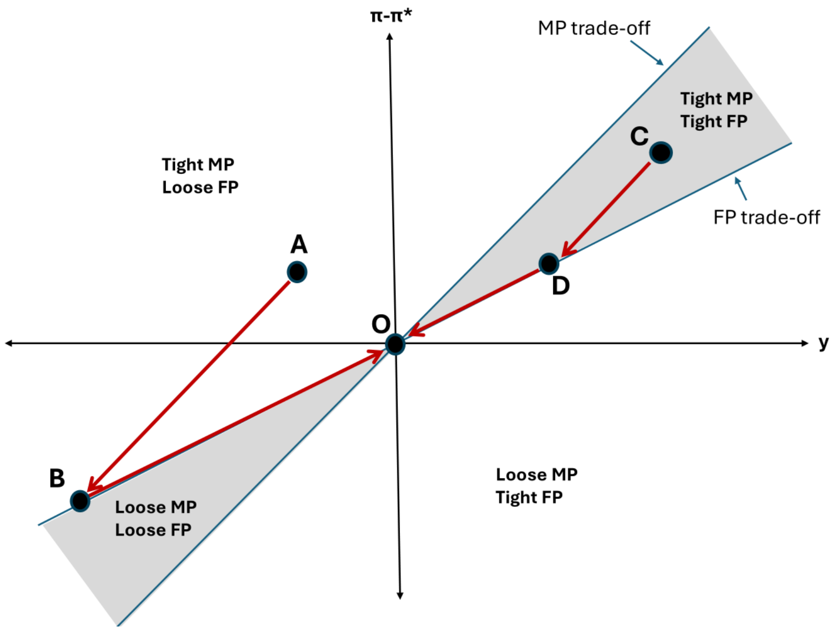


Figure 1: Towards the bull's eye. (MP: Monetary policy. FP: Fiscal policy).

uses two policy instruments, as in our analysis, one can also avoid being in the northwest and southeast quadrants and bring the economy to the origo (bullseye).

In Figure 1, each point represents a possible combination of the inflation gap and the output gap. The curve labeled "MP trade-off" shows how monetary policy affects inflation and output gaps, with the slope given by the sacrifice ratio. The curve labeled "FP trade-off" shows the corresponding relationship for fiscal policy. The fiscal policy trade-off is less steep than the monetary policy trade-off, since fiscal policy cannot utilize the exchange rate channel to affect inflation directly.

Consider point A in the figure. From this starting point, the optimal monetary policy is represented by the vector $\overrightarrow{AB}$, indicating the required degree of monetary tightening. The optimal expansionary fiscal policy is represented by the vector $\overrightarrow{BO}$. As $\overrightarrow{AB}+\overrightarrow{BO} = \overrightarrow{AO}$, this is the divergent policy mix that closes both gaps. Similarly, starting out in point C, $\overrightarrow{CD}$ represents the contractionary monetary policy, $\overrightarrow{DO}$ the contractionary fiscal policy, and $\overrightarrow{CD} + \overrightarrow{DO} = \overrightarrow{CO}$ the congruent policy mix that closes both gaps.

It is straightforward to verify that if the economy is represented by a point outside the gray area, the optimal policy mix should be divergent. Conversely, when the economy is within the gray area, monetary and fiscal policies should be congruent. Specifically, if the economy is below the gray area, the optimal mix involves expansionary monetary policy and contractionary fiscal policy, whereas if the economy is above the gray area, the reverse applies. Only in the special case where the starting point lies exactly on one of the trade-off curves can both policy objectives be achieved using a single policy instrument.[12]

From this simple analysis, two additional observations also follow. The more similar

[12]Thus note also that the crucial assumption in our approach is that monetary and fiscal policy have different sacrifice ratios, not that monetary policy affects the exchange rate while fiscal policy does not. In Subsection 4.5 both monetary and fiscal policy directly affect the exchange rate.

the monetary and fiscal trade-offs are, the smaller the gray area where congruent policies are optimal. Second, as a result, the magnitude of the optimal policy responses outside the gray area increases - meaning vectors like $\overrightarrow{AB}$ and $\overrightarrow{BO}$ become longer.

2.3 SHORTCOMINGS OF THE SIMPLIFIED APPROACH

The model in this section has many obvious shortcomings. For instance, the model is static, there are no explicit microfoundations and therefore demand and inflation are simply determined by reduced form assumptions, all expectations are exogenous, and there is no public sector budget constraint, to mention a few. In the remainder of the paper, we show that the main arguments carry over also to a fully specified, microfounded model without these shortcomings.

3 A SMALL OPEN ECONOMY NEW KEYNESIAN MODEL

The basic framework for our model is developed in the canonical paper by Galí and Monacelli (2005). However, we add a more richly specified public sector in order to analyze fiscal policy. Following Justiniano and Preston (2010) and many others, we aim for enhanced realism by adding nominal wage stickiness, imperfect exchange rate pass-through, wage and price indexation, habit persistence in consumption, as well as an endogenous risk premium that depends on the net foreign asset position. In the following, we restrict attention to the model's log-linear system of equations.[13]

Consider two countries; "home" and "foreign". Home is a small open economy that relies on trade with foreign. Business cycle shocks originate both at home and abroad, but home shocks have a negligible effect on the foreign economy. Aggregate private consumption in the home economy, c_t, is given by a constant elasticity of substitution (CES) function that aggregates domestic goods and imports. Thus, up to first order, $c_t = \alpha c_{h,t} + (1-\alpha)\, c_{f,t}$, where $c_{h,t}$ represents consumption of domestically produced goods and $c_{f,t}$ represents consumption of imported goods. The parameter $\alpha \in [0,1]$ determines the degree of home bias, capturing a closed economy as the special case with $\alpha = 1$ (and $c_t = c_{h,t}$). The consumer price index (CPI) is given by $p_t = \alpha p_{h,t} + (1-\alpha)\, p_{f,t}$, where $p_{h,t}$ and $p_{f,t}$ represent the nominal price levels of domestic and imported goods, respectively. We assume producer currency pricing among domestic firms, implying that they charge the same price $p_{h,t}$ regardless of whether goods are sold in domestic markets or abroad. This allows us to define the terms of trade as $tot_t = p_{f,t} - p_{h,t}$. The cost-minimizing consumption gap between domestic goods and imports is given by $c_{h,t} - c_{f,t} = \eta tot_t$, where η represents the substitution elasticity between domestic and imported goods.

3.1 CONSUMPTION, INCOME, AND THE LABOR MARKET

A representative household seeks to smooth consumption over time. The optimal consumption plan is determined by a standard Euler equation:

$$\lambda_t = \mathbb{E}_t \lambda_{t+1} + (i_t - \mathbb{E}_t \pi_{t+1}) + v_t. \tag{7}$$

[13]Unless explicitly stated otherwise, the variables are expressed in percentage deviations from their steady-state values.

We denote the marginal utility of private consumption by λ_t, the real (consumer) interest rate by $r_t = i_t - \mathbb{E}_t \pi_{t+1}$, and let v_t represent a demand shock. The baseline specification assumes that utility is separable in private and public consumption. However, our results carry over if we instead assume non-separable utility, as shown in Appendix E. The marginal utility of private consumption is given by

$$\lambda_t = -\frac{\sigma}{1-h} \left(c_t - h c_{t-1} \right).$$

The intertemporal elasticity of substitution is denoted by σ^{-1} while $h \in [0, 1]$ determines the degree of (external) habit formation.

A representative wage setter (labor union) seeks to set the nominal wage rate in order to stabilize a wage markup given by $\mu_{w,t} = w_t - (\varphi n_t - \lambda_t)$, where w_t represents the real (consumer) wage rate and $\varphi n_t - \lambda_t$ captures the marginal rate of substitution between leisure and consumption. n_t stands for hours worked. The wage setter faces nominal wage stickiness á la Calvo (1983). This friction implies a New Keynesian wage Phillips curve which prevents full markup stabilization in the short run:

$$\pi_{w,t} - \gamma_w \pi_{t-1} = \beta \mathbb{E}_t \left(\pi_{w,t+1} - \gamma_w \pi_t \right) - \kappa_w \mu_{w,t} + z_{w,t}. \tag{8}$$

The parameter $\gamma_w \in [0, 1]$ represents partial indexation to past consumer price inflation for the nominal wages that are not re-optimized. κ_w, in contrast, governs the direct wage pass-through from fluctuations in the current wage markup. The conventional assumption of Calvo wage stickiness implies that $\kappa_w = \frac{(1-\theta_w)(1-\beta\theta_w)}{\theta_w} \frac{1}{1+\epsilon_w \varphi}$, where $\theta_w \in [0, 1]$ is the Calvo probability that a wage setter is not able to re-optimize in a given period, and $\epsilon_w > 0$ is the elasticity of substitution between different labor types. Finally, we include an exogenous wage markup shock $z_{w,t}$.

Domestic goods market clearing can be derived as follows, when we consider a log-linear approximation around a steady state with balanced trade and relative prices equal to unity:

$$y_t = c_y \left\{ \alpha c_t + (1-\alpha) \left[y_t^* + \eta \left(tot_t + q_t \right) \right] \right\} + (1 - c_y) g_t. \tag{9}$$

We denote domestic output by y_t and public spending by g_t. The latter is assumed to be directed solely towards domestically produced goods. The parameter $c_y \leq 1$ represents the steady state ratio between private consumption and output. Foreign output (and demand) is denoted by y_t^*, and the real (consumer) exchange rate by $q_t = e_t + p_t^* - p_t$. e_t and p_t^* represent the nominal exchange rate and the nominal, foreign price level, respectively. Importantly, the presence of nominal rigidities implies that output is demand determined in the short run. A depreciation of the terms of trade (or the real exchange rate), for example, causes substitution among domestic and foreign agents towards domestic goods. The closed economy is captured as a special case with $\alpha = 1$. Finally, output is assumed to be constant returns to scale in hours worked, $y_t = a_t + n_t$, with a_t representing labor productivity.

3.2 PRICE DYNAMICS

A continuum of domestic wholesale firms set prices subject to monopolistic competition and Calvo price stickiness. This gives rise to an average price markup $\mu_{h,t} = a_t - w_t -$

$(1-\alpha)\,tot_t$, where $(1-\alpha)\,tot_t$ corrects for differences between real wages in consumer and producer prices, respectively. The New Keynesian Phillips curve for domestic price inflation follows:

$$\pi_{h,t} - \gamma_h \pi_{h,t-1} = \beta \mathbb{E}_t \left(\pi_{h,t+1} - \gamma_h \pi_{h,t}\right) - \kappa_h \mu_{h,t} + z_{h,t}. \tag{10}$$

Direct pass-through from current markups to domestic inflation is governed by $\kappa_h = \frac{(1-\theta_h)(1-\beta\theta_h)}{\theta_h}$, where θ_h represents the Calvo probability that a given firm is unable to optimize its price in a given period. The degree of domestic price indexation among non-optimizing price setters is represented by $\gamma_h \in [0, 1]$. Finally, $z_{h,t}$ is an exogenous cost-push to domestic inflation.

Prices on imports are set as in Monacelli (2005): importing wholesale firms buy differentiated import goods in international markets, rebrand them, and set prices in domestic currency subject to monopolistic competition and Calvo price stickiness. The average, nominal marginal cost is $e_t + p_t^*$ when expressed in domestic currency. Thus, the average price markup for importers is equal to $\mu_{f,t} = \alpha tot_t - q_t$. A New Keynesian Phillips curve for price inflation on imported goods follows:

$$\pi_{f,t} - \gamma_f \pi_{f,t-1} = \beta \mathbb{E}_t \left(\pi_{f,t+1} - \gamma_f \pi_{f,t}\right) - \kappa_f \mu_{f,t} + z_{f,t}. \tag{11}$$

Similarly to the domestic Phillips curve, we have that $\kappa_f = \frac{\left(1-\theta_f\right)\left(1-\beta\theta_f\right)}{\theta_f}$, where θ_f represents the Calvo probability that an importer is unable to optimize its price in a given period. The degree of indexation is given by $\gamma_f \in [0, 1]$, while $z_{f,t}$ is a cost-push shock to import prices.

Finally, the CPI inflation rate follows as the average of domestic and imported inflation:

$$\pi_t = \alpha \pi_{h,t} + (1-\alpha)\,\pi_{f,t}. \tag{12}$$

We can now express the dynamics of relative prices such as the real wage, the terms of trade, and the real exchange rate in the home economy:

$$w_t = w_{t-1} + \pi_{w,t} - \pi_t, \tag{13}$$

$$tot_t = tot_{t-1} + \pi_{f,t} - \pi_{h,t}, \tag{14}$$

$$q_t = q_{t-1} + \Delta e_t + \pi_t^* - \pi_t. \tag{15}$$

The combination of nominal wage and price rigidities implies real wage stickiness. Similarly, the combination of nominal rigidities in the prices of domestic and imported goods implies terms of trade stickiness. Finally, the real exchange rate q_t mimics the nominal exchange rate whenever foreign and domestic CPI inflation rates respond sluggishly to shocks.

3.3 Current account dynamics and the foreign economy

We define the trade balance in units of final output. Denote the real net foreign asset position by nfa_t and the trade balance by tb_t. The evolution of net foreign assets, as well as the trade balance, are stated below:

$$nfa_t = \beta^{-1} nfa_{t-1} + tb_t, \tag{16}$$

$$tb_t = y_t - c_y \left[c_t + (1 - \alpha)\, tot_t \right] - (1 - c_y)\, g_t. \tag{17}$$

Moreover, we suppose that the only way to save abroad is through a foreign bond market, and that the interest on these savings is subject to a risk premium. This gives rise to an uncovered interest rate parity (UIP) condition of the form

$$i_t = i_t^* + \mathbb{E}_t \Delta e_{t+1} + rp_t, \tag{18}$$

where i_t^* denotes the foreign interest rate, $\mathbb{E}_t \Delta e_{t+1}$ denotes expected depreciation of the nominal exchange rate, and rp_t represents the risk premium associated with trade in foreign assets. This risk premium is assumed to be decreasing in the net foreign asset position of domestic agents:

$$rp_t = -\xi nfa_t + \varepsilon_t. \tag{19}$$

The risk premium elasticity ξ governs how sensitive the exchange rate is to net foreign asset holdings. As is well known, this specification helps to ensure that foreign asset dynamics are stationary. Finally, we also include an exogenous shock to the risk premium, ε_t. This shock is meant to capture exchange rate disturbances not accounted for by fundamentals in the model.

The domestic economy described above is directly affected by the three foreign variables y_t^*, π_t^* and i_t^*. However, given that home plays a negligible role in global markets, we impose the commonly used block exogeneity assumption that foreign is large and approximately unaffected by home shocks. Thus, foreign variables are kept fixed in the baseline analysis of trade-off shocks hitting the domestic economy. However, as a robustness check we also consider a proper foreign inflation shock that implies joint dynamics in y_t^*, π_t^* and i_t^*, resulting in several channels of transmission to the domestic economy. The foreign block of the model will be specified in detail in this case.

3.4 MONETARY AND FISCAL POLICY

The model is closed with a specification of economic policy. Our prime interest is in the interactions between fiscal and monetary policy for macroeconomic stabilization. As Debortoli, Kim, Lindé and Nunes (2019), we assume that the central bank is assigned a flexible inflation targeting mandate from the political authorities, represented by a standard loss function with inflation and the output gap. Even if it is in principle possible to derive a microfounded welfare loss function, in this model it is not feasible to derive a tractable analytical solution. More importantly, we want to focus on how fiscal policy can support monetary policy in achieving the stabilization objectives given by the political authorities. As mentioned in the introduction, this does not imply that fiscal policy cannot have other objectives and other instruments.

To model the stabilization objectives, we follow Debortoli et al. (2024) and consider a standard quadratic loss function that depends on inflation and output:

$$\mathcal{L}_t = (\pi_t^a)^2 + \lambda y_t^2, \tag{20}$$

where π_t^a is annualized quarterly inflation and λ governs the importance of output stability relative to inflation stability. The policy objective is to minimize the expected discounted sum of losses, i.e., $\mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \mathcal{L}_s$. We assume that the loss function is minimized under discretion[14] and subject to a standard law of motion for public debt:

$$b_t = \beta^{-1} b_{t-1} + (1 - c_y)(g_t - \tau_t). \tag{21}$$

b_t represents the debt level relative to steady-state output, while τ_t is the tax level in percentage deviation from its level in steady-state.

When analyzing the optimal policy mix in the baseline model, we assume that monetary and fiscal policy authorities jointly minimize the loss function (20) using the instruments i_t and g_t, respectively. Taxes, instead, are assumed to adjust as necessary to maintain stationary public debt dynamics. For example, the simple tax rule

$$(1 - c_y)\tau_t = \psi_b b_{t-1}, \tag{22}$$

where the left-hand-side represents taxes as share of steady-state output, implies stationary debt dynamics for all values of ψ_b in the region $\beta^{-1} + 1 > \psi_b > \beta^{-1} - 1$.

This approach to modeling fiscal policy is justified by the presence of Ricardian equivalence in our baseline analysis, which considers a representative agent New Keynesian (RANK) framework. Ricardian equivalence has two important implications: first, as shown by Auclert, Rognlien, and Straub (2024), the fiscal multiplier is 1 when the interest rate is constant.[15] Second, under Ricardian equivalence, the exact timing of tax changes need not be specified, as long as stationary debt dynamics is ensured. However, the tax scheme will be relevant in later sections, when we depart from Ricardian equivalence. Then we will also be precise about the calibration of the tax rule. Finally, note that in the baseline model presented above, government spending does not enter households' marginal utility function for private consumption. Thus, utility is separable in c_t and g_t. We relax this assumption in Appendix E and show that our main results are robust even if there is very strong complementarity between private and public consumption. This completes our description of the baseline, quantitative model.

3.5 Calibration

The model's parameters are set to standard values in the literature when we simulate and analyze policy interactions. That is, we set $\beta = 0.99$, assume log utility by setting $\sigma = 1$, and capture a Frisch elasticity of 0.5 with $\varphi = 2$. We calibrate the home bias parameter to $\alpha = 0.65$, reflecting an import share in GDP of 35%. Regarding the nominal rigidities, we set $\theta_w = \theta_h = \theta_f = 0.75$, which implies that wages and prices change on average once every year. Habit and indexation parameters are set to $h = 0.75$ and $\gamma_w = \gamma_h = \gamma_f = 0.5$, respectively. The risk premium elasticity $\xi = 0.01$ implies only minor feedback from net foreign assets to exchange rates. For the foreign economy we calibrate all parameters to be the same as in the domestic block. The output weight in the loss function is set to $\lambda = 0.25$. Finally, we specify the calibration of tax rules in later sections when we depart from Ricardian equivalence and analyze automatic stabilizers.

[14] Optimal monetary policy under commitment would have implied a stationary price-level, which means that the central bank would have conducted monetary policy *as if* it had a price-level target. Since we do not observe this extreme inflation overshooting strategy in the real world, we focus on the more realistic case of optimal policy under discretion, which does not imply a stationary price level.

[15] In our open economy framework, an endogenous risk premium modifies this result slightly.

4 POLICY COORDINATION IN RESPONSE TO SHOCKS

We now consider the policy responses to different shocks under alternative interactions between monetary and fiscal policy. For each type of shock, we first consider the traditional case with an active monetary policy and a passive fiscal policy. Then, we study the optimal coordination between the two policies. As we will show, unrestricted use of monetary and fiscal policy makes it possible to stabilize both inflation and output perfectly irrespective of the type of shock hitting the economy. While this is arguably an unrealistic case, it is an interesting normative benchmark for analyzing more realistic cases. We will later consider (i) the case in which there are costs of using the policy instruments, and (ii) the case in which fiscal policy stabilization is conducted by the use of automatic stabilizers and not discretionary government spending.

In Subsection 4.1, we discuss an inflation shock, in Subsection 4.2 an exchange rate shock, in Subsection 4.3 a demand shock, in Subsection 4.4 a foreign inflation shock, and in Subsection 4.5 what we term the Liz Truss effect. Each subplot shows the response in the variable(s) of interest along the vertical axis, and time measured in quarters on the horizontal axis. Output, government spending and the real exchange rate are measured as percentage deviations from their respective levels in steady state. Inflation and interest rates are expressed in annualized percentage points. We focus on 16 periods (4 years), since most of the output and inflation gaps will be closed within this time frame.

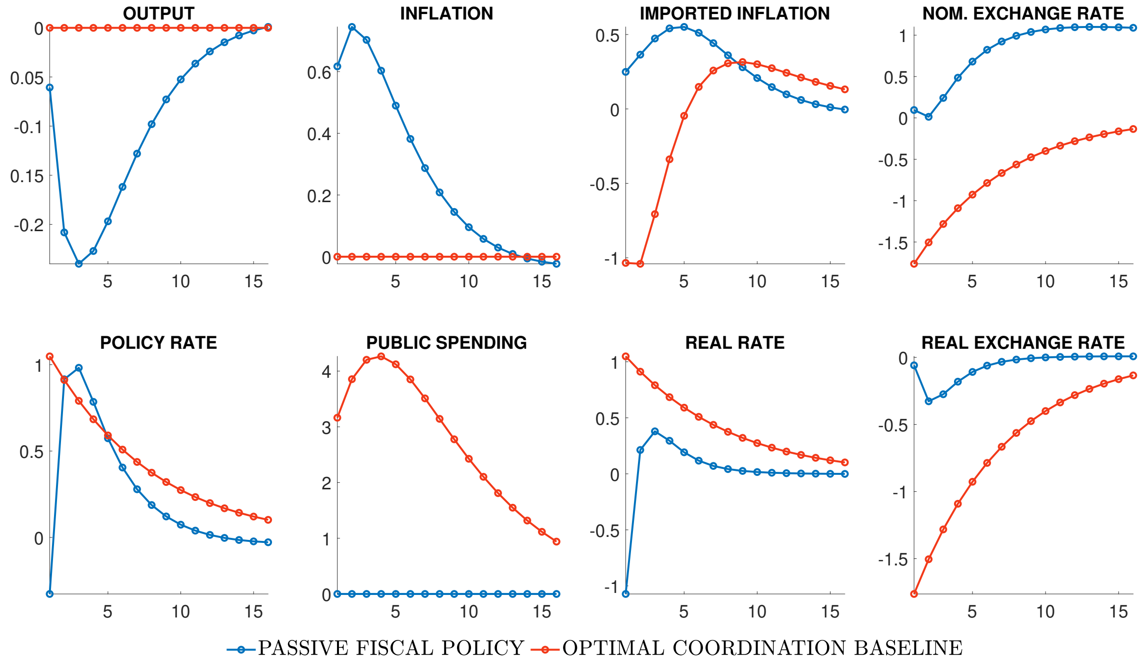
4.1 INFLATION SHOCK

We consider an inflation shock represented by a positive shock, $z_{h,t}$, to the costs of domestic firms, see equation (10).

4.1.1 OPTIMAL MONETARY POLICY, PASSIVE FISCAL POLICY

The blue curves in Figure 2 show the impulse responses in the traditional case of an optimal monetary policy response to a positive inflation shock. As is well known, such a shock generates a conflict between inflation stability and output stability. The optimal trade-off is characterized by inflation above target and a negative output gap. To achieve this trade-off, the interest rate must increase. The real exchange rate appreciates slightly due to an increase in the real interest rate differential. However, the nominal exchange rate depreciates, thereby giving higher imported inflation. To explain this, note that the nominal exchange rate is affected by the inflation shock through two opposing channels. First, a higher nominal interest rate leads to a stronger nominal exchange rate. Second, the inflation shock leads to a higher long run nominal price level, which must lead to a weaker nominal exchange rate in the long run in order to restore the equilibrium real exchange rate. Forward-looking agents front-load this effect immediately, depreciating the exchange rate on impact. As indicated by the higher imported inflation, the second effect dominates in our case. Since fiscal policy is assumed passive, there is no change in government spending.

Figure 2: Inflation shock, passive vs. optimal fiscal policy



Note: Selected impulse response functions conditional on a unit increase in $z_{h,t}$. Inflation rates and interest rates are annualized and measured in percentage points, the remaining variables are measured in percent. Horizontal axes represent time in quarters. We condition on optimal policy under discretion.

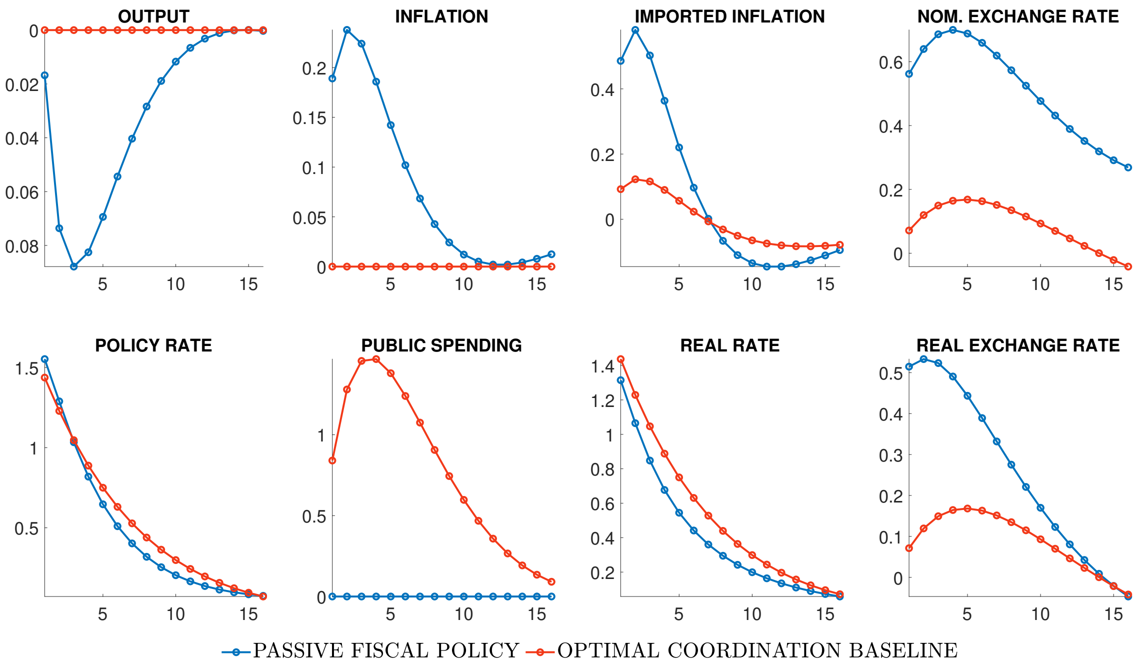
4.1.2 Optimal coordination of monetary and fiscal policy

The red curves in Figure 2 show the impulse responses when both monetary and fiscal policies are active and jointly optimal. We see that both inflation and output are perfectly stabilized. To achieve this, policies need to be divergent; monetary policy is contractionary, while fiscal policy is expansionary. In this case a higher interest rate leads to both a nominal and a real exchange rate appreciation, since the effect on the long run domestic price level is eliminated. A stronger nominal exchange rate leads to lower imported inflation in the short run, which perfectly offsets the effect of higher domestic inflation on CPI inflation. An expansionary fiscal policy counteracts the adverse effects on output from the contractionary monetary policy. Consequently, compared to the case with a passive fiscal policy, the optimal monetary policy now becomes more contractionary. The combination of more contractionary monetary policy and expansionary fiscal policy allows for the achievement of both inflation and output stability. These results confirm the findings in the simplified model in Section 2.

A possible objection to the above result is that, in practice, the exchange rate might be weaker than suggested by the UIP condition. If this is the case, however, our result of policy divergency is strengthened. The intuition for this is that in such a case, the interest rate must respond even stronger to achieve the desired exchange rate appreciation. As a result, fiscal policy must be more expansionary to offset the negative demand effect of the higher interest rate.

Another objection is that the exchange rate is affected by many other, and potentially more important, factors than the interest rate. Such factors can be captured by a risk

Figure 3: Exchange rate shock, passive vs. optimal fiscal policy



Note: See Figure 2 for details.

premium shock.

4.2 Exchange rate shock

We now consider a positive shock to the risk premium, ε_t, which gives rise to an exchange rate depreciation, see equation (18).

4.2.1 Optimal monetary policy, passive fiscal policy

Figure 3 shows, by the blue curves, the impulse responses with optimal monetary policy under passive fiscal policy. Again, as is well known[16], the central bank increases the interest rate to dampen the depreciation, but not sufficiently to neutralize the effect on the exchange rate, since that would have implied a too sharp contraction in output. With monetary policy as the only policy instrument, the optimal trade-off after a positive shock to the risk premium implies that the interest rate should be set to give a positive inflation gap and a negative output gap. The ratio of the two gaps depends on λ in the loss function and on the sacrifice ratio, which depends on the parameters of the model.

4.2.2 Optimal coordination of monetary and fiscal policy

Figure 3 shows (red curves) the impulse responses when monetary and fiscal policies are jointly optimal. As seen, both output and inflation are stabilized. To achieve this, monetary policy must be contractionary while fiscal policy must be expansionary. The

[16]See, e.g., Monacelli (2005) or Svensson (2000).

intuition is that monetary policy can be used to fully to counteract the risk premium shock, so that the exchange rate is unchanged in spite of a higher risk premium. Since this requires a higher interest rate, fiscal policy must be expansionary to prevent output from falling. Compared to the case with passive fiscal policy, the central bank increases the interest rate less sharply in the first period, but keeps it higher for longer, until the risk premium has been phased out. The accumulated increase in the interest rate is thus larger under optimal fiscal policy than under a passive policy, implying that monetary policy is more contractionary.

4.3 Demand shock

Next, we consider a positive demand shock, represented by v_t in equation (7).

4.3.1 Optimal monetary policy, passive fiscal policy

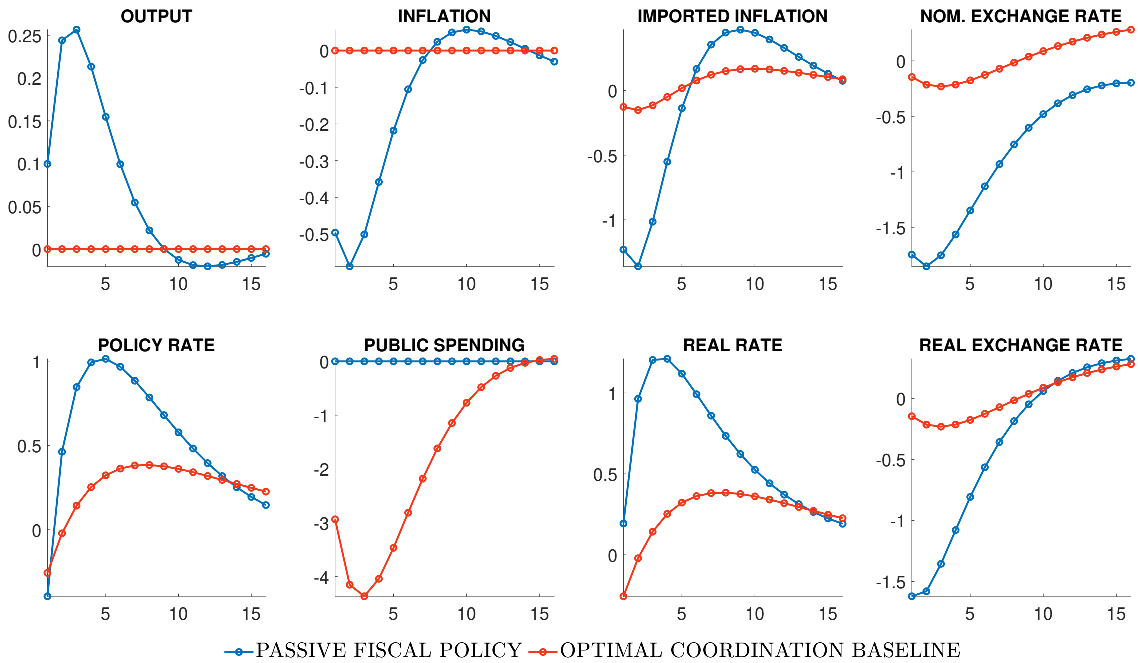
Figure 4 shows (blue curves) that the demand shock is met by a contractionary monetary policy. The optimal trade-off implies a positive output gap and a negative inflation gap. The intuition is as follows: If the interest rate were increased sufficiently to neutralize the effect of the demand shock on output, inflation would have been too far below target due to the exchange rate appreciation. Thus, a monetary policy that stabilizes output completely can never constitute an optimal trade-off. In our open-economy model, the trade-off between CPI inflation and output stability is due to the direct exchange rate channel on imported inflation. This is in contrast to a closed economy, where demand shocks can be completely neutralized by monetary policy.[17] Thus, also in the case of demand shocks, the optimal trade-off implies that the inflation gap and the output gap should have opposite signs.

4.3.2 Optimal coordination of monetary and fiscal policy

The red curves in Figure 4 represent the impulse responses when policy is optimal. In the simple model in Section 2, both inflation and output could be perfectly stabilized by fiscal policy alone, as a contractionary fiscal policy response to positive demand shocks would prevent output and thereby inflation from rising. That result hinges on an exogenous risk premium. In the current model, the risk premium is endogenous and depends on net foreign assets. Although the main motivation for this specification is to make net foreign assets stationary in the model, one could also argue that it provides some realism. With an endogenous risk premium, a contractionary fiscal policy that neutralizes the effect of the demand shock on output would generate a negative trade balance since the reduction in government spending is in terms of domestically produced goods only, while the increase in private consumption is in terms of both domestically produced and imported goods. The risk premium therefore increases, and this would give rise to a weaker exchange rate and higher imported inflation. Due to the endogenous risk premium, the central bank must increase the interest rate if both CPI inflation and output shall be unaffected by the

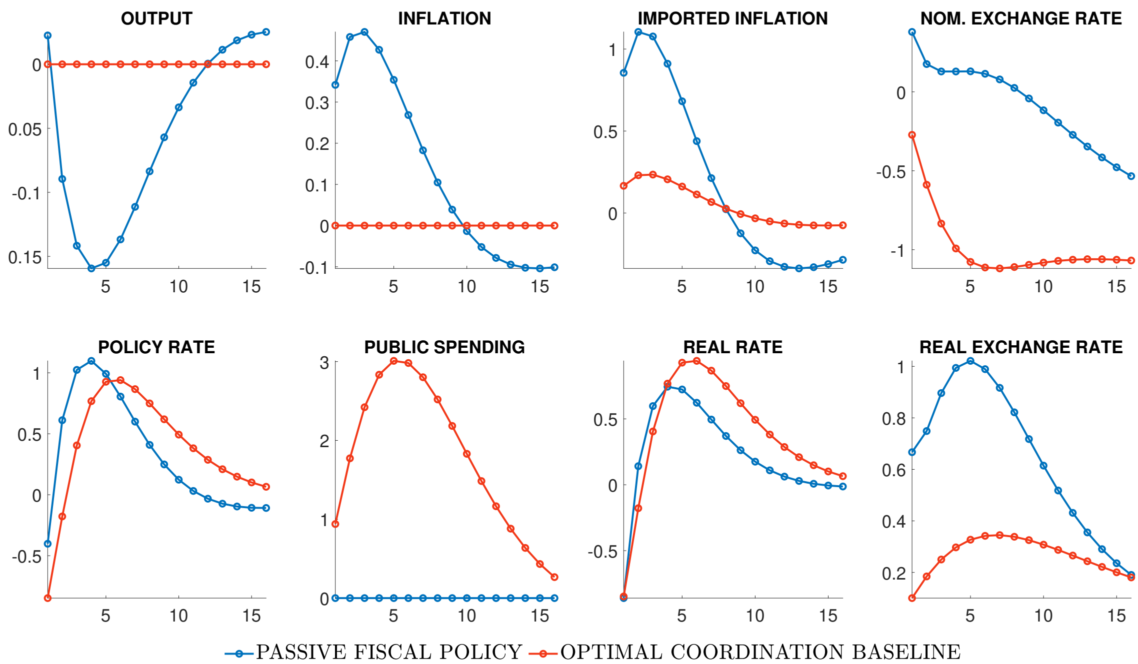
[17] In small open economy models with perfect exchange rate pass-through to import prices and no imported inputs, it is optimal to stabilize domestic inflation, see Gali and Monacelli (2005). In such models, unlike our model, demand shocks do not create a trade-off for monetary policy.

Figure 4: Demand shock, passive vs. optimal fiscal policy



Note: See Figure 2 for details.

Figure 5: A foreign inflation shock



Note: See Figure 2 for details.

demand shock. The two policy instruments should thus pull in the same direction when demand shocks occur, that is, be congruent.

4.4 Foreign inflation shock

Finally, we consider a foreign inflation shock, π_t^*, taking into account the endogenous interaction between the foreign variables in general equilibrium. The foreign economy is defined as a special case of home when $\alpha = 1$. Thus, foreign is effectively a large, closed economy. However, to keep the analysis as tractable as possible, we abstract from optimal policy abroad by assuming that the foreign interest rate follows a simple Taylor rule and that foreign fiscal policy is passive. Finally, we abstract from foreign nominal wage rigidities. The foreign block follows below:

$$\text{Output } y_t^*: \quad y_t^* = h^* y_{t-1}^* + \mathbb{E}_t \left(y_{t+1}^* - h^* y_t^* \right) - \frac{1-h^*}{\sigma^*} \left(i_t^* - \mathbb{E}_t \pi_{t+1}^* \right) + d_t^*. \tag{23}$$

$$\text{Inflation } \pi_t^*: \quad \pi_t^* = \gamma^* \pi_{t-1}^* + \beta^* \mathbb{E}_t \left(\pi_{t+1}^* - \gamma^* \pi_t^* \right) + \kappa^* \left(y_t^* - h^* y_{t-1}^* \right) + z_t^*. \tag{24}$$

$$\text{Interest rate } i_t^*: \quad i_t^* = \phi_i^* i_{t-1}^* + (1-\phi_i^*) \left(\phi_\pi^* \pi_t^* + \phi_y^* y_t^* \right) + \phi_t^*. \tag{25}$$

d_t^*, z_t^* and ϕ_t^* represent a foreign demand shock, a foreign inflation shock, and a foreign monetary policy shock, respectively. Below we restrict attention to the inflation shock. Regarding the calibration of the parameters in the foreign block, we opt for symmetry and set $h^* = h$, $\sigma^* = \sigma$, and $\beta^* = \beta$. The Phillips curve slope is calibrated to $\kappa^* = 0.1$. Finally, the foreign Taylor rule coefficients are set as follows: $\phi_i^* = 0.85$, $\phi_\pi^* = 2$, and $\phi_y^* = 0.125$. Figure A.1 in the appendix reports the joint dynamics in the foreign economy. A positive innovation in z_t^* raises foreign inflation, causing foreign nominal and real interest rates to increase as well. This, in turn, leads to a contraction in global activity. Thus, for agents in the domestic economy, this shock looks like a combination of shocks to the risk premium and domestic exporters' demand.

4.4.1 Optimal monetary policy, passive fiscal policy

The blue curves in Figure 5 show the domestic impulse responses to a foreign inflation shock when fiscal policy at home is passive. Given the nature of this shock, it generates a conflict between inflation and output stability. The optimal trade-off is characterized by inflation above target and a negative output gap. To achieve this trade-off, the interest rate must increase. Not surprisingly, this shock is qualitatively similar to a domestic cost-push shock.

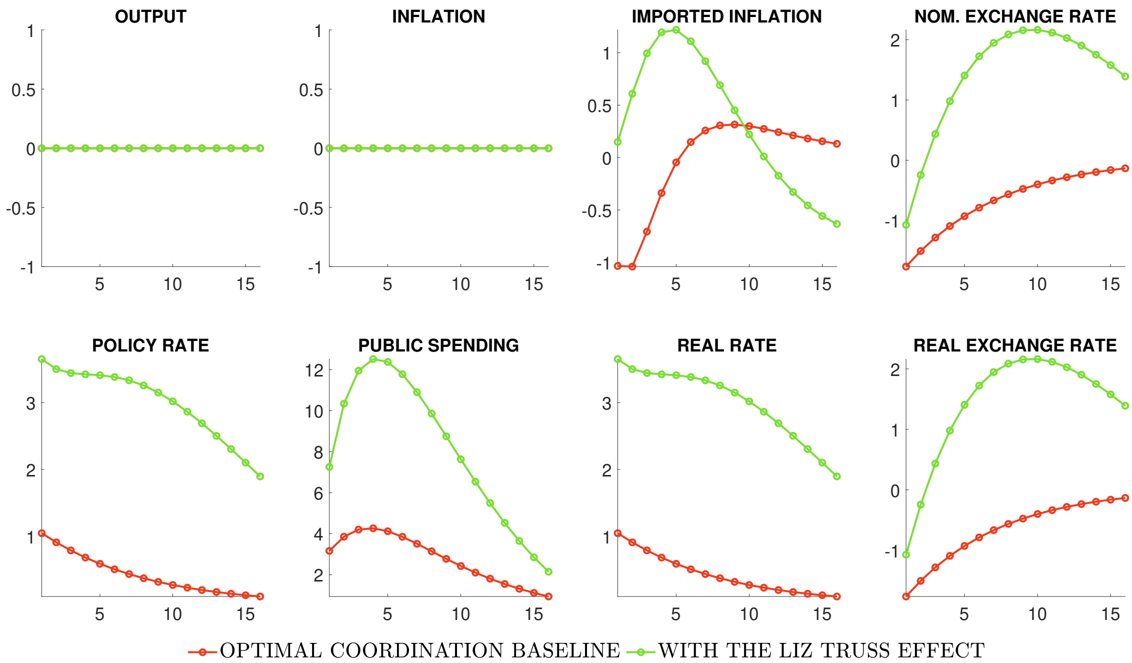
4.4.2 Optimal coordination of monetary and fiscal policy

As seen from Figure 5, it is optimal for monetary and fiscal policy to be divergent also in this case. The interest rate is increased to offset the inflationary effect of an exchange rate depreciation (due to a lower interest rate differential, as the foreign interest rate increases). Fiscal policy is expansionary to counteract the negative effect on output of the higher interest rate and lower demand for the home country's exports. Moreover, as is the case for a domestic inflation shock, the optimal response of monetary policy is even more contractionary when the fiscal authorities are allowed to act in an optimal manner.

4.4.3 Global inflation shock

An interesting case to consider is a global shock that is common to both the foreign and the domestic economy. If the rest of the world can be characterized as a closed economy,

Figure 6: Optimal coordination with the Liz Truss effect



Note: See Figure 2 for details.

as analyzed above, the world economy cannot utilize the exchange rate channel, contrary to the domestic economy. Then, our conclusions above are still valid. However, if the world economy also can be characterized by a group of open economies, they can all in principle make use of the exchange rate channel. In such a case, there will be no Nash equilibrium, as each country has an incentive to set a higher interest rate (and more expansionary fiscal policy) than the others. In order to have a Nash equilibrium, there must be costs of using the policy instruments, as we analyze in Section 5. Then, if the economy we consider is more open than the rest of the world, there will be an equilibrium characterized by a higher interest rate and thus an appreciated exchange rate, and a more expansionary fiscal policy, for the home economy.[18]

4.5 THE LIZ TRUSS EFFECT

In the above model, it was assumed that fiscal policy did not affect the exchange rate directly - only indirectly through the interest rate response to fiscal policy and through its effect on inflation and thus the expected long-run price-level relative to the foreign price-level. While this is in accordance with standard theoretical models, one may argue that in practice fiscal policy could affect the exchange rate more directly, for example through foreign exchange market participants' perceptions of risk and their required compensation for this risk. In countries where confidence in government debt sustainability is limited, a larger budget deficit may lead to a depreciation of the exchange rate. A notable example is the announcement by Liz Truss in September 2022 of a significant debt-financed fiscal

[18]The Nash equilibrium will, however, generally be sub-optimal for the world as a whole, as there are negative international externalities of utilizing the exchange rate channel.

expansion, which caused considerable concern in financial markets and led to a sharp depreciation of the British pound. Consequently, we extend the exchange rate component of the model by assuming that the risk premium is positively correlated with the level of government debt:

$$rp_t = -\xi nfa_t + \xi_b b_t + \varepsilon_t. \tag{26}$$

We will refer to exchange rate depreciation arising from public debt accumulation (illustrated by $\xi_b > 0$) as "the Liz Truss effect". Note that since the risk premium enters the forward-looking UIP condition, it is mainly the exptected future path of debt that affects the exchange rate, and not the current level of debt.

Figure 6 compares impulse responses to an inflation shock under optimal policy coordination in the baseline (red) with the counterpart when the Liz Truss effect is activated (green). The latter is implemented by setting $\xi_b = 0.05$. Now, in order to achieve full stabilization of inflation and output, we note that the two policy instruments need to be even more divergent. The reason is that the Liz Truss effect makes fiscal policy more similar to monetary policy, as it also affects the exchange rate directly. Generally, as we discussed in Subsection 2.2, the more similar the policy instruments are, the more divergent they have to be in order to reach the objectives. In the limit, when the two instruments have the same relative effects on inflation and output, there is in essence only one policy instrument.[19] The same qualitative results hold for a risk premium shock (shown in Figure B.1 in Appendix B).

For a demand shock, however, the above result—that the policies should be congruent—may no longer hold, as seen from Figure B.2 in Appendix B. Fiscal policy is still contractionary, but now monetary policy is expansionary. Thus, when the Liz Truss effect is operative, the optimal policy mix may be divergent even conditional on demand shocks. The reason for this result is that when fiscal policy becomes contractionary to offset the demand shock, it also reduces the risk premium, which gives an exchange rate appreciation. In order to prevent too low inflation due to the appreciation, monetary policy must counteract this effect by becoming expansionary. The expansionary monetary policy stimulates output, which in turn requires an even more contractionary fiscal policy.

5 COSTS OF USING THE POLICY INSTRUMENTS

The above results, which suggest that the optimal policy mix can achieve perfect stabilization of both inflation and output, serve as an interesting normative benchmark. However, this is arguably unrealistic for two main reasons. First, in practice, neither monetary policy nor fiscal policy can perfectly control inflation and output due to uncertain effects and transmission (and implementation) lags. Second, and more importantly, the optimal policy mix in response to inflation and risk premium shocks might necessitate very active use of policy instruments. This is more pronounced when the policy instruments are optimally divergent. Significant changes in government spending and taxes based on the

[19] If the Liz Truss effect is sufficiently large, fiscal policy becomes relatively more efficient in stabilizing inflation compared to monetary policy. In this case, the two policy instruments shall still be divergent, but with opposite signs, so that monetary policy becomes expansionary and fiscal policy contractionary, as a response to a positive inflation shock.

business cycle and the nature of shocks could lead to undesirable welfare costs, such as unpredictable public services and costs of distortionary taxes.[20] Additionally, for political reasons, it might be challenging to reverse fiscal expansions when they are no longer needed for economic stabilization. This suggests a need for more moderated fiscal policy responses to shocks.

Similarly, significant changes in the interest rate can also incur costs. One such cost is related to the uncertainty of the effects of monetary policy. The well-known attenuation result by Brainard (1967) can be shown to be equivalent to adding a term with the squared interest rate (gap) to the standard loss function. Additionally, there may be mechanisms or policy concerns not captured by the standard model. For instance, aggressive use of the interest rate could lead to financial instability, which may, in turn, affect output and inflation. There may also be concerns beyond the stability of inflation and aggregate output. Even if central banks focus on aggregate variables, significant changes in the interest rate could have undesirable distributional effects. These effects might prompt central banks to consider them, at least implicitly, in their monetary policy trade-offs.

To add adjustment costs we shall in the following consider the following loss function:

$$\mathcal{L}_t = (\pi_t^a)^2 + \lambda_y y_t^2 + \lambda_g g_t^2 + \lambda_r (r_t^a)^2 . \tag{27}$$

We consider adjustment costs in the annualized *real* interest rate rather than the nominal rate, since the monetary policy stance in this model should be measured by the real rate. In addition, as shown by Alstadheim and Røisland (2017), adding adjustment costs in the nominal rate may result in a *less* stable interest rate under a discretionary policy due to the time-inconsistency problem.[21]

Costs of adjusting a policy instrument obviously implies that the instrument should be used less actively. However, it also implies that the other instrument should be used less actively when policies are optimally divergent. To see the intuition for this, consider the case of fiscal adjustment costs. Then, under an inflation shock fiscal policy should be less expansionary. But then monetary policy must be less contractionary, since it to a lesser degree must counteract the expansionary fiscal policy. In the limit, we are back to the case with a passive fiscal policy. The same intuition holds for monetary adjustment costs.[22]

Figure 7 illustrates a scenario involving both fiscal and monetary adjustment costs. As depicted by the green curves, both policy responses are significantly more subdued compared to the case without adjustment costs. Consequently, neither inflation nor output are fully stabilized. The underlying reason is that with adjustment costs included in the loss function, there are effectively more than two targets, which implies that the Tinbergen rule does no longer apply.

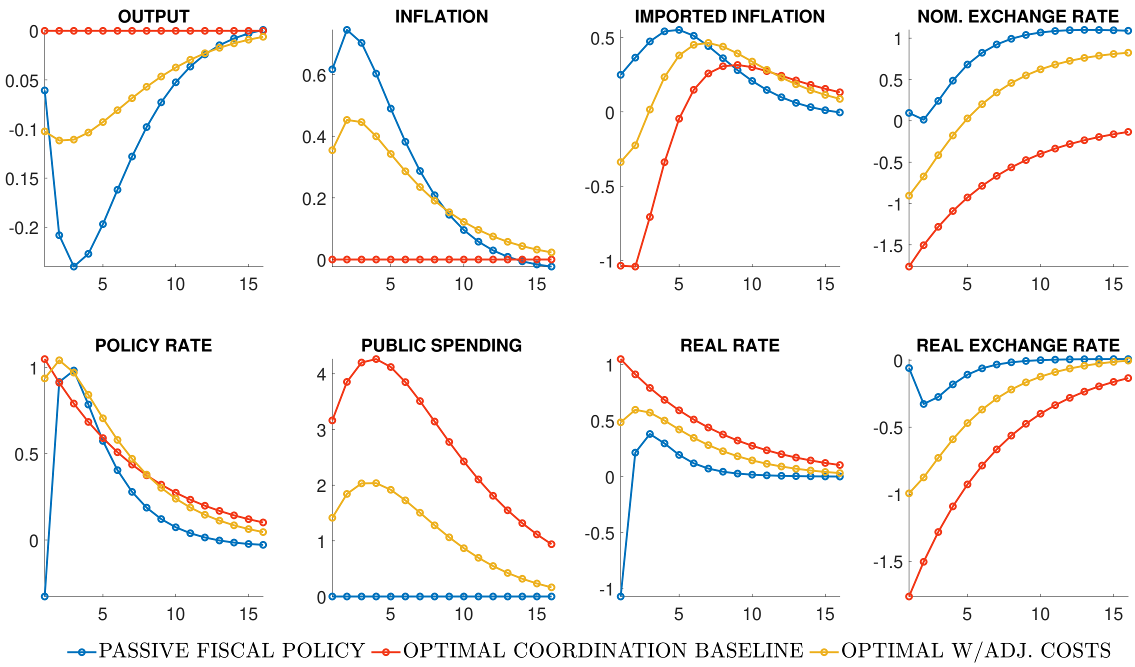
In Figure 7 policies are still divergent. However, with adjustment costs in monetary policy, this is not a general result. If the cost of adjusting the interest rate is sufficiently large, then fiscal policy must support monetary policy in stabilizing inflation, so that fiscal policy also becomes contractionary under a positive inflation shock. This is illustrated

[20] We have for simplicity assumed lump-sum taxes, which are by construction non-distortionary. In reality, however, taxation will be distortionary.

[21] It is also common to include an interest rate smoothing term, represented by a squared term with the change in the nominal rate, in the loss function. This would make the responses more gradual, but would not prevent relatively large deviations from the natural rate.

[22] When policies are optimally congruent, however, as in the case with demand shocks, higher adjustment costs on one policy instrument implies more active use of the other instrument.

Figure 7: Optimal coordination with adjustment costs



Note: Calibration of adjustment costs: $\lambda_r = 0.02$, $\lambda_g = 0.002$. See Figure 2 for details.

in Figure 8, which shows the responses of fiscal policy and monetary policy to an inflation shock as a function of monetary adjustment costs. As seen by the blue curve, for sufficiently high adjustment costs in monetary policy, the fiscal policy response becomes contractionary (when the blue curve falls below zero), thus supporting the contractionary monetary policy, making the policy responses congruent.

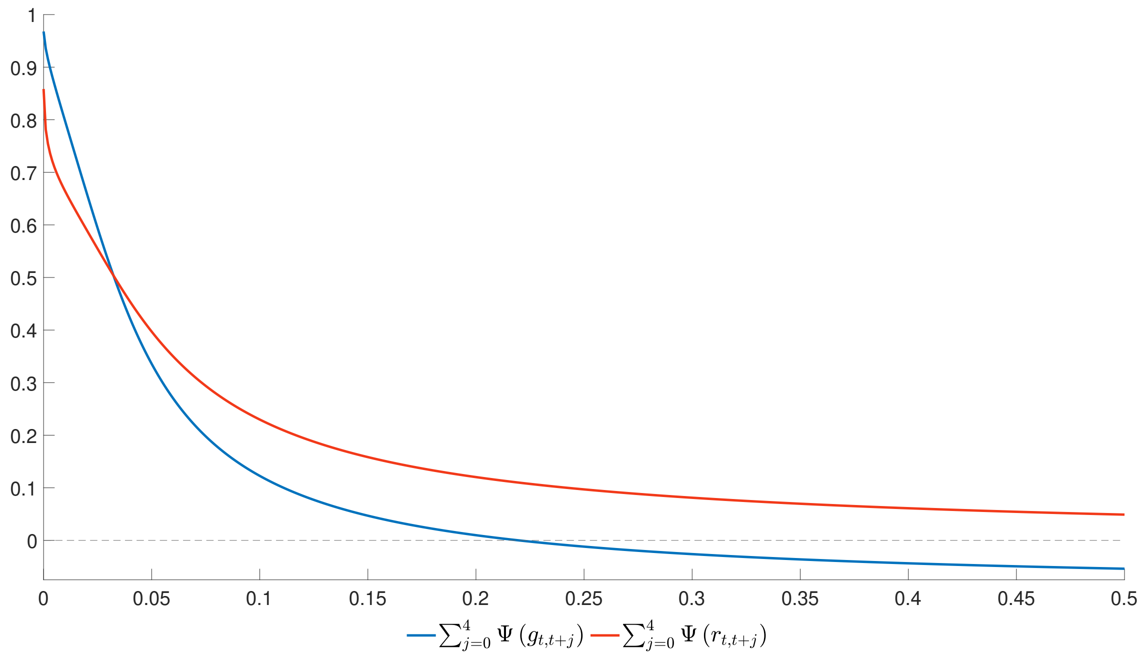
6 AUTOMATIC STABILIZERS

So far, we have considered fiscal policy as discretionary changes in public spending. Although not modeled here, such active discretionary fiscal policy has well-known drawbacks. First, there is a debt bias due to time-inconsistency problems. Second, there are political decision lags. Third, it usually takes time to implement policy changes. The first drawback is probably the most significant, as the fiscal policy measures during the pandemic illustrated that decision and implementation lags need not be very binding under specific circumstances. An institutional solution to the debt bias is to introduce fiscal policy rules. A related, but less ambitious, solution is to rely on automatic stabilizers.

When aggregate income falls, both the tax system and the transfer system contribute to automatic stabilization, as taxes fall and transfers (such as unemployment benefits) increase. Automatic stabilizers can be seen as a special case of fiscal policy rules. Blanchard and Summers (2020) consider an intermediate case which they denote ”semi-automatic stabilizers”, which is automatic stabilizers supplemented by fiscal rules.

Blanchard (2006) commented that “very little work has been done on automatic stabilization [...] in the last 20 years”. Unfortunately, research on automatic stabilization has remained quite limited in the nearly 20 years since Blanchard made this comment. A

Figure 8: The stance of monetary and fiscal policy with adjustment costs in monetary policy



Note: We condition on optimal monetary policy under discretion. $\sum_{j=0}^{4} \Psi (g_{t,t+j})$ represents the average impulse response of public spending over the first year (4 quarters) after the shock, $\sum_{j=0}^{4} \Psi (r_{t,t+j})$ represents the same object, but for the real interest rate. The horizontal axis shows the value of λ_r. All other parameters are set to their baseline values, including $\lambda_g = 0$.

notable exception is McKay and Reis (2016), who estimated the effects of automatic stabilizers for the US economy. They found that automatic stabilizers have not significantly contributed to more stable business cycles. However, they observed that in situations where monetary policy is constrained, such as by the lower bound, automatic stabilizers have large effects. This suggests that active monetary policy neutralizes some of the effects of automatic stabilizers. This result aligns with our model. In a closed economy, monetary and fiscal policy are perfect substitutes for macroeconomic stabilization, as they affect output and inflation similarly. When monetary policy is actively used for stabilization, fiscal measures are largely counteracted by monetary policy. In a small open economy, however, the two policy instruments have different relative effects on inflation and output, so the effects of fiscal measures are not counteracted by monetary policy. Therefore, automatic stabilizers have a more dampening effect on business cycles in a small open economy than in a closed economy.

6.1 A TWO-AGENT MODEL EXTENSION

To analyze automatic stabilizers, which primarily work through taxes and transfers, and not government spending, we need to extend the model. In the representative agent New Keynesian (RANK) model above, Ricardian equivalence holds, and thus the timing of taxes and transfers does not affect demand. There are different ways to invalidate Ricardian equivalance, such as imperfect financial markets and bounded rationality. We choose to deviate from Ricardian equivalence by assuming that some households consume their disposable income in a hand-to-mouth fashion. This could be interpreted either as reflecting borrowing restrictions for parts of the population (i.e. imperfect financial markets), or that certain households have a rule-of-thumb behavior (i.e. bounded rationality). Thus, we extend the baseline framework by considering a two-agent New Keynesian (TANK) model. As shown by Debortoli and Galí (2024), the implications of household heterogeneity for macroeconomic fluctuations can largely be captured by these two types of households.

In particular, we assume that a fixed share ι of households in the home economy is restricted from participating in financial markets. Restricted household members consume all their current income in a hand-to-mouth manner, with their income consisting solely of labor earnings after taxes. The remaining $1-\iota$ households are unrestricted and make consumption-saving decisions in a fully Ricardian fashion, as in the baseline model. We also assume a common wage rate across household types, as further specified below.

We log-linearize the model around a steady state with balanced trade, zero government debt, and equal per capita consumption across restricted and unrestricted households.[23] Moreover, we abstract from considering redistributive policies because our prime interest is in optimal policy coordination given a macroeconomic stability mandate. Thus, it is assumed that all households face the same tax schedule. Consumption among restricted households is given by

$$c_{R,t} = \frac{1}{c_y}\left\{w_t + n_{R,t} - (1-c_y)\left[\tau_t - (1-\alpha)\, tot_t\right]\right\}, \tag{28}$$

where $c_{R,t}$ represents per capita consumption for restricted households, w_t is the hourly real wage, and $n_{R,t}$ is labor hours among restricted household workers. τ_t is net taxes as before, while the term $(1-\alpha)\, tot_t$ cor rects for differences between the CPI and the price on domestically produced goods (recall that taxes are expressed in units of the domestic good). Consumption for the savers is determined by the standard consumption Euler equation $\lambda_{S,t} = \mathbb{E}_t\lambda_{S,t+1} + (i_t - \mathbb{E}_t\pi_{t+1}) + v_t$, where the marginal utility of consumption for savers is

$$\lambda_{S,t} = -\frac{\sigma}{1-h}\left(c_{S,t} - hc_{S,t-1}\right). \tag{29}$$

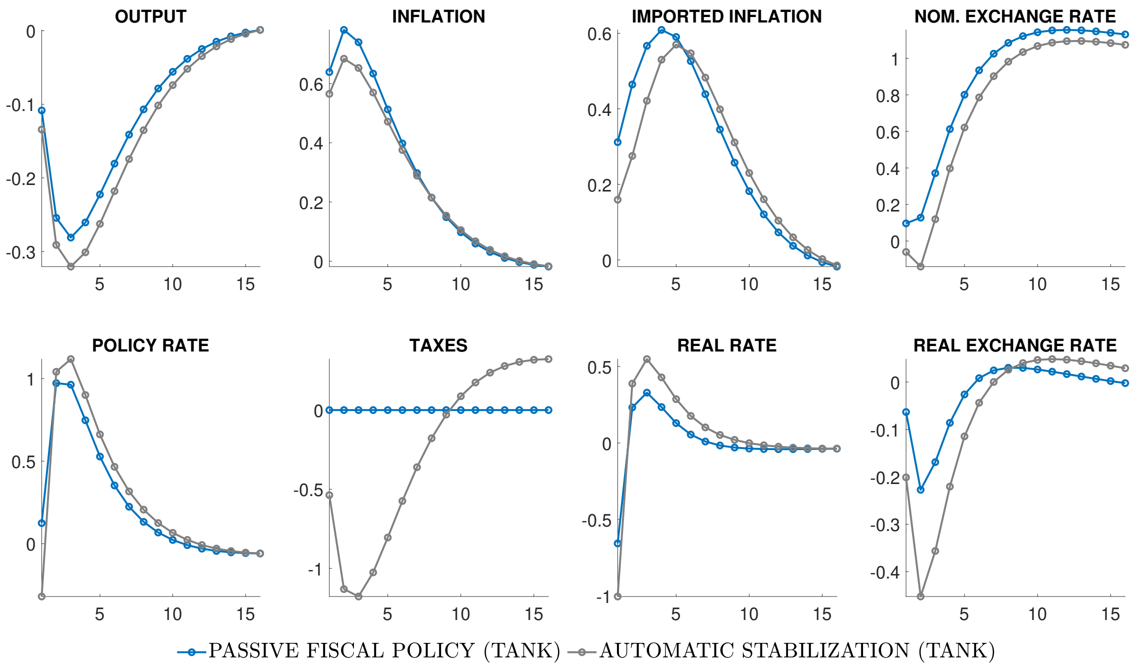
Aggregate consumption in the economy is the sum of consumption among restricted and unrestricted households:

$$c_t = \iota c_{R,t} + (1-\iota)\, c_{S,t}. \tag{30}$$

Finally, the representative wage setter (labor union) is assumed to stabilize the population-weighted wage markup $\mu_{w,t} = w_t - (\varphi n_t - \lambda_t)$, where $n_t = \iota n_{R,t} + (1-\iota)\, n_{S,t}$ represents average hours worked across the two agents. $\lambda_t = \iota\lambda_{R,t} + (1-\iota)\,\lambda_{S,t} = -\frac{\sigma}{1-h}\left(c_t - hc_{t-1}\right)$ is the average marginal utility of consumption in the economy. The rest of the model remains as before.

[23] Equal per capita consumption is facilitated with a price subsidy to firms. This subsidy removes the steady state distortion caused by market power, and is financed by a lump-sum tax on the firm owners, as in Biilbie, Monacelli and Perotti (2024).

Figure 9: Inflation shock and the role of automatic fiscal stabilization



Note: Passive fiscal policy ($\psi_y = 0$) versus automatic stabilization policy ($\psi_y = 1$). See Figure 2 for details.

6.2 The quantitative role of automatic stabilizers

In Appendix C, we document that the introduction of hand-to-mouth households does not alter our baseline results. In fact, quantitatively, we obtain very similar results to those in the baseline when the share of hand-to-mouth households is set to $\iota = 0.4$. Thus, in the following, we restrict our attention to automatic stabilization. To isolate the effect of automatic stabilizers, we keep public spending g_t constant and extend equation (22), the simple rule for lump-sum taxes, as follows:

$$(1 - c_y)\,\tau_t = \psi_b b_{t-1} + \psi_y y_t. \tag{31}$$

The left-hand-side represents tax deviations relative to steady state output. The right-hand-side now also includes systematic responses to fluctuations in the output gap y_t. The degree of automatic stabilization is captured by the size of the (non-negative) coefficient ψ_y, while $\psi_y = 0$ brings us back to the baseline tax specification.

During the simulations of automatic stabilizers, we set $\psi_b = 0.0625$. This value implies a half-life of public debt of about 3.5 years, abstracting from contemporaneous changes in output and public spending.[24] Moreover, we keep the share of hand-to-mouth households at $\iota = 0.4$. The remaining parameters are unchanged. While fiscal policy is determined by automatic stabilization, monetary policy is set optimally to minimize the loss function.

Figure 9 compares the impulse responses to a positive inflation shock when fiscal policy is passive, $\psi_y = 0$, with automatic stabilization where $\psi_y = 1$. The latter value implies

[24]More generally, the autoregressive nature of debt dynamics in our model implies that the half-life of public debt is given by *half-life* $= -\frac{\ln 2}{\ln(\beta^{-1} - \psi_b)}$, where $1 + \psi_b > \beta^{-1}$.

that the taxes respond one-to-one to output in absolute terms. Thus, $\psi_y = 1$ can be interpreted as the maximum degree of automatic stabilization where households are fully compensated for income changes. Larger values may be interpreted as "semi-automatic stabilizers" proposed by Blanchard and Summers (2020), i.e., automatic stabilizers supplemented by fiscal rules for stabilization.

As shown above in the baseline analysis, inflation and output can be perfectly stabilized with optimal use of the two instruments, where they pull in different directions. Qualitatively, automatic stabilization implies the same type of coordination, since it effectively makes fiscal policy expansionary as a response to a contractionary monetary policy. This results in better goal achievement, as measured by the loss function (20).[25] However, we see from the the figure that even for the maximum value of ψ_y that can be interpreted as automatic stabilization, the difference from a passive fiscal policy is modest. Realistic degrees of automatic stabilization can thus only bring the policy mix a modest step towards the optimal policy mix, so that "semi-automatic stabilizers" would be needed to bring the policy mix further towards the optimal one. However, if there are costs of using fiscal policy, which we considered above, automatic stabilization could in principle come close to the optimal policy mix if the costs are sufficiently large.

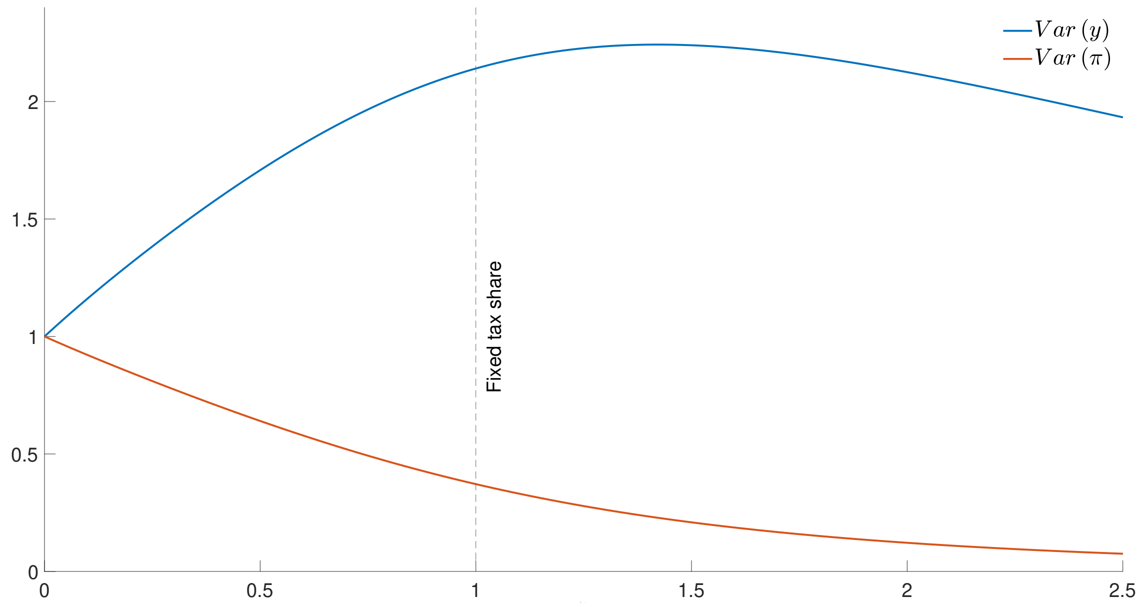
In Appendix D we show the cases of automatic stabilization also with exchange rate, demand, and foreign inflation shocks. Also for these shocks, automatic stabilization moves policy responses in the direction of the optimal policy mix from Section 4.

Interestingly, as seen from Figure 9, output becomes *less* stable with automatic stabilization. This may, at first sight, seem counter-intuitive, since the direct effect of automatic stabilization is more stable output. However, there is also an indirect effect. Automatic stabilization makes monetary policy relatively more effective in stabilizing inflation and less effective in stabilizing output. The reason is that while automatic stabilization dampens the effect of interest rate changes on output, it does not alter the effect of the interest rate on the exchange rate, and thereby on imported inflation. This makes it optimal for monetary policy to stabilize inflation more relative to output. As seen, the indirect effect dominates the direct effect in the impulse responses.

It is clear, however, that this indirect effect of higher output volatility from more responsive fiscal stabilization cannot always dominate as can be verified by setting ψ_y infinitely large in equation (22). Then output will be completely stabilized. The remaining question is thus for what value of ψ_y the indirect effect dominates. Figure 10, which shows the variance of output and inflation as functions of ψ_y, casts light on this question. As seen by the blue curve, a ψ_y of about 1.5 is required to have the direct effect dominate the indirect one. This is higher than what could be interpreted as automatic stabilization, but rather as a very responsive fiscal rule. Thus for realistic parameter values in our model, more responsive automatic stabilization implies higher output volatility. The red curve shows that the variance of inflation is decreasing in the compensation parameter.

[25] It may not seem obvious from the simulation that the loss is lower with automatic stabilization, since output becomes more negative. To see that this must be the case, however, consider a situation where monetary policy counteracts the effect of the expansionary fiscal policy on output such that output remains the same as with a passive fiscal policy and optimal monetary policy. Then, the exchange rate must be stronger due to a higher interest rate, and inflation thereby closer to the target. Thus, with no change in output relative to passive fiscal policy, but inflation closer to target, it is always possible for monetary policy to achieve a lower loss. When it is optimal to raise the interest rate further from such a case, it must by construction be because it lowers the loss further. See further analysis below.

Figure 10: Output and inflation volatility as functions of ψ_y



Note: The horizontal axis represents the value of ψ_y, the vertical axis reports the variance of output relative to the case with passive fiscal policy ($\psi_y = 0$).

7 CONCLUSION

In this paper, we have discussed the optimal interaction of monetary and fiscal policies. When the economy is hit by inflation shocks or risk premium shocks to the exchange rate, the optimal policy mix implies that monetary and fiscal policies shall be divergent. A expansionary fiscal policy calls for an even more contractionary monetary policy than when fiscal policy is passive. And vice versa, the contractionary monetary policy induces an even larger expansion of fiscal policy than under a regime where stabilization is undertaken by fiscal policy alone. This policy mix is not exactly in line with the recommendation of Mundell (1962), but it is still in his spirit; it allows the different policies to concentrate on their comparative advantages. Monetary policy has a comparative advantage in controlling inflation by utilizing the exchange rate channel, and it follows that fiscal policy has a comparative advantage in controlling the level of activity. We have also shown that automatic stabilizers imply a divergent policy mix, which is qualitatively in line the the prescription from the the optimal policy mix with a discretionary fiscal policy.

The divergence result does not hold in all situations. First, if the economy is hit by a demand shock, both monetary and fiscal policy should pull in the same direction, except when the risk premium is exogenous, in which case only fiscal policy should respond to the shock. Second, if there are significant costs associated with actively using the interest rate, fiscal policy might need to support monetary policy in stabilizing inflation, thereby aligning with monetary policy under an inflation shock.

Fiscal policy should not be regarded as a single instrument, but rather as a collection of instruments. We have considered traditional government spending, financed by lump-sum taxes, and automatic stabilizers. Other fiscal measures, such as indirect taxes and income taxes, might alter the results and are a topic for future research. Moreover, it would be interesting to consider the optimal policy mix from a utility-based welfare perspective instead of the usual mandates for monetary policy. However, welfare-maximizing policies are typically more sensitive to the model and assumptions than when using a standard *ad hoc* loss function. Therefore, it would be important to compute the optimal policy mix in different types of models to validate the generality of the results.

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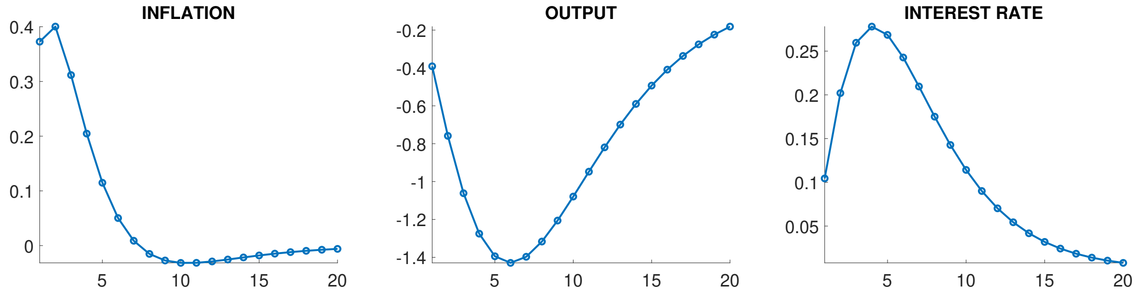
APPENDIX

A EFFECTS OF AN INFLATION SHOCK IN THE FOREIGN ECONOMY

Figure A.1: The joint responses in the foreign economy to a foreign inflation shock



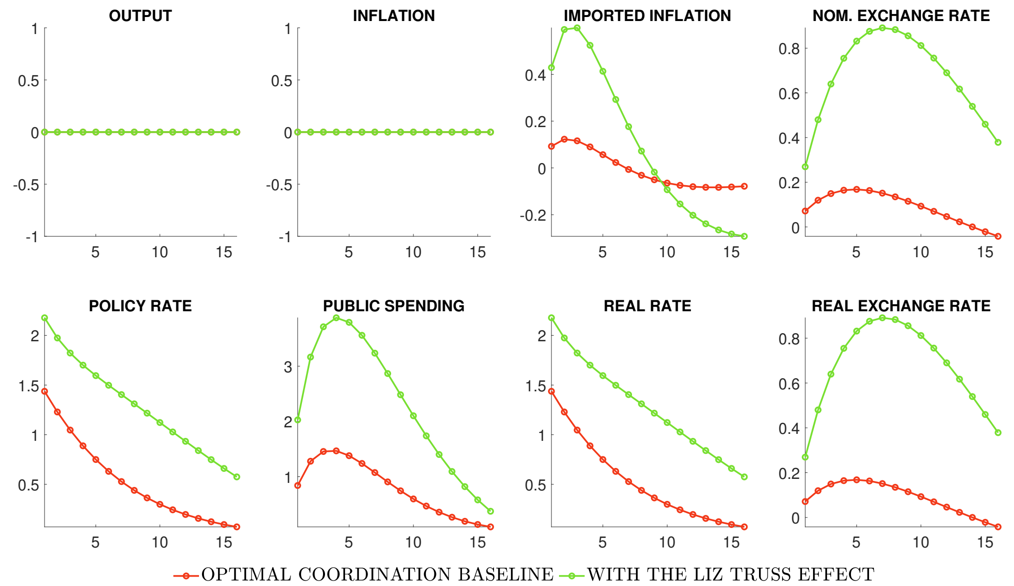
Note: Selected impulse response functions in the foreign economy conditional on an innovation in z_t^*. Foreign inflation and the foreign interest rate are measured in percentage points, the output gap is measured in percent. Horizontal axes represent time in quarters.

Figure A.1 reports the impulse responses for foreign output y_t^*, foreign inflation π_t^*, and the foreign interest rate i_t^*, conditional on an unexpected rise in z_t^* in the foreign Phillips curve. The effects are standard: inflation rises, foreign monetary policy responds such that the nominal and real interest rate paths increase, resulting in a decline in foreign activity.

B THE LIZ TRUSS EFFECT

Below we show the figures referred to in subsection 4.5 in the main text.

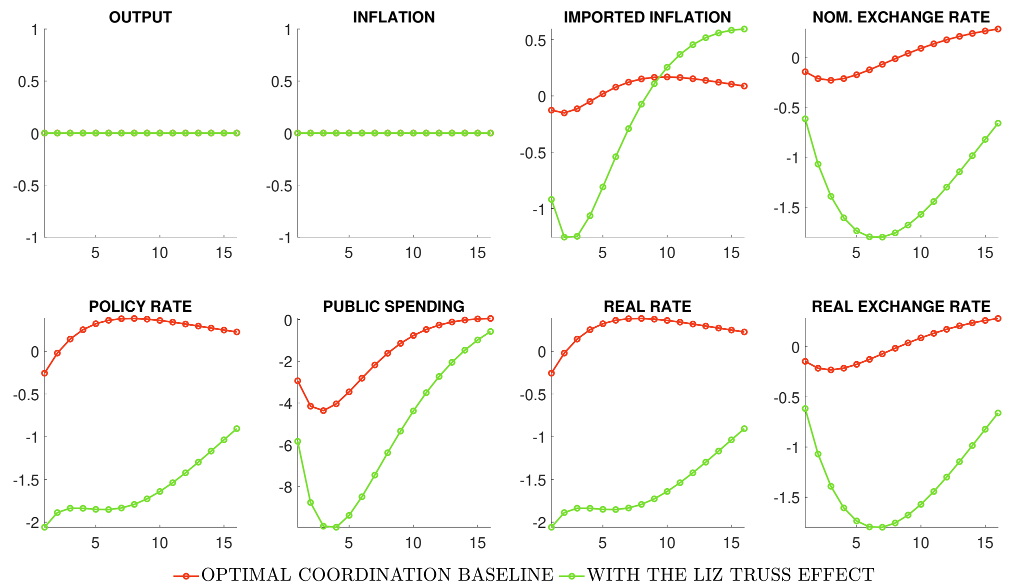
Figure B.1: Risk premium shock, optimal coordination with the Liz Truss effect



Note: See Figure 2 for details.

Figure B.1 reports the impulse responses conditional on a risk premium shock that leads to an exchange rate depreciation. As can be seen, the same results appear qualitatively as those conditional on the inflation shock discussed in the main text.

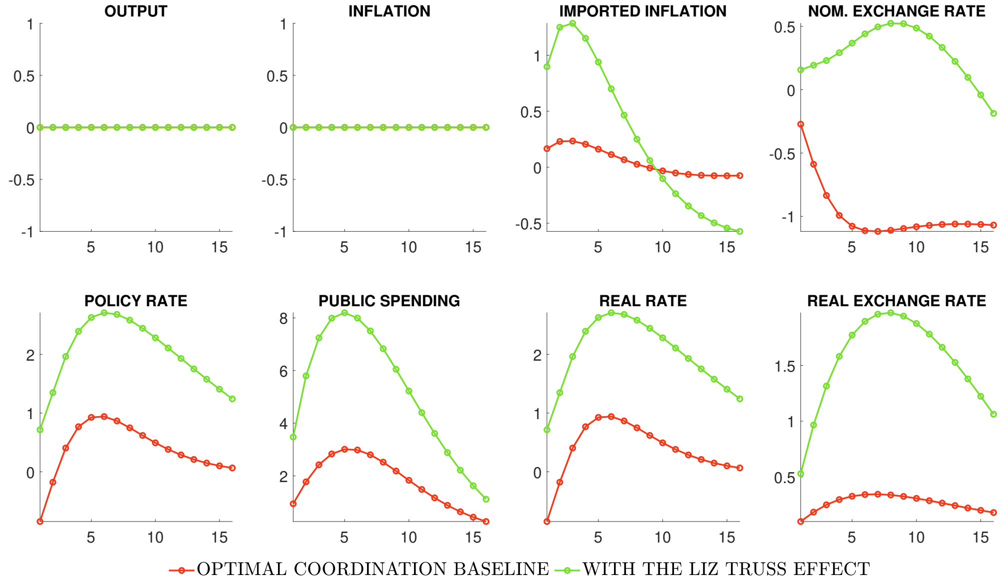
Figure B.2: Demand shock, optimal coordination with the Liz Truss effect



Note: See Figure 2 for details.

Figure B.2 reports the impulse responses conditional on a demand shock. Comparing the coordination baseline with the Liz Truss counterpart, we note that the latter can imply divergent policies even when demand shocks are realized.

Figure B.3: Foreign inflation shock, optimal coordination with the Liz Truss effect



Note: See Figure 2 for details.

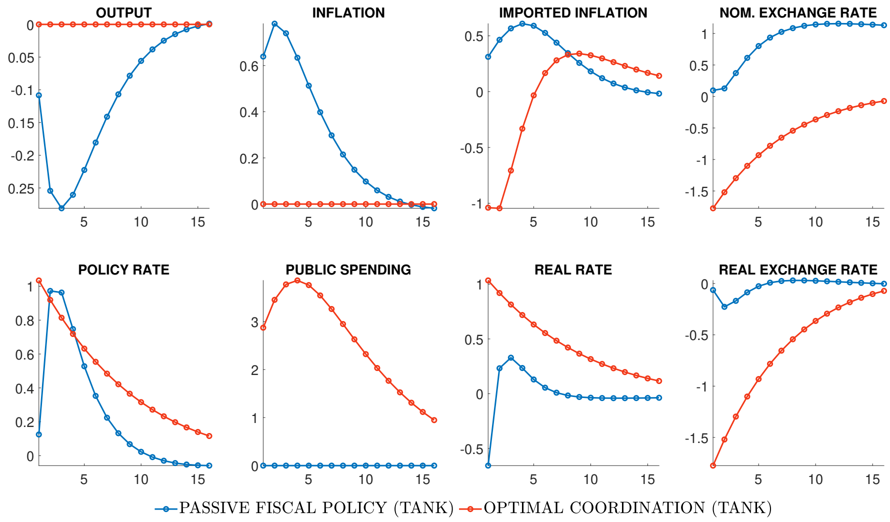
Finally, Figure B.3 reports the impulse responses conditional on a foreign inflation shock. Qualitatively, we obtain the same results as with a domestic inflation shock: the Liz Truss effect implies that monetary and fiscal policy should be more divergent than in the baseline case.

C Policy coordination in the TANK model

In this appendix we report additional impulse response functions in the model with hand-to-mouth households. The share of hand-to-mouth households is set to $= 0.4$. Regarding the tax rule given by (22), we set $\psi_b = 0.0625$, implying a half-life of public debt of about 3.5 years.

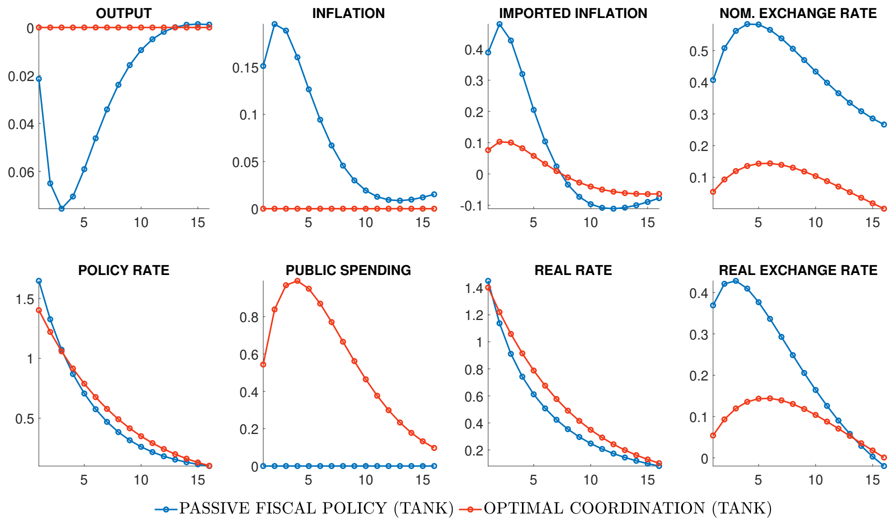
Figure C.1 documents the effects of an inflation shock, while shocks to the risk premium, demand and foreign inflation are shown in Figure C.2, Figure C.3, and Figure C.4 respectively. Importantly, for all shocks the impulse responses are nearly identical to those in the baseline case with a representative household and Ricardian equivalence. This is true also with alternative calibrations of ψ_b, results are available upon request.

Figure C.1: An inflation shock in the TANK model



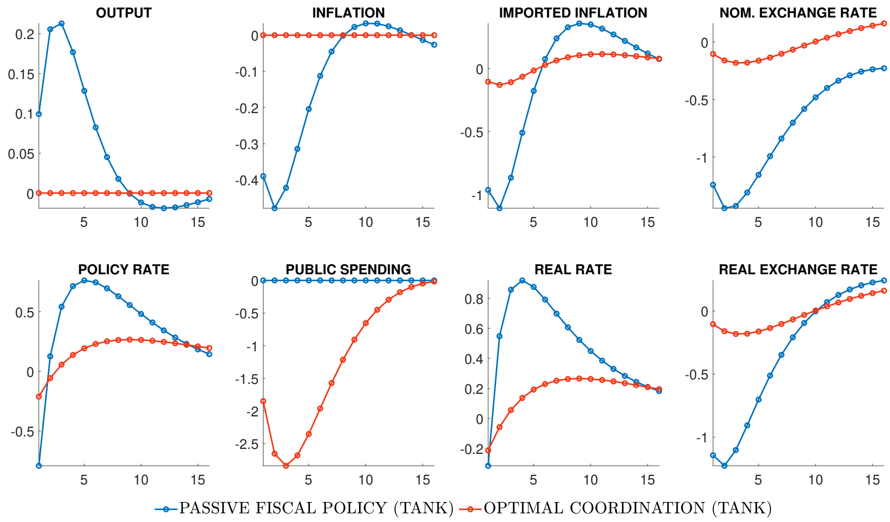
Note: See Figure 2 for details.

Figure C.2: A risk premium shock in the TANK model



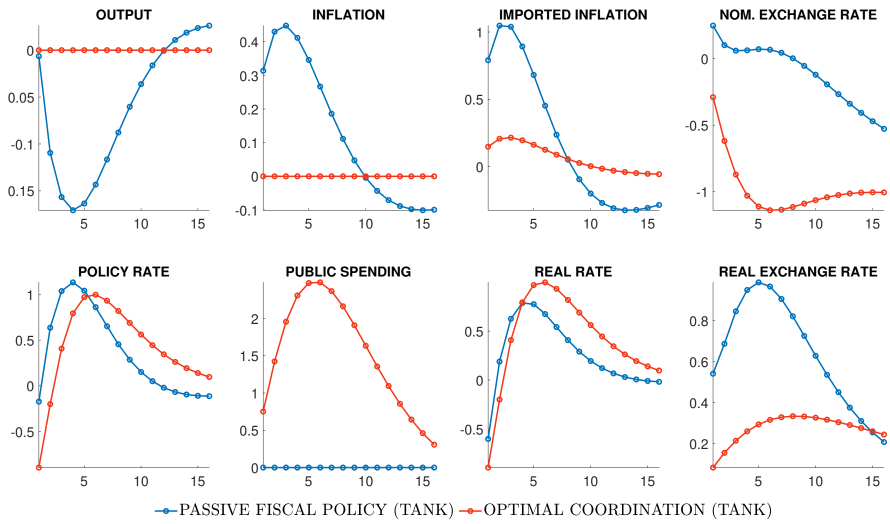
Note: See Figure 2 for details.

Figure C.3: A demand shock in the TANK model



Note: See Figure 2 for details.

Figure C.4: A foreign inflation shock in the TANK model



Note: See Figure 2 for details.

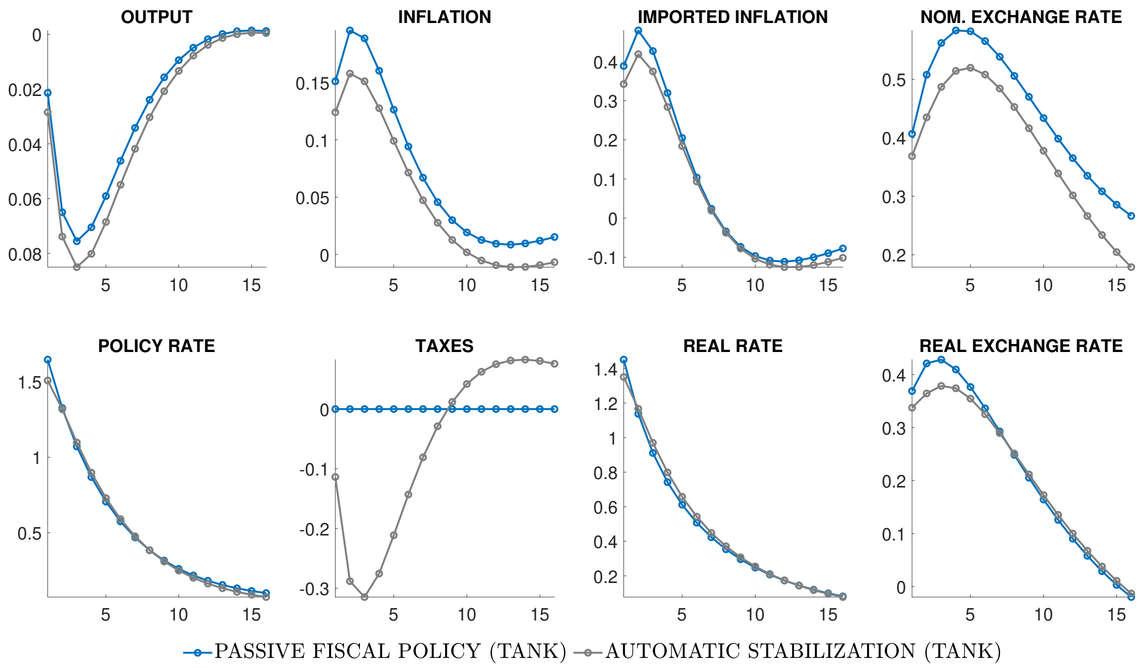
D Automatic stabilization

In this appendix we discuss automatic stabilization. In the main text we limited the discussion of automatic stabilization to the case of an inflation shock. We here discuss automatic stabilization also under a risk premium shock, a demand shock, and a foreign inflation shock.

D.1 Risk premium shock under automatic stabilization

Figure D.1 shows, again by the grey impulse responses, how automatic stabilization compares with passive fiscal policy given by the blue impulse responses. Again, we see that automatic stabilization increases output volatility and decreases inflation volatility. Automatic stabilization also in this case makes monetary and fiscal policy divergent, and thus moves fiscal policy in the optimal direction. However, the quantitative effect is small, and moves fiscal policy only marginally in the optimal direction.

Figure D.1: Risk premium shock, passive fiscal policy vs. automatic fiscal stabilization

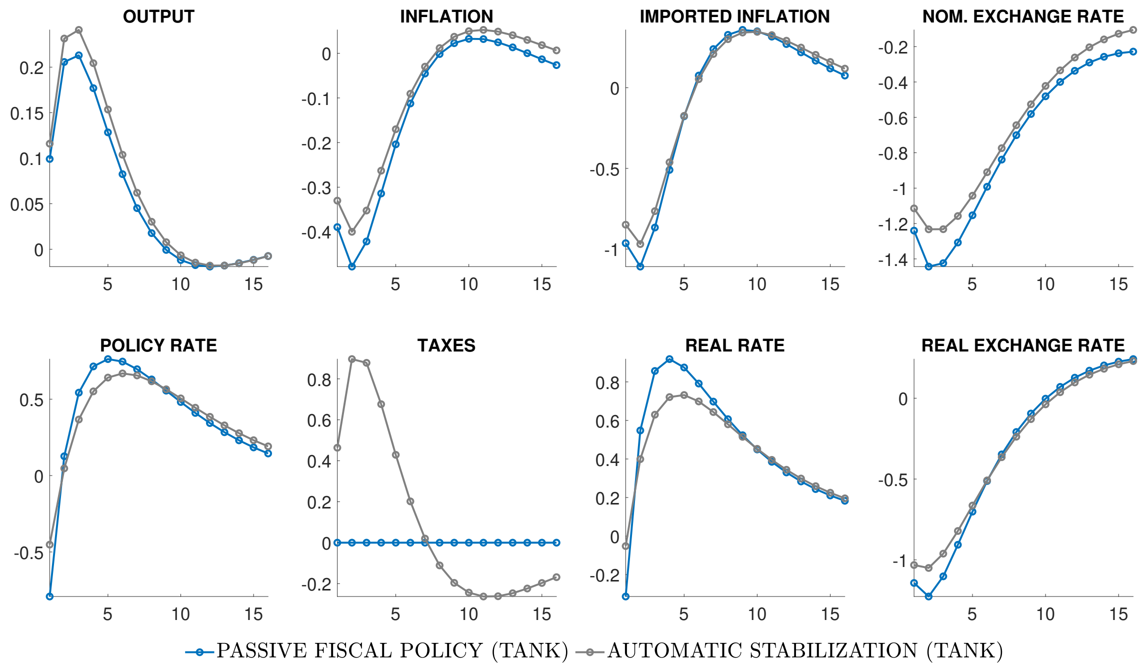


Note: Automatic stabilization policy: $\psi_y = 1$. See Figure 2 for details.

D.2 Demand shock under automatic stabilization

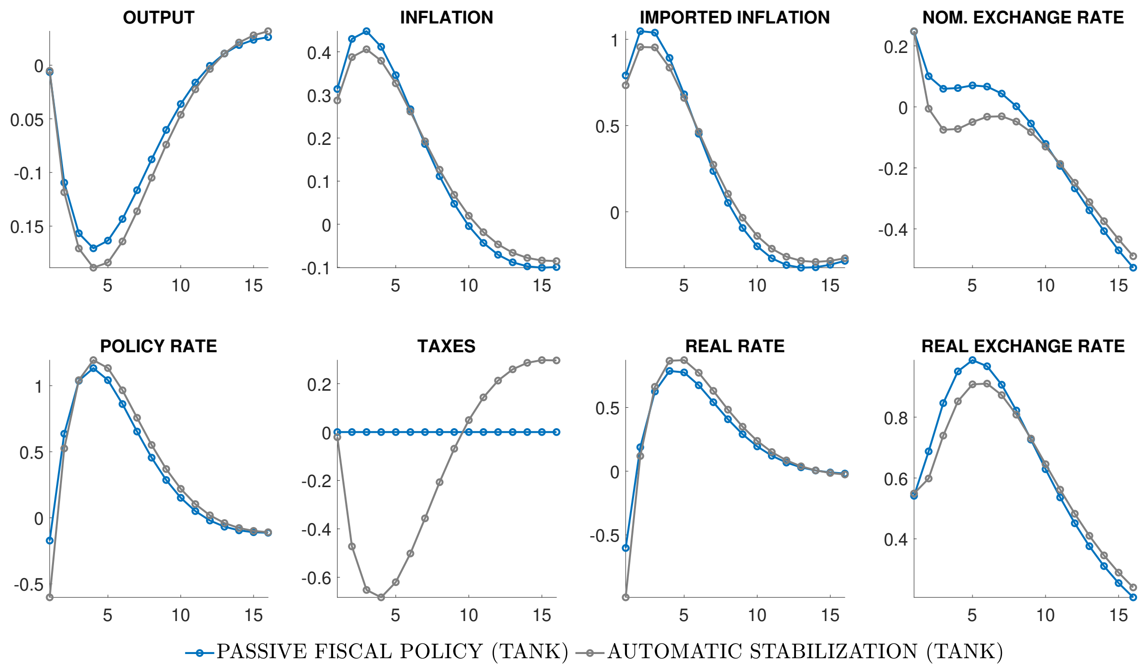
Figure D.3 shows that also for a demand shock output volatility increases and inflation volatility decreases with automatic stabilization. However, the strength of the contractionary fiscal policy response is negligible compared to a passive fiscal policy, since monetary policy almost fully stabilizes output in the first place. Thus automatic stabilization does not move the policy mix notably in the optimal direction of fiscal policy replacing monetary policy as the main policy instrument, which we have seen is the optimal response when demand shocks hit.

Figure D.2: Demand shock, passive fiscal policy vs. automatic fiscal stabilization



Note: Automatic stabilization policy: $\psi_y = 1$. See Figure 2 for details.

Figure D.3: Foreign inflation shock, passive fiscal policy vs. automatic fiscal stabilization



Note: Automatic stabilization policy: $\psi_y = 1$. See Figure 2 for details.

E NON-SEPARABILITY BETWEEN PRIVATE AND PUBLIC CONSUMPTION

Finally, we consider a case where public consumption generates utility for domestic households: suppose that households' utility is non-separable in private and public consumption, so that private consumption-saving decisions depend directly on the level of public demand. The period utility of the representative household is given by

$$\mathcal{U}_t = \frac{\left(\tilde{C}_t - h\tilde{C}_{t-1}\right)^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\varphi}}{1+\varphi},$$

where the consumption aggregate features constant elasticity of substitution between the two inputs:

$$\tilde{C}_t = \left[\omega^{\frac{1}{\zeta}} C_t^{\frac{\zeta-1}{\zeta}} + (1-\omega)^{\frac{1}{\zeta}} G_t^{\frac{\zeta-1}{\zeta}}\right]^{\frac{\zeta}{\zeta-1}}.$$

As before we consider a log-linear approximation in the neighborhood of a steady state with balanced trade and relative prices equal to unity. Then,

$$\tilde{c}_t = \omega c_t + (1-\omega)\, g_t,$$

and the marginal utility of *private* consumption can be expressed as follows:

$$\begin{aligned}
\lambda_t &= \left(\frac{1}{\zeta} - \frac{\sigma}{1-h}\right)\tilde{c}_t - \frac{1}{\zeta}c_t + \frac{\sigma h}{1-h}\tilde{c}_{t-1} \\
&= -\left(\frac{\omega\sigma}{1-h} + \frac{1-\omega}{\zeta}\right)c_t - (1-\omega)\left(\frac{\sigma}{1-h} - \frac{1}{\zeta}\right)g_t + \frac{\sigma h}{1-h}\tilde{c}_{t-1}.
\end{aligned}$$

A couple of remarks are in place: first, an exogenous increase in public demand g_t raises marginal utility and crowds in private consumption if and only if $\zeta < \frac{1-h}{\sigma}$. Intuitively, when this condition holds, the complementarity between private and public demand is strong enough to dominate the intertemporal smoothing motive of households that arises from fluctuations in public spending. On the contrary, private and public demand become perfect substitutes when ζ goes to infinity. In that case we have full crowding out of private consumption. Finally, note that the expressions above collapse to those in the main text when $\omega = 1$. Thus, we capture separability in preferences between private and public consumption as a special case.

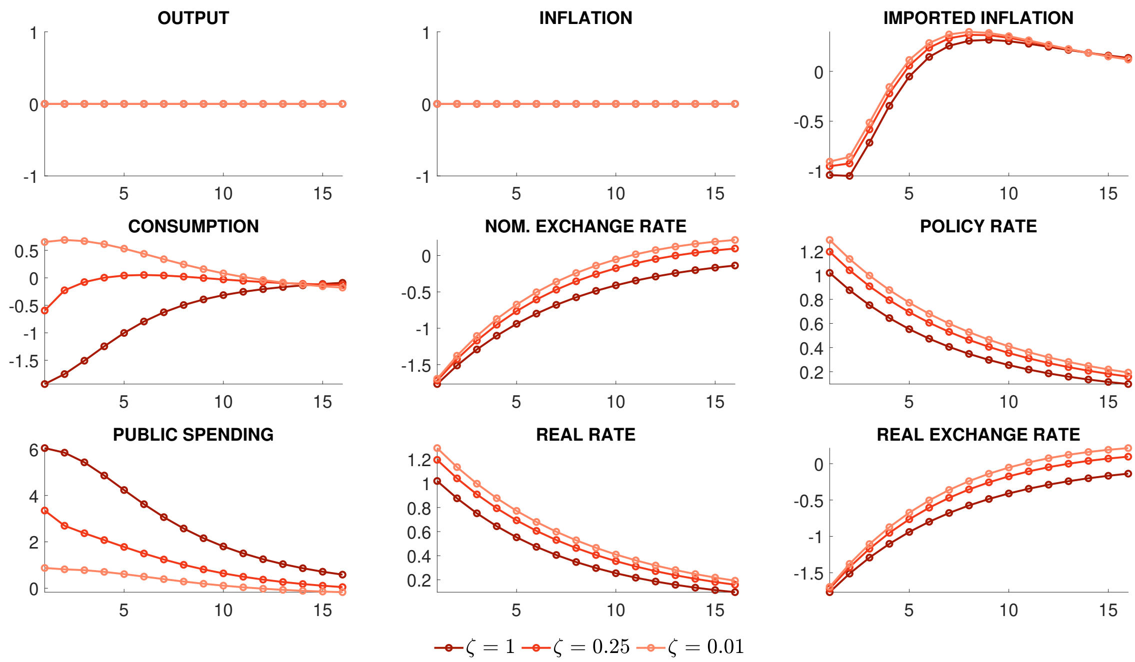
Below we report the impulse response functions conditional on optimal fiscal and monetary policy coordination when preferences are non-separable in private and public consumption. We consider three cases: (i) "net substitutability" with $\zeta = 1$, (ii) "neutral substitutability" with $\zeta = \frac{1-h}{\sigma} = 0.25$, and (iii) "net complementarity" with $\zeta = 0.01$. In all cases we use $\omega = c_y = 0.25$, assuming that the utility weight on public consumption corresponds to the observed public consumption share in data. The remaining parameters are calibrated as before.

We first note that with all the shocks, the qualitative conclusions about the optimal policy mix we derived in Section 4 remain valid.

For inflation and risk premium shocks, as seen in Figure E.1, Figure E.2 and Figure E.4, the optimal fiscal policy response is stronger when private and public consumption are substitutes, and weaker when they are complements. For the strength of the monetary policy response, the opposite is the case. The intuition for this is that when private and public consumption are substitutes, then fiscal policy becomes less effective in pushing demand up, as increased public consumption partially crowds out private consumption. Therefore, in order to to stabilize output, fiscal policy must respond more. In turn, the stronger expansionary fiscal policy and the reduced private consumption implies that the imported content in total demand decreases. As a consequence, the net foreign asset position becomes more favorable, and the risk premium lower. The decreased imported inflation that follows from this effect calls for a less contractive monetary policy.

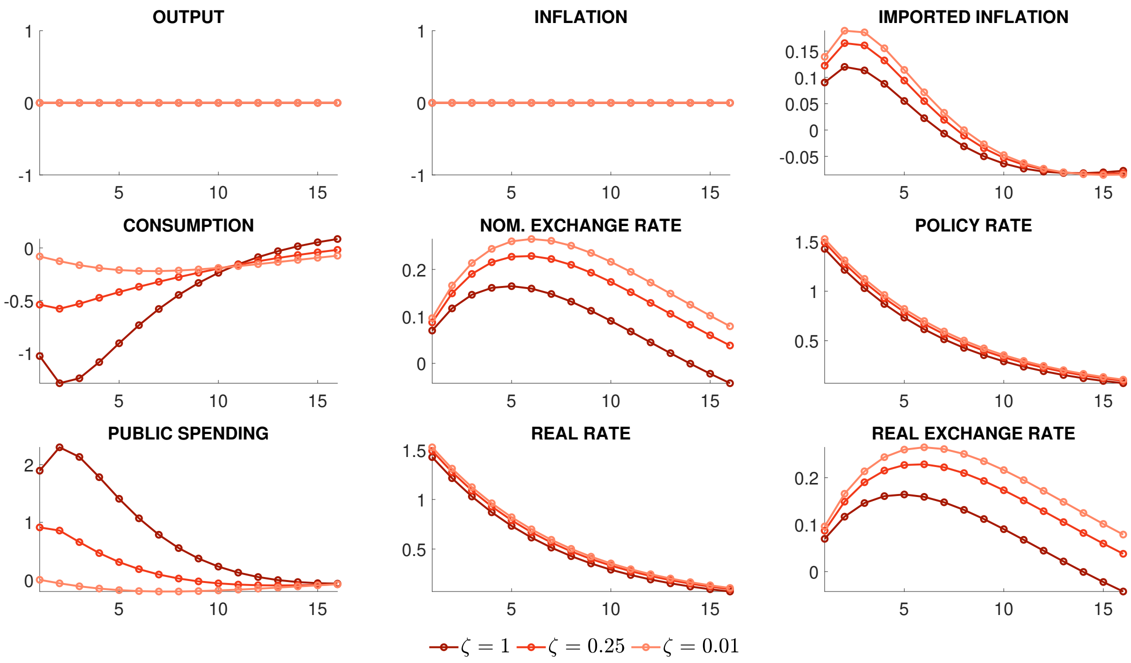
In contrast, as seen in Figure E.3, when the economy faces a demand shock, both fiscal and monetary policy becomes more contractionary when private and public consumption are substitutes. The risk premium effect again explains the intuition. With substitutability in private and public consumption, public consumption must be reduced by more to stabilize output. In turn, this increases private consumption. The higher import content in total consumption pushes the risk premium up, thereby calling for a stronger interest rate increase to combat inflation.

Figure E.1: Inflation shock with non-separability in private and public consumption



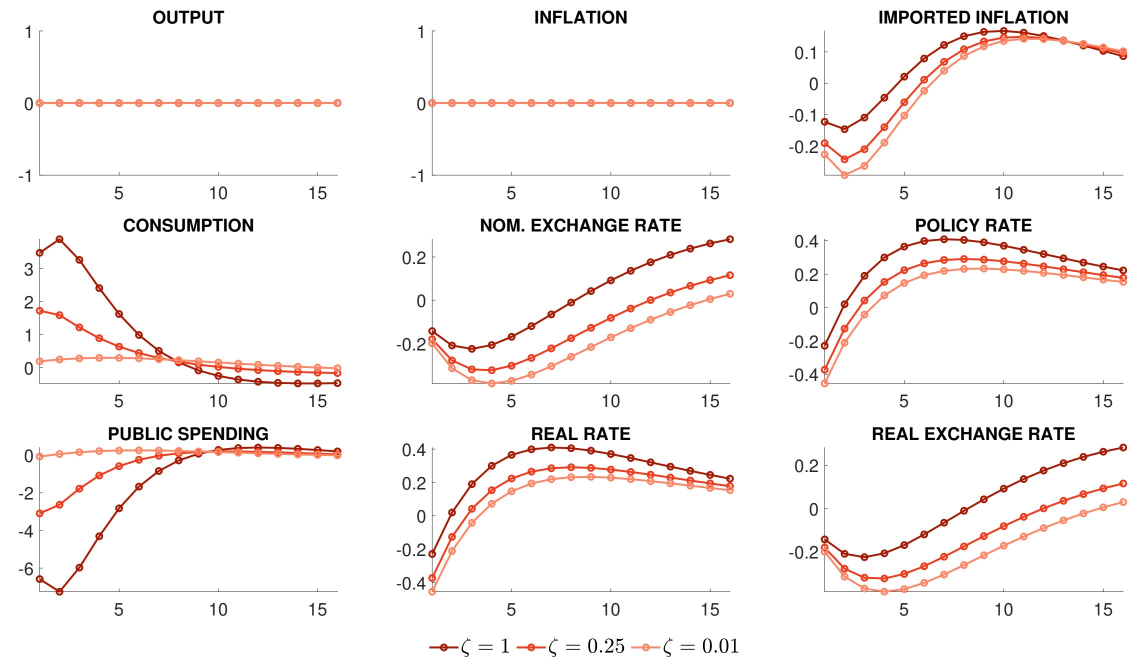
Note: See Figure 2 for details.

Figure E.2: Risk premium shock with non-separability in private and public consumption



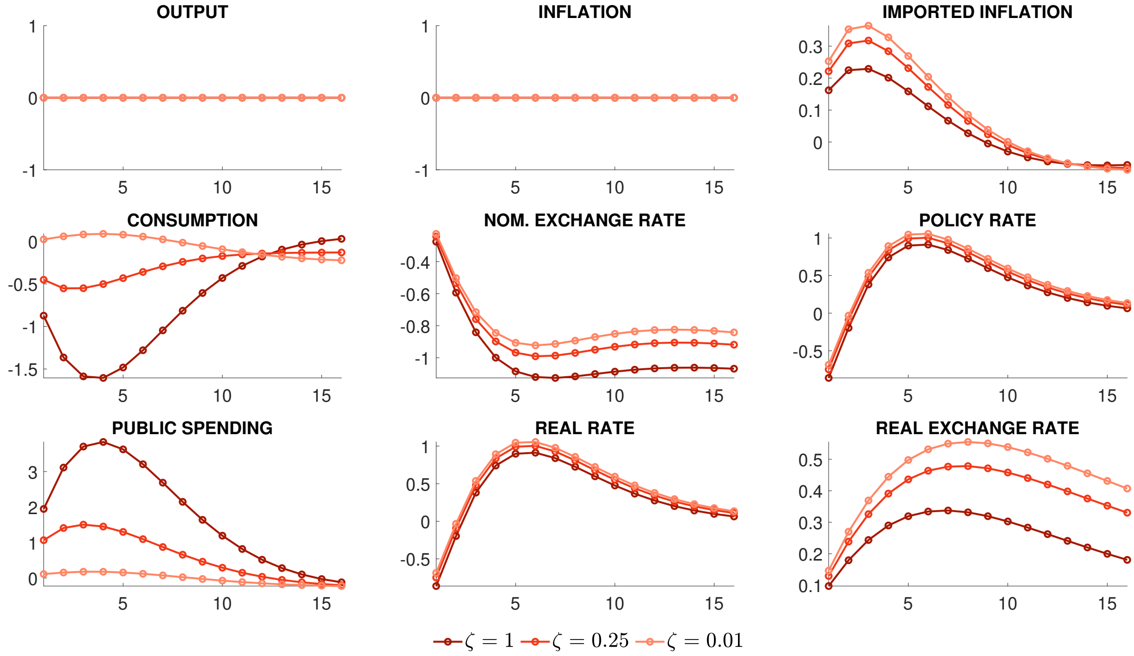
Note: See Figure 2 for details.

Figure E.3: Demand shock with non-separability in private and public consumption



Note: See Figure 2 for details.

Figure E.4: Foreign inflation shock with non-separability in private and public consumption



Note: See Figure 2 for details.