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Can Fiscal Consolidation help Central Banks' Fight Inflation?

By Jiaqian Chen, Era Dabla-Norris, Carlos Goncalves, Zoltan Jakab and Jesper Lindé

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ABSTRACT: This paper argues that a tighter fiscal policy stance can meaningfully support central banks in fighting inflation in both advanced and emerging market economies. While the standard textbook result suggest that monetary policy is much more effective than fiscal policy in battling inflation in open economies due to the exchange rate channel, we show that a tigher fiscal stance is notably more effective in the current situation. This is so because when many countries currently need to tighten the policy stance simultanously, the exchange rate channel does not provide monetary policy with an edge over fiscal policy. We also show that fiscal consolidation can be helpful in small open emerging markets and developming economies by reaffirming their commitment to price stability, and by putting the fiscal house in order which reduces risk premiums and strenghtens the currency. Furthermore, we show that spillovers from major economies can be more adverse from tigher monetary policy. By applying a two-agent New Keynesian modelling framework with unconstrained and hand-to-mouth households, we show that any adverse effects of tighter fiscal policy (relative to tighter monetary policy) on consumption inequality can be handled with a combination of general spending cuts and targeted transfers to vulnerable households.

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WORKING PAPERS

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1. Introduction

The persistent rise in inflation and government debt in many countries around the world is raising policy challenges. Expansive monetary and fiscal policy during the acute phases of the pandemic and its immediate aftermath, combined with pandemic-related supply chain disruptions and energy market shocks from Russia's invasion of Ukraine led to a surge in inflation in many parts of the world, with global headline inflation reaching 8.7 percent in 2022.[1] Core inflation has also risen significantly above central bank targets in many countries, and remains stubbornly high (Figure 1). At the same time, fiscal support deployed during the pandemic and the recent energy crisis have resulted in record government debt levels in many economies (Figure 1).

Amid rising core inflation and upside inflation risks, many central banks tightened monetary policy, but higher-for-longer rates pose financial stability risks. Higher interest rates push up debt service costs, lower economic activity, and tax revenues, putting further upward pressure on government debt. This nexus is particularly relevant at this juncture as government debt in many countries is at historical highs.

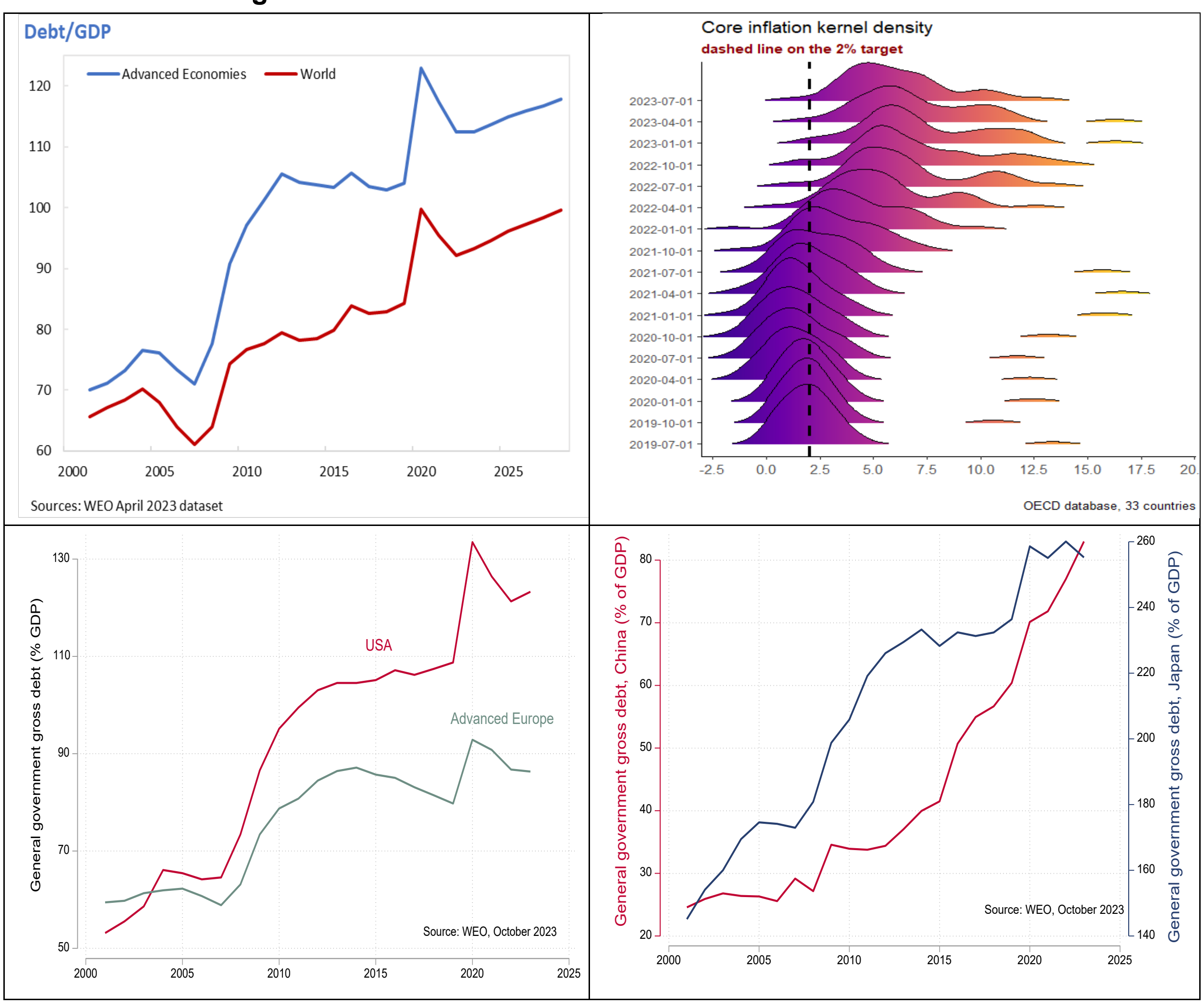
This paper argues that fiscal consolidation can help in the fight against inflation although the impact depends on country and institutional characteristics. Using a variation of Woodford's (2003) textbook closed economy model, examine whether fiscal policy can achieve the same inflation-reducing effect as monetary policy. A closed economy framework is useful starting point if fiscal and monetary policy in many countries across the world move in tandem, say in response to a global inflation surge. Even so, in order examine the robustness of the results in a more empirically realistic framework and to analyze the merits of alternative policy mixes undertaken by small open advanced and emerging market economies, we then turn to a workhorse open-economy two-agent New Keynesian (TANK) DSGE model. This richer model allows us to explore additional channels to assess the effects the joint discretionary fiscal-monetary interventions, including financial frictions in capital accumulation, liquidity constrained households, endogenous movements in UIP risk-premiums and real rigidities.

The textbook closed economy model implies that fiscal tightening can reduce inflation as much as monetary policy for a given decline in the output gap. This is because monetary tightening under gradual price adjustment raises the actual real rate relative to the potential real interest rate thereby reducing domestic demand (i.e., the output gap) and lowering inflation according to a standard Phillips curve. In this framework, fiscal tightening also reduces the

[1] For instance, Hodge et al. (2023) argues that a sizeable share of the surge in US core inflation in 2021 can be explained by monetary and fiscal policy. They also find that a smaller, yet significant share of the euro area 2021 surge in core inflation can be explained by expansionary monetary and fiscal policy in the euro area and in the US.

potential real interest rate, increasing the gap between the real policy rate and potential real interest rate. This wedge reduces domestic demand and lowers inflationary pressures in a commensurate manner as monetary policy. However, the stylized model highlights that the transmission of fiscal policy to output and inflation depends crucially on the central bank policy response: if inflation is at target prior to the fiscal intervention and the central bank does not welcome a tighter policy stance, fiscal tightening can be undone with a more stimulative monetary policy stance. An additional insight from the stylized model is that even if there is isomorphism between fiscal and monetary policy when it comes to the inflation-output gap sacrifice ratio, fiscal policy may be notably less efficacious when it comes to reducing inflation for a given decline in the level of output. This finding obtains because a tighter monetary policy stance does not affect potential output, whereas a tighter fiscal path that triggers the same-sized output gap decline is associated with a larger output decline because potential output falls.

Figure 1: Elevated Government Debt and Inflation Risks.



Source: IMF staff calculations.

In the workhorse open-economy TANK model, we show that fiscal policy is less effective in reducing inflation in small open advanced economies due to the exchange rate channel. When the central bank tightens monetary policy, the domestic currency appreciates which lowers inflation in addition to the direct impact of lower domestic demand. Fiscal tightening, on the other hand, strengthens the country's external position and weakens the exchange rate as the domestic policy rate differential vis-a-vis the rest of the world falls. The weaker exchange rate worsens the ability of tighter fiscal policy to battle inflation, consistent with the argument put forward by Dao and others (2023).

In emerging economies with shallow FX markets, an improvement of the external position driven by tighter fiscal policy may strengthen the currency. This is because the UIP risk premium declines sizably as the external position improves in EMs with shallow FX market (see Chen et al., 2023, for evidence). As a result, fiscal tightening that improves the country's net foreign asset position can even lead to appreciation of the domestic currency, which dampens inflation more than in advanced economies. This implies that fiscal policy in vulnerable EMEs and LICs can be as effective in battling inflation as monetary policy.

The open-economy TANK model implies that fiscal consolidation is more effective in reducing inflation when many countries tighten simultaneously. When many countries experience well-above target inflation rates and need to tighten simultaneously, the exchange rate does not move much and the edge that monetary policy has in curbing inflation via the exchange rate channel dissipates even in advanced economies. Although the exchange rate channel becomes irrelevant, both monetary and fiscal tightening are still effective as weaker global demand helps to lower inflation. This implies that a smaller monetary and fiscal tightening is needed to curb inflation compared with the case where a single country tightens. Importantly, the TANK model implies a similar inflation-output elasticity for monetary and fiscal policy, in contrast to the stylized model which generates a notably smaller inflation-output elasticity for fiscal policy.[2] We show that the key features why fiscal policy has a notably larger impact on inflation relative to output in the workhorse model is the presence of financial frictions and endogenous capital accumulation, hand-to-mouth households and habit formation for optimizing households. These frictions boost the impact of monetary and fiscal policy on output, but amplify the effects of fiscal policy on inflation relatively more than monetary policy.

Finally, we show that spillovers from disinflations in large economies to emerging market and developing economies (EMDEs) can be more severe from monetary policy versus a

[2] With inflation-output elasticity we mean how much average core inflation declines under a given time period when average output is reduced 1 percent over the same horizon. Notice that the stylized model generates the same inflation-output gap elasticity for monetary and fiscal policy, while it implies a notably lower inflation-output elasticity for fiscal policy.

policy package with both tighter monetary and fiscal policy. From the perspective of recipient small open economies, both policies reduce foreign demand, but tighter monetary policy cushions spillovers to output in small open economies by depreciating their currencies (i.e., the currency of the major advanced tightening economy appreciates) which maintains larger net exports. Therefore, tightening via fiscal policy in major advanced economies reduces inflation more in small recipient economies as it has a greater impact on demand. As a result, this reduces the pressure for foreign central banks to hike policy rates. However, spillovers to EMDEs with shallow currency markets can be notably severe. For instance, in EMDEs that have to defend their currency due to FX misalignments and large exchange rate pass-through, we show that the adverse spillovers on output in recipient economies can be more negative for monetary policy tightening in the major economy as financial conditions tighten.

We parameterize the TANK model to be in line with US and euro area empirical evidence of monetary and fiscal policy on inflation and output. An extensive literature has documented the effects of monetary policy on inflation and output in the US and the euro area, and a large body of empirical papers have studied the role of fiscal policy in bringing down output (i.e., the fiscal multiplier). Even so, notably fewer papers have assessed the impact of fiscal policy on inflation in both the US and the euro area. IMF (2023) uses identification via sign restrictions and narrative-based methods to examine the impact of spending shocks on inflation for a group of OECD countries and for the US, respectively. It suggests a 1 percent of GDP increase in public spending leads to roughly 0.5 percent higher CPI. We set parameters in the TANK model so that a closed economy formulation of the model implies effects of monetary and fiscal policy in line with existing empirical evidence.

The fiscal impact on output and inflation has been studied more extensively with New Keynesian macro models. The general message from this literature is that the effect of fiscal policy depends on the reaction of the central bank. In particular, fiscal policy is more powerful when monetary policy is constrained, either because of the effective lower bound (see Eggertsson, 2011, Woodford, 2011, Christiano, Eichenbaum, and Rebelo 2011, Erceg and Linde, 2014, or Chen et al. 2022) or when countries are in a currency union (see e.g., Erceg and Linde, 2013, Blanchard, Erceg and Linde, 2016, and Beyer et al., 2023). Using a range of structural models, Coenen et al. (2012) show that a temporary fiscal stimulus of 1 percent of GDP in one country raises inflation by 0.1 to 0.3 percentage point, depending on the type of fiscal measures and the degree of monetary accommodation.

In this paper, we rely on structural macroeconomic models to assess the impact of fiscal policy on inflation.[3] Our model-based approach allows for an examination of how a tighter fiscal stance can help central banks curb inflation depends on a number of key factors such as trade openness, FX market frictions, and the number of economies engaged in tightening. In this regard, an empirical analysis of the effects of alternative policy mixes is less desirable as the current global surge in inflation and commitment to fight inflation is unique from an historical perspective. The global inflation surge in the 1970s is an exception yet is less relevant as many central banks were not independent and practicing inflation targeting.

The remaining of the paper is structured as follows. Section II illustrates conceptually how fiscal and monetary policy affects domestic demand and inflation using a stylized NK model. Section III introduces the analytical framework, based on Erceg and Linde (2013), and shows that fiscal and monetary policy can have a similar impact on inflation in a closed economy. Section IV considers the results for small open economy. Section V explores the role of fiscal policy in EMEs. Section VI concludes.

2. Results with a Stylized Model

We begin the analysis by outlining a standard simple closed economy model with gradual price adjustment. The specific model considered is the Erceg and Linde (2014) variation of the model in Eggertsson and Woodford (2003) with zero steady state government debt and lump-sum taxes finances and changes in government debt driven by monetary policy or government spending. This model is similar in spirit to the model analyzed in Clarida, Gali and Gertler (1999).

The stylized closed economy model consists of the following equations:

$$x_t = x_{t+1|t} - \widehat{\sigma}(i_t - \pi_{t+1|t} - r_t^{\text{pot}}), \tag{1}$$

$$\pi_t = \beta\pi_{t+1|\text{t}} + \kappa_p x_t, \tag{2}$$

$$i_t = (1-\gamma_i)[\gamma_\pi \pi_t + \gamma_x x_t] + \gamma_i i_{t-1} + \varepsilon_{i,t}, \tag{3}$$

$$y_t^{\text{pot}} = \frac{g_y}{\phi_{mc}\widehat{\sigma}} g_t, \tag{4}$$

$$r_t^{\text{pot}} = \frac{1}{\widehat{\sigma}}\left[\Delta y_{t+1|t}^{\text{pot}} - g_y \Delta g_{t+1|t}\right], \tag{5}$$

$$y_t = x_t + y_t^{\text{pot}}, \tag{6}$$

[3] Our models impose a standard “active monetary” and “passive fiscal” policy equilibrium following the terminology of Leeper (1991), although debt stabilization is very gradual in our calibration of the workhorse model. We discuss in the conclusions that it would be interested to extend our analysis to allow for deviations for from this setup.

where $\hat{\sigma}^*$, κ_p=$\kappa_{mc}\phi_{mc}$, and ϕ_{mc} are composite parameters defined as:

$$\hat{\sigma} = \sigma(1 - g_y), \tag{7}$$

$$\kappa_{mc} = \frac{(1-\xi_p)(1-\beta\xi_p)}{\xi_p}, \tag{8}$$

$$\phi_{mc} = \frac{\chi}{1-\alpha} + \frac{1}{\hat{\sigma}} + \frac{\alpha}{1-\alpha}. \tag{9}$$

All variables are measured as percentage or percentage point deviations from their steady state levels.[4] In addition, $\varepsilon_{i,t}$ is an i.i.d. monetary policy shock, and g_t is a government spending shock which follows a stochastic AR(1) process:

$$g_t = \rho_g g_{t-1} + \varepsilon_{g,t}. \tag{10}$$

The steady-state level of g is financed by labor income taxes, but any variations in government spending around its steady state are assumed to be paid for via lump-sum taxes. This simplifying assumption allows us to abstract from dynamic aspects of fiscal policy including the evolution of government debt since Ricardian equivalence holds.

Table 1 summarizes the parameters we use in the model, which are completely standard.

Table 1: Calibrated Parameters in Stylized Model

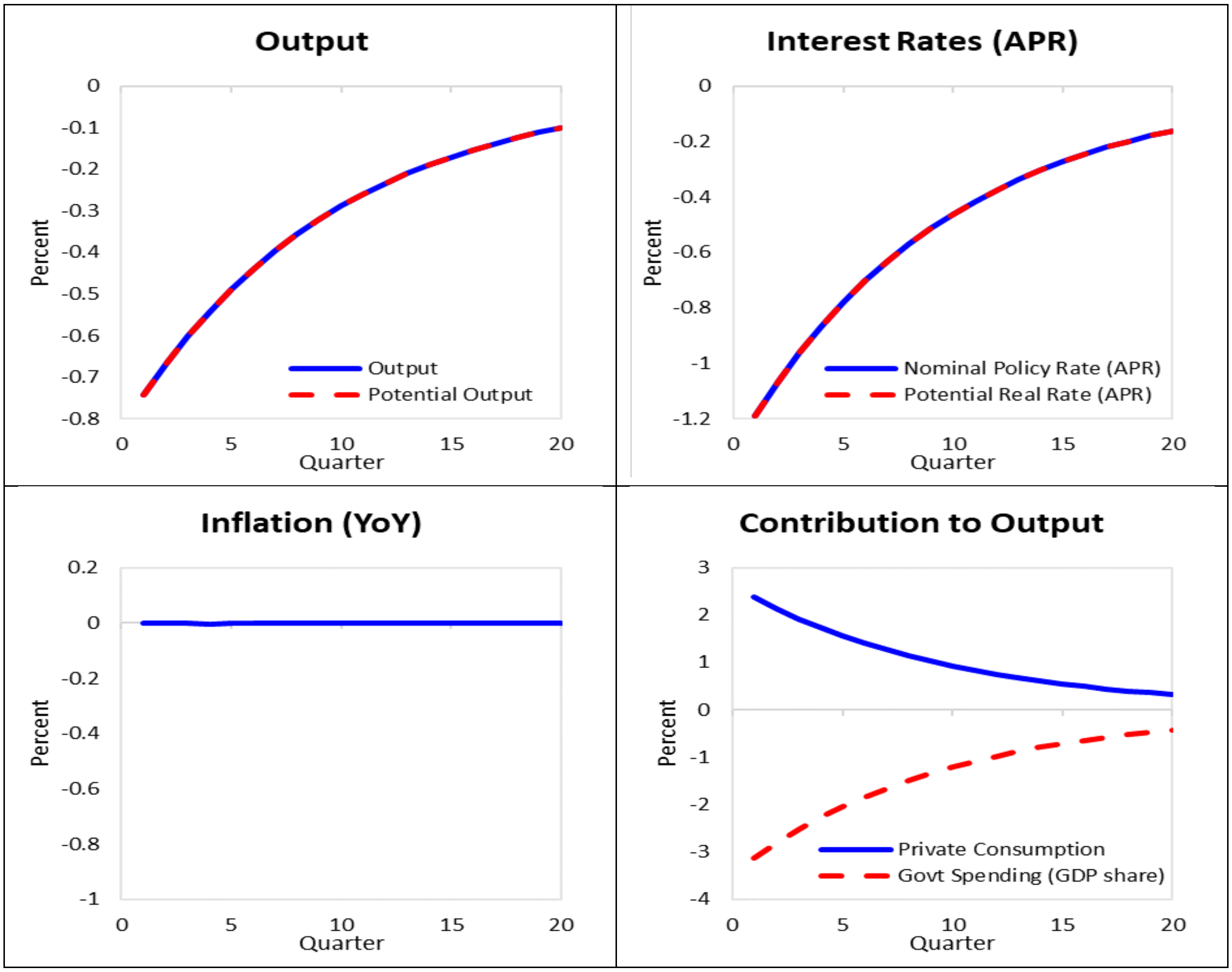
Parameter	Explanation	Values
α	Production function parameter	0.3
g_y	Government spending share in SS	0.2
χ	$1/\chi$ Frisch Elasticity	2.5
σ	Intertemporal Elas of Subst.	1
ξ_p	Sticky price Calvo Probability	0.9
β	Discount factor	0.995
γ_π	Resp coeff to π in policy rule	1.5
γ_x	Resp coeff to x in policy rule	0.125
γ_i	Smoothing coeff in policy rule	0.9
ρ_g	AR(1) coeff for gov't spending	0.9

We use the model to do two simulations in Dynare (see Juillard, 1996). First, Figure 2 shows that in a situation in which inflation is at target and the output gap is closed, the central bank can undo any drag on inflation and provide full stabilization of the output gap if the treasury adopts a tighter fiscal stance (i.e., cuts government consumption g_t). In this simple model, a cut in government spending (i.e., negative realization of $\varepsilon_{g,t}$), causes a decline in the equilibrium real rate (r_t^{pot}). If the central bank announces its intention to cut its policy rate (i_t) in lockstep with

[4] We use the notation $y_{t+j|t}$ to denote the conditional expectation of a variable y at period $t+j$ based on information available at t, i.e., $y_{t+j|t}$ = E $_t y_{t+j}$. See Erceg and Linde (2014) for a detailed derivation of the model.

the decline in r_t^{pot}, it can keep the output gap unchanged and inflation is maintained at target. To achieve this stabilization of the output gap and inflation following fiscal consolidation, either the response coefficient on inflation (γ_π) or the output gap (γ_x) has to be set arbitrarily large while the smoothing coefficient γ_i is small in the policy rule (eq. 3).

Figure 2: Government Spending Cut with Aggressive Central Bank Response.



Source: IMF staff calculations.

It is important to note, however, that even if inflation is perfectly stabilized and the output gap remains unchanged, actual output (y_t) is lower. The reason for this is that potential output (y_t^{pot}) is lowered when the government implements a lower public consumption path. Even so, the decline in y_t^{pot} is relatively modest (about ¾ of a percent) for a cut in government consumption with 3 percent of baseline GDP (lower right panel). The modest decline in output following the sizeable cut in government consumption stems from a crowding in of private consumption, which rises because real interest rates are lower.

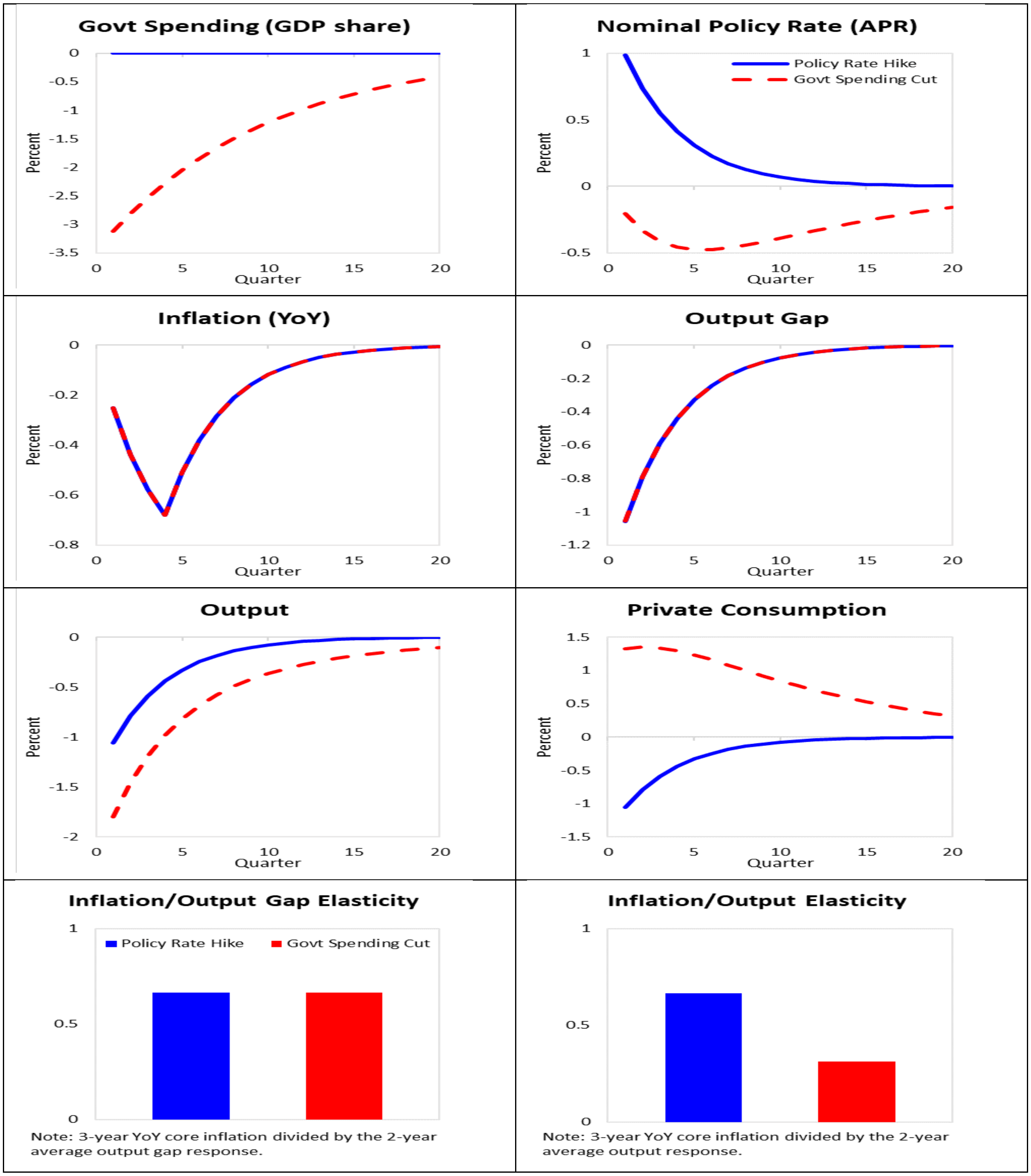
An important insight from this simple analysis is that the extent to which inflation responds when the government consolidates depends importantly on the actions of the central bank. The inflation-output elasticity, defined as the 3-year average of the inflation (YoY) response divided by the 2-year average decline in output, is nil in Figure 2 because inflation is perfectly stabilized. As a result, when the central bank cuts rates aggressively to keep inflation at target, fiscal policy has very little (zero) traction to reduce inflation.

Figure 3 considers a more realistic case when the central bank follows a more standard reaction function which responds gradually to movements in inflation and output. In this case, there is more scope for fiscal policy to influence inflation, as can be seen from the dashed red line in Figure 3. Figure 3 also includes a blue solid line, which shows the effects of a discretionary tightening of monetary policy ($\varepsilon_{i,t}$) in the policy rule (3) under the assumption that g_t is unchanged. We size $\varepsilon_{i,t}$ so that i_t causes inflation and the output gap paths to be identical as in the case with a 3 percent cut in g_t.

Since the paths of inflation and the output gap can by design be made identical, there is isomorphism between monetary and fiscal policy in terms of the inflation/output gap elasticity shown in the bottom left panel. However, monetary policy is still notably more potent in the basic canonical NK model considering the inflation to actual output elasticity. The lower right panel in Figure 3 compares the 3-year average inflation effect divided by the 2-year actual output response for the two alternative tightening strategies. We see that the elasticity is still twice as high for monetary policy, as the reduction in potential output lowers the elasticity for fiscal policy.

Hence, in the case when inflation is projected to remain well above the central banks' target absent any further monetary tightening, the central bank welcomes the fiscal consolidation. This implies that the transmission of fiscal policy to inflation is positive. Still, the simple stylized model implies that the inflation-output elasticity is notably lower for fiscal than monetary policy. However, as we will show in Section 5, fiscal policy can be almost as effective as monetary policy in battling inflation in a more elaborate model with a more realistic monetary and fiscal transmission mechanism.

Figure 3: Discretionary Monetary vs Fiscal Policy Tightening.



Source: IMF staff calculations.

3. A Workhorse Open Economy TANK Model with Capital

In this section we first provide an overview of the structural two-country New Keynesian model used to simulate the effects of tighter fiscal and monetary policy on inflation. Next, we consider a parameterization of the model with monetary and fiscal policy effects that are in line with existing empirical evidence for the U.S. and the euro area.

3.1 Model Overview

The general equilibrium New Keynesian modelling framework provides a rich environment for studying the impact of monetary and fiscal policy changes on the real economy. The specific model we use has been shown by Blanchard et al. (2016) to match the impulse response functions to monetary policy and government spending shocks in the euro area well. The modeling approach is helpful in shedding light on the mechanisms at work, capturing broader general equilibrium effects, and showing how these depend on economy-wide conditions and parameters of choice.

The two-country model with endogenous capital and labor supply closely follows Erceg, Guerrieri and Gust (2006) and Erceg and Lindé (2013). The home economy is calibrated to resemble a typical small, open advanced economy, while the foreign economy is a large and relatively closed advanced economy. Abstracting from open economy features, the specification of each country block closely resembles the estimated models of Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2003, 2007). The model contains a range of features that allow for matching empirical evidence to the macroeconomic response to monetary changes. These include sticky nominal wages and prices, habit persistence in consumption, investment adjustment costs, and a financial accelerator mechanism. To match the transmission of fiscal shocks, the model includes Keynesian households that consume their current after-tax income in a hand-to-mouth fashion.[5] Monetary policy is assumed to follow a simple interest rate rule:

$$i_t = (1-\gamma_i)[\gamma_\pi \pi_t + \gamma_{\Delta x}\Delta x_t] + \gamma_i i_{t-1} + \varepsilon_{i,t}, \tag{11}$$

where γ_i=0.92, γ_π=2.5, and $\gamma_{\Delta x}$=0.25; $\varepsilon_{i,t}$ is a discretionary monetary policy shock.

[5] Gali, Lopez-Salido and Vallés (2007) show that the inclusion of non-Ricardian households helps account for structural VAR evidence indicating that private consumption rises in response to higher government spending. Debortoli and Gali (2017) argues that dynamics in TANK models mimic key aspects of the so-called Heterogeneous Agent New Keynesian (HANK) models (Kaplan, Moll and Violante, 2016).

The fiscal authority raises revenues via distortionary taxes and spends on public consumption and transfers to liquidity constrained households. Government spending is assumed to be AR(1) in growth rates with an error correction term ($\rho_{g,2} > 0$):

$$\Delta g_t = \rho_{g,1}\Delta g_{t-1} - \rho_{g,2}g_{t-1} + \varepsilon_{g,t}. \tag{12}$$

which can be rewritten as the following AR(2) process: $g_t = \left(1 + \rho_{g,1} - \rho_{g,2}\right)g_{t-1} - \rho_{g,1}g_{t-2} + \varepsilon_{g,t}$. Relative to the process for the government spending shock in the stylized model (eq. 10), the specification in eq. (12) enables us to set values for $\varepsilon_{i,t}$ and $\varepsilon_{g,t}$, which, given the parameters in the model and the policy rules in equations (11)-(12), provide near-identical output paths for fiscal and monetary tightening in the model. This allows us to obtain a clean comparison of the effects of monetary and fiscal policy on inflation.

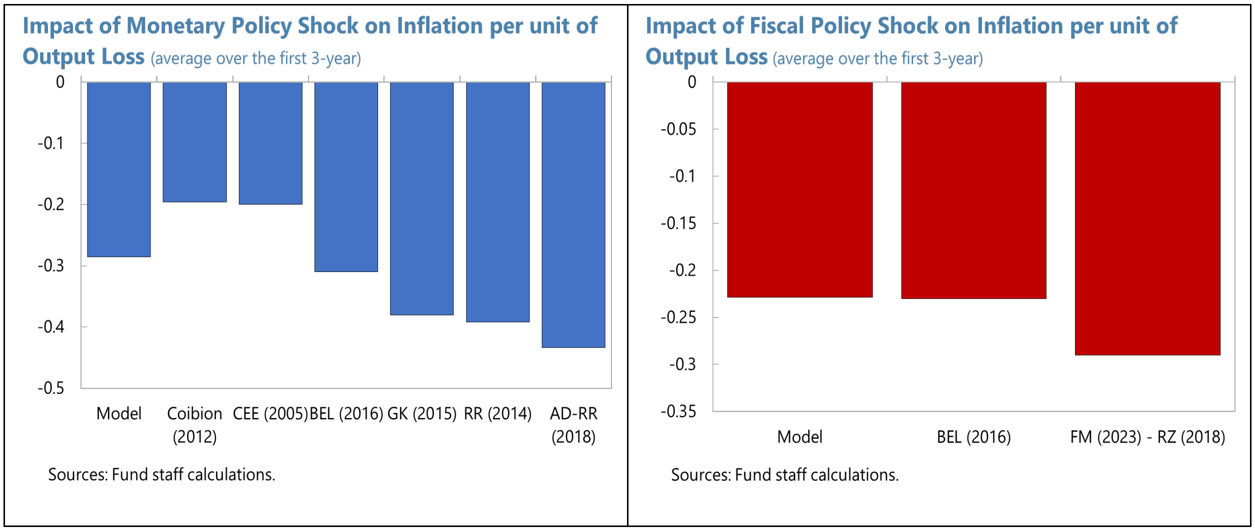
Although government spending is modelled as additive in the optimizing households' utility function and hence does not directly affect economic agents' welfare nor improve total factor productivity (for e.g., as in Baxter and King, 1990), public expenditures affect economic activity via the aggregate demand channel. Apart from its effect on the real exchange rate via interest rate differentials and net foreign assets, this is the key channel through which fiscal policy affects inflation. Moreover, the fiscal authority can issue long-term government debt to finance its deficit. A full exposition of the model is provided in Appendix A.

3.2 Model Calibration

The model features transmission of monetary policy and fiscal shocks in line with existing empirical evidence. The full parameterization of the model is provided in Table A.1 in Appendix A. Most parameters are standard values obtained from the literature on calibrated and estimated New Keynesian models. Figure 4 compares the effects on inflation-output elasticities of discretionary fiscal and monetary policy shocks in a closed economy version of the model with existing empirical evidence for the U.S. and euro area.[6] The figure shows that the structural model used for the simulations describes effects of monetary and fiscal policy in terms of effects on inflation per unit of lost output that are well in line with empirical estimates from the literature.

[6] These numbers are calculated as the numbers in the lower right panel in Figure of 2, i.e., as the percentage points change in average year-over-year inflation for the first three years (i.e., first 12 quarters) divided by the average decline in actual output the first two years (i.e., first 8 quarters) following the shocks. We use a three-year horizon for inflation as this is a common forecast horizon for inflation targeting central banks, and two years for output since central banks tend to emphasize current and next year output activity in their monetary policy reports. The results broadly unchanged if we normalized by the three year decline in average output.

Figure 4: Transmission of Monetary and Fiscal Policy: Model vs. Empirical Evidence.



Source: CEE is Christiano, Eichenbaum and Evans (2005), GK is Gertler and Karadi (2015), RR is Romer and Romer (2014), and AD-RR is Antolin-Diaz and Rubio-Ramirez (2018), FM-RZ is IMF (2023) (who report results based on Ramey and Zubairy, 2018). All these papers report results on U.S. data. BEL is Blanchard, Erceg and Linde (2016) who report results on euro data. The model results are for the coordinated (closed economy) consolidation reported in Figure 7 reflecting that US and Euro area are large less open economies.

4. Effectiveness of Discretionary Monetary and Fiscal Policies in Small Open Economies

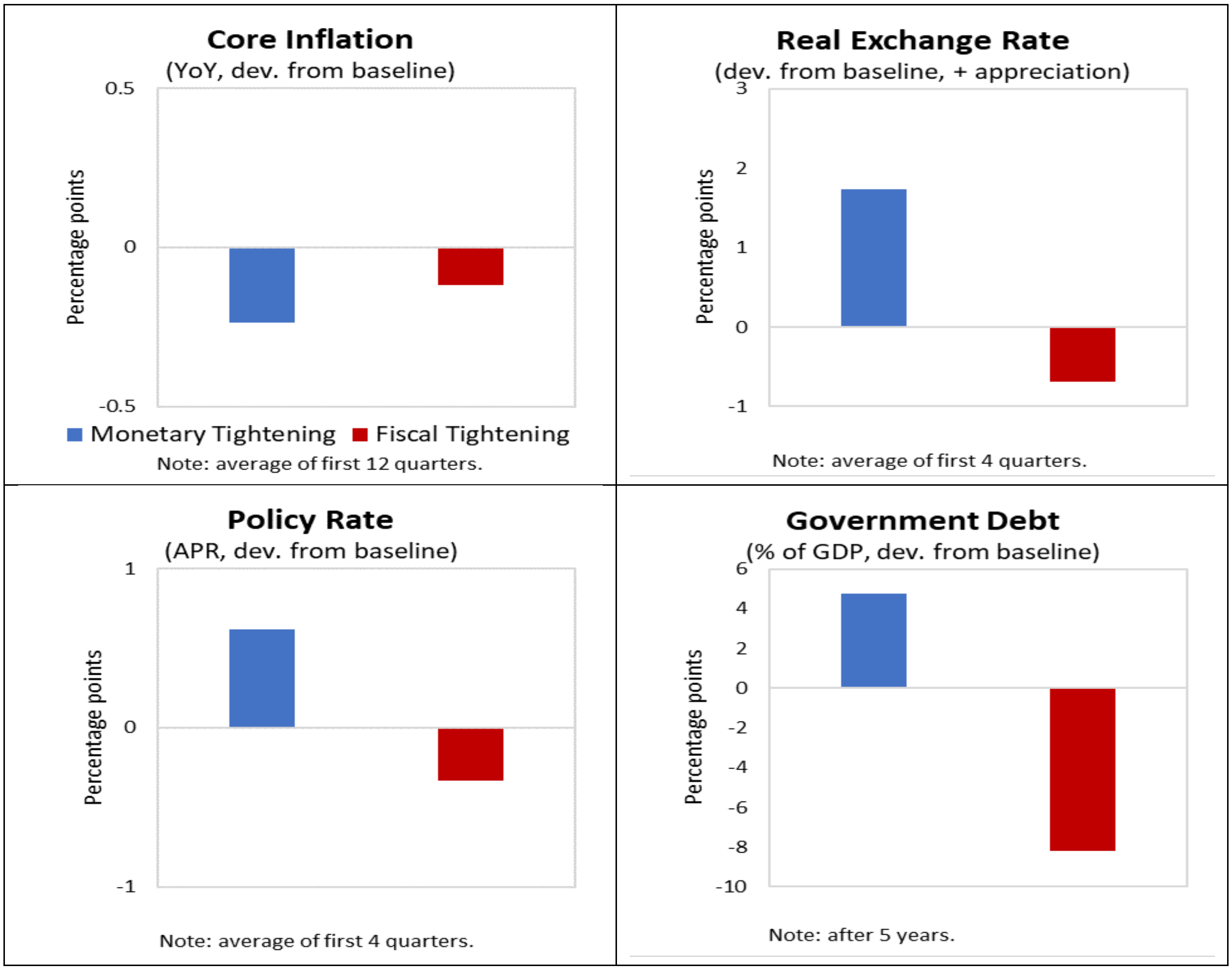
In this section we compare the effectiveness of discretionary monetary and fiscal policy actions. We begin with a calibration of the model aimed at capturing advanced economies (i.e., with deep FX markets and well anchored inflation expectations). Next, we consider an emerging market economy with shallow FX markets, where the UIP risk-premium is sensitive to the countries' external liability position.

4.1 Advanced Small Open Economies with Flexible Exchange Rates

The simulations compare the macroeconomic impact of different monetary and fiscal policy mixes aimed at curbing inflation. The first case entails a tighter monetary policy stance (positive shocks $\varepsilon_{i,t}$ in eq. 11) only and passive fiscal policy that slowly changes (labor) taxes to stabilize debt. The second case entails tighter fiscal policy through cuts in government spending (i.e., negative shock $\varepsilon_{g,t}$ in equation 12), which allows the central bank to pursue a lower interest rate path via its Taylor rule in eq. (11).

Monetary and fiscal tightening are both calibrated to reduce output by one percent on average over the first two years. This facilitates a comparison between the two policy approaches. We undertake the experiments in this section under the assumption that the consolidating country is arbitrarily small relative to its neighbors and hence exerts a negligible impact on the foreign economy. We also assume that FX markets are deep, so that neither policy strategy exerts any significant influence on the UIP risk premium.

Figure 5: Monetary vs. Fiscal Tightening in Small Open Advanced Economies.



Source: IMF staff calculations.

Figure 5 presents results for the case where only a small-open advanced economy tightens. The results for monetary tightening are presented in blue bars and the case of fiscal tightening in red bars. Recall that in both cases output (not shown) falls by 1 percent over the first two years. As shown in the upper left panel, monetary policy has a larger effect on core inflation compared to the fiscal tightening case because monetary tightening results in a real exchange rate appreciation as shown in the right upper panel. Moreover, fiscal tightening takes pressure off the central bank as seen in the bottom left panel: policy rate falls. Accordingly, government debt is reduced notably after 5 years as shown in the lower right panel under fiscal consolidation but rises in the case with tighter monetary policy.

The results in Figure 5 broadly confirm the argument in Dao et al. (2023) whereby fiscal policy has little traction in reducing inflation in open economies with a floating exchange rate. We next consider two alternative setups where these results no longer apply.

4.2 Small Open Emerging Market Economies with Flexible Exchange Rates

We next consider the case in which the home economy is a small open EM economy. EMs differ from a small open advanced economy along a few dimensions. In particular, EMs have shallower foreign exchange markets and more intrinsic persistence in import and wage Phillips curves, implying that an impulse to the exchange rate can affect actual and expected inflation more persistently. Finally, we assume that EMs have lower initial government debt level than in AEs, equaling 65 percent of annual GDP.

The assumption of shallow currency markets implies that the UIP risk-premium falls when the EME net foreign asset position improves. The UIP condition in the model is given by:

$$i_t - i_t^* = \Delta s_{t+1|\mathrm{t}} - \Gamma b_t + \varphi_t, \tag{13}$$

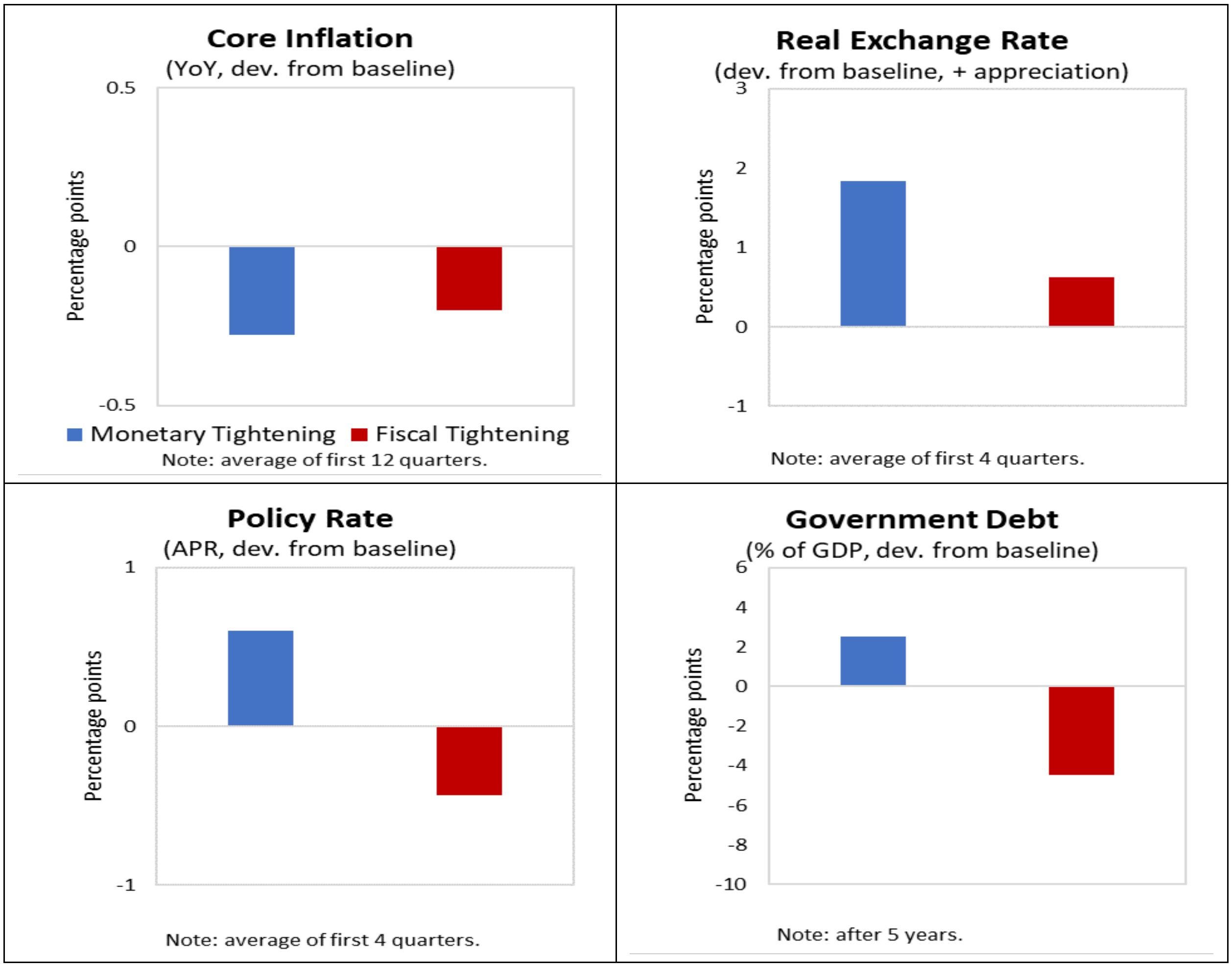
where we set the market depth parameter (Γ) (see Gabaix and Maggiore, 2015, for further details) to 0.001 for the baseline advanced economy calibration with a deep FX market, so that interest differentials are little affected by the net foreign asset (b_t) position but can still be affected by UIP risk premium shocks φ_t.[7] In the calibration for an EME, we set Γ =0.10 inspired by the high-end estimates of this parameter in Chen et al. (2023). This value of Γ implies that a fiscal consolidation which reduces imports and improves the NFA reduces the UIP risk premium, triggering an appreciation of the domestic currency.

Figure 6 illustrates the simulation results. The bars represent the same two fiscal and monetary experiments as before (i.e., average output falls 1 percent the first two years). The impact of monetary policy tightening (blue lines) is broadly similar to the case of the advanced small open economy, see e.g., Figure 5. However, the impact of fiscal tightening on core inflation is similar to the impact of monetary tightening, and significantly larger than the advanced small open advanced economy case. This is because fiscal tightening improves the country's trade balance, in turn leading to an improvement in the country's net foreign asset position. The improvement in net foreign asset position implies a more appreciated exchange rate putting further downward pressure on the core inflation.

[7] The assumptions in Turnovsky (1985) leads to an observationally equivalent log-linearized UIP condition.

The take home lesson is that fiscal policy is more potent in reducing inflation in EMDEs relative to small-open advanced economies. Further, if the central bank does not reduce the policy rate when fiscal policy tightens, fiscal policy can be as potent as monetary policy as shown in the robustness results in Appendix B.

Figure 6: Monetary vs. Fiscal Tightening in Small Open EMEs.



Source: IMF staff calculations.

An additional important difference between Figures 4 and 5 is the smaller improvement in debt improvement in the EME case (Figure 6) compared to the advanced economy case (Figure 5). Since fiscal policy has a higher multiplier in EMEs, less consolidation is needed, with government debt improving by less in this case.

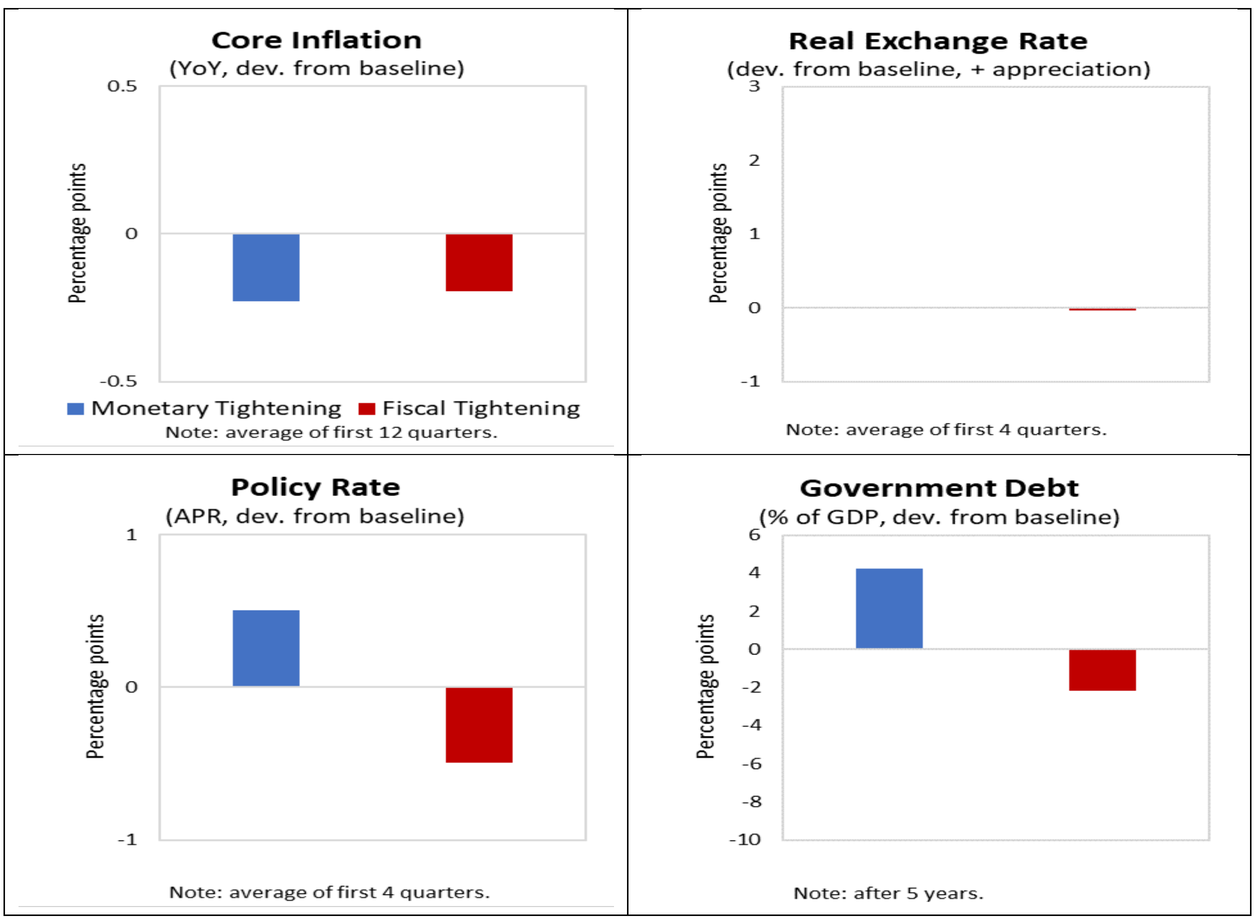
5. Synchronized Discretionary Monetary and Fiscal Actions in Open Economies

In this section, we compare the relative effectiveness of fiscal and monetary policy when many advanced economies tighten their policy stance jointly. The motivation behind this analysis is that high inflation in the wake of the pandemic has been a global phenomenon with many countries needing to tighten policy to restore price stability.

5.1 Baseline Results

Figure 7 illustrates the simulation results when all countries consolidate jointly in a fully-fledged TANK model with endogenous capital accumulation, financial frictions and distortionary taxes. The colored bars represent the same two fiscal and monetary experiments as before (i.e., average output falls 1 percent the first two years).

Figure 7: Joint Monetary vs. Fiscal Tightening in many Countries.



Source: IMF staff calculations.

Figure 7 shows that since all countries tighten simultaneously, the exchange rate does not move measurably, and the edge monetary policy has in curbing inflation is significantly diminished. In this setting, monetary and fiscal policy are equally effective tools as weaker global demand helps to lower inflation. This also implies that less fiscal tightening is needed compared to the case where only one country tightens.

As discussed before, an important difference between the policies is that a tighter fiscal stance takes pressure off from the central bank, interest rates fall (or rise by less) and the government debt outlook improves.

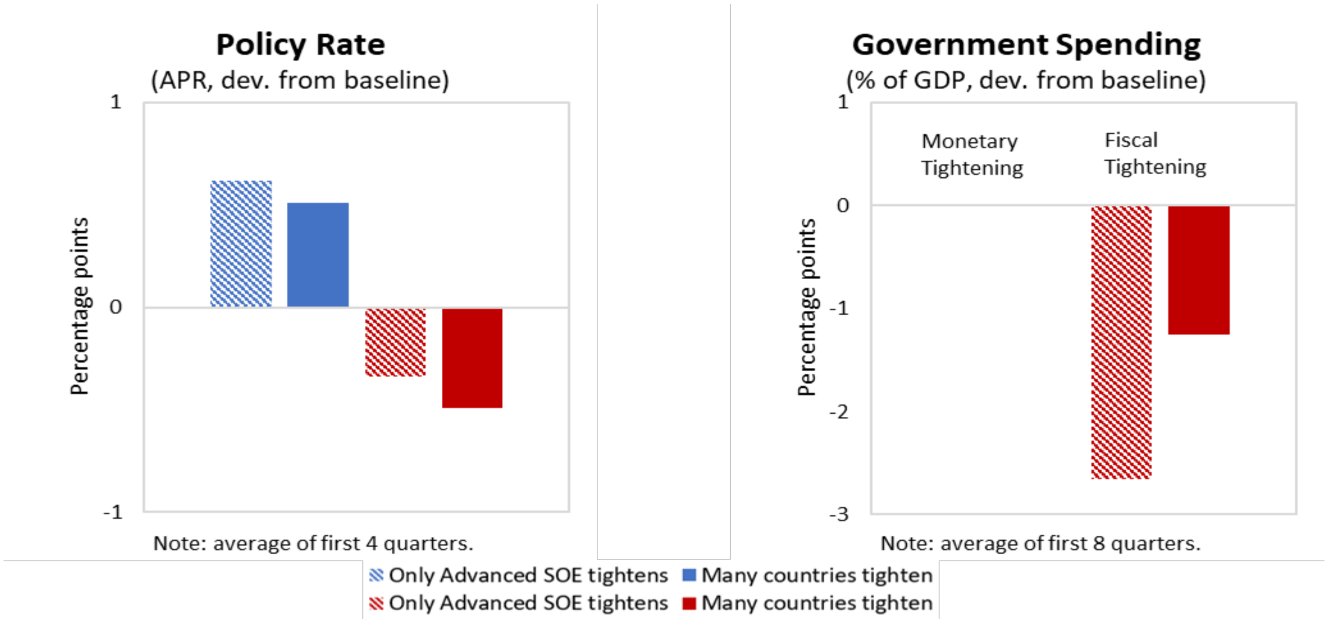
We have assumed so far that fiscal consolidation is based on discretionary spending cuts. Our TANK model implies that spending cuts are more effective to reduce inflation than a mix of tax hikes.[8] The reason is that tax hikes have adverse effects on the supply side which tends to keep inflation higher, whereas spending-cuts mainly works through the demand side and hence more effective in reducing inflation when conditioning on the same-sized output contraction.[9] We notice, however, that recent empirical evidence suggest that also certain tax instruments can be effective in reducing inflation. Using linear local projections, empirical work on US data by Cloyne et al. (2023a, 2023b) and Dabla-Norris and others (forthcoming) suggests a sizeable decline in inflation for an increase in the personal income tax, while a corporate income tax increase has small (if any) effects on inflation when both instruments are sized to imply an average output contraction with one percent the first two years. So while the TANK model stresses the importance of spending cuts to lower inflation, the recent empirical work suggest that consolidation based on a mix of spending cuts and tax hikes should be effective as well.

Another important aspect of a joint global tightening is that notably smaller policy actions are needed to achieve the same output and inflation effect. Figure 8 examines the policy actions needed to achieve a 1 percent decline in domestic output when only the advanced small open economy tightens versus the case when all economies tighten. The left panel shows changes in the interest policy rate; the light-dotted blue bar shows how much the policy rate needs to move during the first year to engineer a one percent output drop for two years when only the advanced small open economy tighten interest rate policy, whereas the solid-blue bar shows how much higher the central bank in the advanced small open economy needs to tighten the policy rate when the rest of the world is tightening as well. The central bank in the small open economy only needs to raise its policy rate by ¾ as much as when other countries are tightening the policy stance too.

[8] In Appendix B, we compare the effects of spending-based and tax-mix based consolidation strategies.

[9] Throughout the paper we consider cuts in government consumption. It is of course likely that sizeable cuts in government investment may transmit differently than cuts in government consumption, see e.g. Lemoine and Linde (2023).

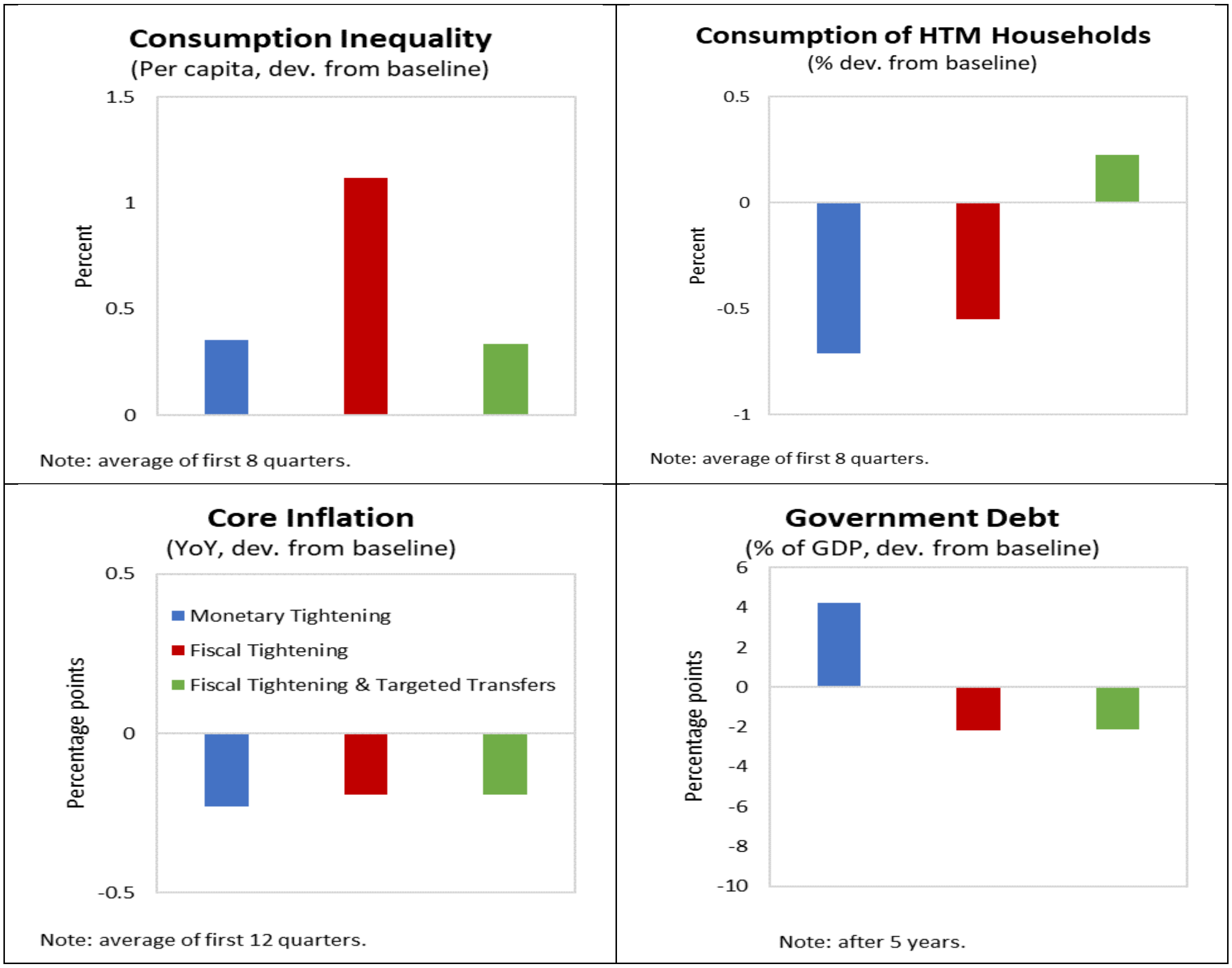
Figure 8: Effectiveness of Monetary and Fiscal Policies when many Countries Tighten.



Source: IMF staff calculations.

The light and solid red bars for the policy rate in the left panel pertains to how much the model endogenously implies that the central bank in the advanced small open economy central bank lower its policy rate path (recalling that CB always follow the Taylor type policy rule in eq. 11) the first year in response to discretionary cuts in government consumption in only the advanced small open economy (light red) and globally (solid red) reported in the right panel. By looking the fiscal spending cuts, we notice two important considerations. When everyone is cutting government consumption, a much smaller cut – say about ½ as large as when only a single economy consolidates – is needed to reduce output with 1 percent for two years. This smaller cut also more effectively reduce inflation as the exchange rate does not depreciate (compare the inflation responses in Figures 4 and 6 for tighter fiscal policy). Moreover, as can be seen from the red bars for the policy rate in the left panel, the model implies that the central banks can cut their policy rate path more in response to a global fiscal consolidation effort. By implication, the fiscal consolidation is even more effective if central banks welcomed the tightening and kept the policy rate path unchanged. This point was made in Section 4.2 for the small open EME case, and it holds up also for advanced economies, especially when all countries jointly tighten its fiscal policy stance.

Figure 9: Targeted Transfers can Attenuate Inequality Effects.



Source: IMF staff calculations.

Another important consideration is the effects on inequality of alternative policy mixes (see, for example, Bilbiie, Monacelli, and Perotti 2021).[10] The upper left panel in Figure 9 shows the effects on consumption inequality (i.e. the difference between consumption of optimizing households and households without saving buffers that consume hand to mouth) in our TANK model. As can be seen by the differences between the blue (MP tightening) and red (FP tightening) bars in this panel, our model implies that FP tightening has a larger effect on consumption inequality than MP tightening. This is because FP tightening affects labor income relatively more, which hurts hand-to-mouth households more while financially unconstrained households benefit from lower real interest rates by the central bank. However, it is important to note that the percent decrease in consumption by the hand to mouth households is lower for a cut in government consumption than a tightening of the policy rate. In particular, the adverse

[10] Bilbiie, Monacelli, and Perotti (2021) analytically show with a TANK model that inequality enters into the welfare objective for policy makers.

effect on consumption inequality under fiscal consolidation is driven by crowding in of private consumption of financially unconstrained households rather than the crowding out of their consumption when the central bank tightens. The green bar in Figure 9 shows that an appropriate combination of general spending cuts coupled with targeted transfers to vulnerable households can offset any adverse inequality effects (relative to tighter MP) while achieving the same effects on inflation, output, and government debt as in the case of spending based fiscal consolidations.[11]

5.2 Why Fiscal Policy is more Potent in the Workhorse Model

An important finding from Figure 7 is that fiscal policy is almost equally potent as monetary policy when all countries jointly tighten their policy stance. This result differs from the simple closed economy model in Section 2 (lower right panel in Figure 3), in which fiscal policy was shown to be only about half as potent as in the workhorse model. The difference between the findings in Figures 2 and 6 is intriguing, as the results of coordinated spending cut in Figure 7 are similar to those obtained in a closed economy formulation of the TANK model. When discussing the differences between the findings in the stylized and TANK models, we focus on the inflation-output elasticity to recognize that fiscal policy also operates via potential output.

Table 2 reports the inflation-output elasticities (i.e., the average three-year inflation impact divided by the 2-year average decline in output) following either discretionary fiscal or monetary tightening. Figure 10 report the underlying impulse responses in the TANK model underlying the numbers in Table 2. Importantly, Figure 10 shows results for discretionary monetary and fiscal policy actions normalized to imply a one percent decline in output in the first two years in the full model. The shocks in the alternative calibrations are sized to give rise to the same initial policy rate response and decline in government consumption.

The first row in Table 2 shows results from the simple model (i.e., the columns in the lower right panel in Figure 3). The second-row reports findings from the baseline TANK model (i.e., the two columns in the upper left column in Figure 7, where joint monetary vs. fiscal tightening in many countries is considered). Table 2 reports inflation-output elasticities because the inflation response is normalized by the output contraction. The final column reports the relative effectiveness of fiscal FP and monetary policy MPin reducing inflation (i.e., the fiscal inflation-output elasticity divided by the monetary inflation-output elasticity). We find that the relative effectiveness of fiscal policy is notably higher in TANK model compared to the stylized model in Section 2, although the inflation-output elasticities for both policies lower in the TANK model

[11] The FP consolidation package that consists of both spending cuts and positive targeted transfers to vulnerable households features larger spending cut to offset aggregate demand effects by the targeted transfers.

because of lower transmission to inflation due to the presence of slow nominal wage adjustment (the simple model in Section 2 only features slow price adjustment).

Table 2: Understanding Inflation-Output Elasticities in the TANK Model.

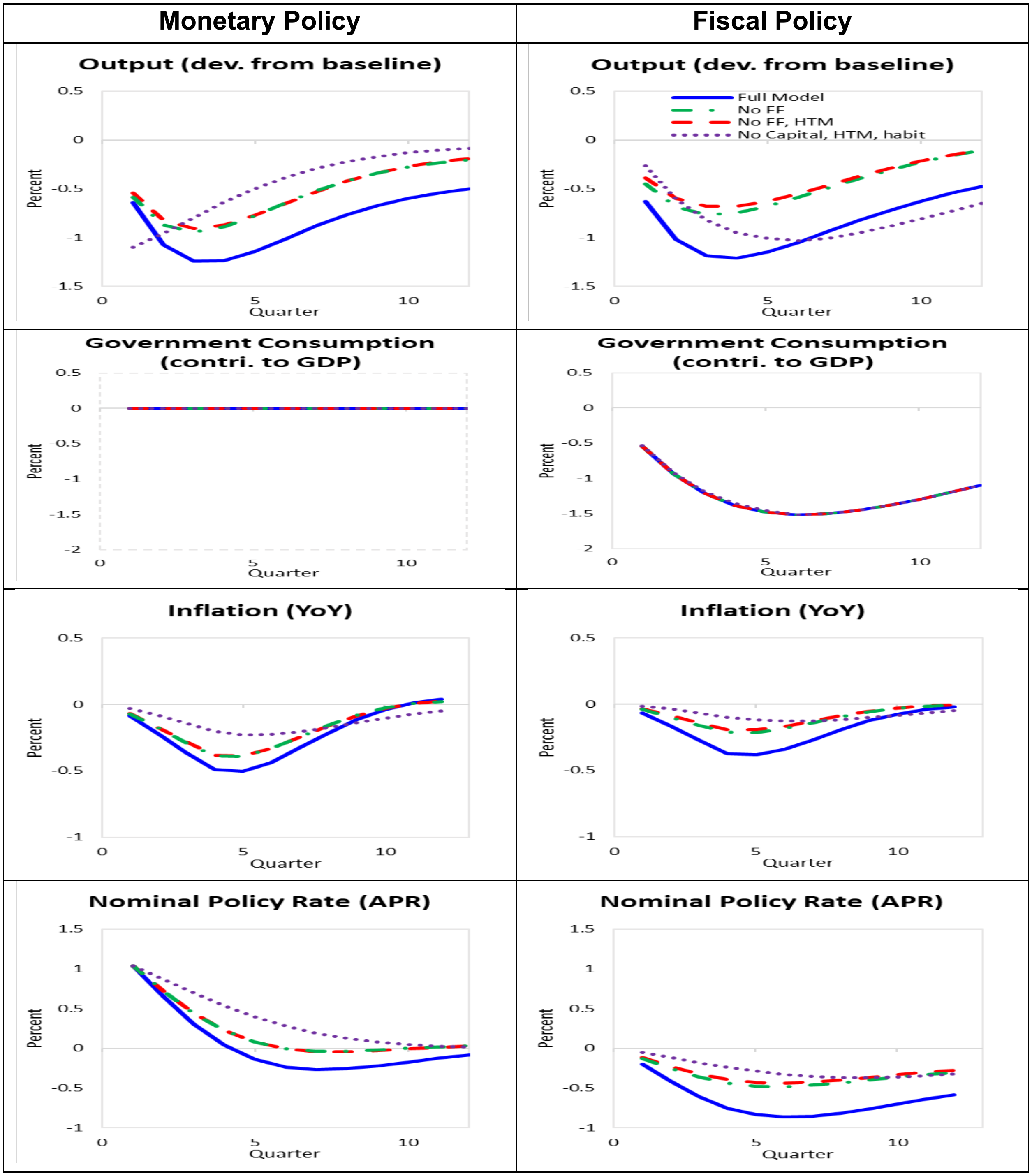
	Inflation-Output Elasticity		Relative Effectiveness (FP/MP)
	Fiscal Policy (FP)	**Monetary Policy (MP)**	
Simple Model	0.31	0.66	0.47
TANK Model	0.19	0.23	0.83
- No Financial Frictions (FF)	0.17	0.25	0.68
- No FF and Keynesian households (HTM)	0.17	0.26	0.65
- No Capital, HTM and Habit	0.10	0.22	0.46

Notes: Inflation-output elasticity is calculated as the average three-year inflation impact divided by the 2-year decline in output following a discretionary policy intervention. Because we use a linearized model, this elasticity is independent on the policy intervention size. The relative effectiveness is defined as the FP inflation-output elasticity divided by the MP inflation-output elasticity. Simulations all assume the case of joint monetary and fiscal tightening in many countries.

While the inflation-output elasticities is lower for both policies in the TANK model, fiscal policy is relatively more effective. To examine the key driver of this finding, the lower rows in Table 2 removes some features from the TANK, zooming-into the relative effectiveness of fiscal and monetary consistent with the stylized model. We first remove the Christiano, Motto, and Rostagno (2008, 2014) formulation of the Bernanke, Gertler and Gilchrist (1999) financial accelerator mechanism in the model. As can be seen from the third row in the Table, this lowers the relative effectiveness of fiscal policy. Figure 10 shows that the relatively larger moderation of inflation without a financial accelerator mechanism is driven by the larger persistent fall in output than the case of monetary policy.

When we additionally remove Keynesian hand-to-mouth households, we do not observe significant changes. Only a slight decline in the relative effectiveness of fiscal policy obtains although Figure 10 shows the overall impact of both policies is attenuated somewhat. However, when endogenous capital accumulation and habit formation in preferences ($\aleph$ is set arbitrarily low) are additionally removed (as seen in the fourth row), we see that the relative effectiveness of fiscal and monetary policy are consistent with the results in the stylized model in Section 2. This suggests that to reconcile the results in the simple model with the ones in the TANK model, excluding capital, hand-to-mouth households and habit formation suffices. Still, it is important to note that the effects on inflation relative to output remains smaller in the TANK model due to the presence of nominal wage stickiness in this model.

Figure 10: Transmission of Monetary and Fiscal Policy in the Workhorse Model.



Source: IMF staff calculations.

6. Spillovers of Alternative Policy Mixes in Advanced Economies on EMEs

In this section, we discuss spillovers of alternative policy tightening strategies in major advanced economies on EMEs and low income countries. As discussed before, many EMEs and low income countries have shallow FX markets, with UIP risk-premiums that are sensitive to their net lending position. They are also assumed to run managed floating exchange regimes and use policy rates to lean against exchange movements. The source economy undertaking the policy action is roughly set to mimic she share of advanced economies in the world economy (75 percent) and their trade with the rest of the world.[12]

Monetary and fiscal policy actions are modelled in the same way as before, but the policy tools are resized to have the same one percent reduction in annualized core CPI inflation over three years in the advanced economies undertaking the policy action.[13] Because fiscal policy has a slightly smaller inflation imprint than monetary policy for the reasons discussed earlier, this means that output in the source economy falls a bit more in the fiscal case compared to the monetary policy case.

As shown in Figure 11, spillovers to EMEs with shallow currency markets can be severe. For instance, in EMEs and low income countries that have to defend their currency due to FX misalignments and large exchange rate pass-through, the simulation shows that the adverse spillovers on output can be more negative for monetary policy tightening in advanced economies because policy rates and term premiums rise. However, the effects on inflation in EMEs is broadly similar with a tighter fiscal stance in advanced economies, as fiscal consolidation leads to appreciation of EME currencies.

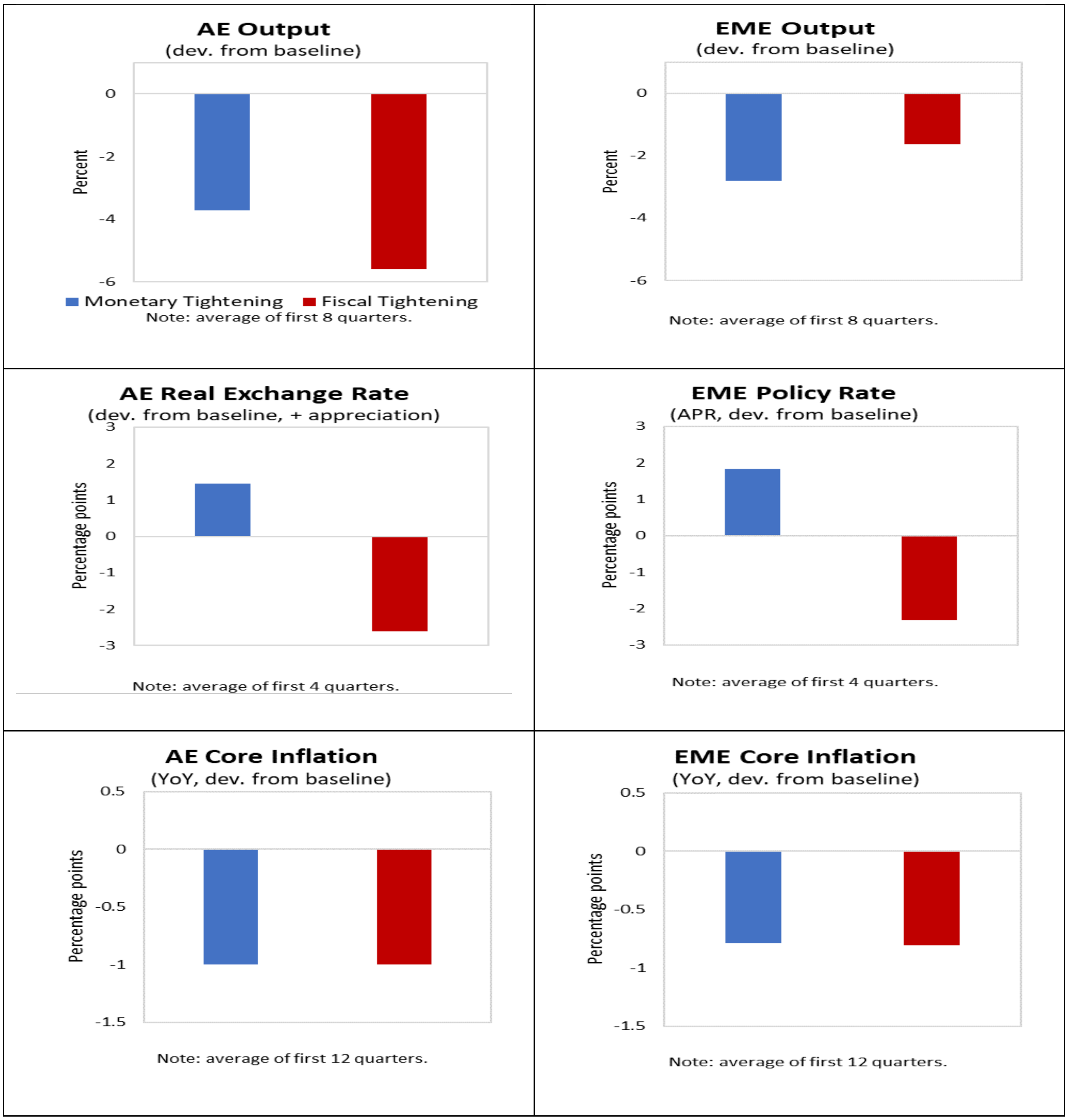
When simulating alternative mixes of tight monetary and fiscal policy in a calibration reflecting the US and other advanced economies, we find that the spillovers to foreign advanced economies of tighter US fiscal policy can be larger than for tighter US monetary policy. From the perspective of recipient advanced economies, both policies reduce foreign demand, but tighter US monetary policy cushions the spillovers to output in other advanced economies by depreciating their currency (i.e., the dollar appreciates) which results in larger net exports.

[12] We set the consolidating country countries trade share with EMEs slightly below 5 percent, which given the assumed share of advanced economies of the world economy (75 percent) implies a trade share in EMEs with AEs of about 14 percent (i.e., three times the trade share of AEs).

[13] Previously, we assessed the domestic effects of alternative mixes on inflation with both tools implying the same reduction in output. But when looking at international spillovers it makes more sense to condition on same inflation reduction since this is the objective of policy in the major source economies.

One implication of this is that tighter US fiscal policy reduces inflation more in advanced foreign economies, which can be helpful when core inflation in the latter is running well above target. It also eases pressure to hike policy rates by central banks in the latter.

Figure 11: Spillovers to EMEs with Managed Float Exchange Rates from Alternative monetary-fiscal tightening mixes in major AEs.



Source: IMF staff calculations.

7. Conclusions

Using a quantitative model, this paper studies how tighter fiscal policy can support central banks in reducing inflation. While monetary policy should remain the primary tool to maintain price stability, a tighter fiscal policy can lower inflation via reduced domestic demand—just as the case with tighter monetary policy. The twin benefit of a tighter fiscal stance is that it stabilizes and eventually lower government debt to levels that are sustainable if real rates rise whereas tighter monetary policy puts further upward pressure on government debt.

However, the effectiveness of fiscal policy in reducing inflation varies across county. In small open advanced economies, fiscal policy is less effective compared with monetary policy. This is because when the central bank tightens monetary policy, the domestic currency appreciates while a fiscal tightening weakens the exchange rate. This additional exchange rate channel makes monetary policy more powerful in reducing inflation in small open advanced economies. However, in EMDEs with shallow FX markets, fiscal tightening can be just effective as monetary policy tightening in reducing inflation. This is because a tighter fiscal stance improves the country's debt sustainability position. In particular, fiscal policy tightening can lead to an appreciation of domestic currency that dampens inflation, making fiscal policy equally effective in battling inflation.

Fiscal consolidation is more effective in reducing inflation when many countries tighten simultaneously. In this case, exchange rates do not move much. Therefore, the edge that monetary policy has in curbing inflation via exchange rate appreciation dissipates. Further, fiscal tightening is just as effective as monetary policy tightening in reducing inflation in this case. Moreover, when many countries tighten, weaker global demand acts as an additional channel to lower inflation.

Fiscal tightening comes with additional benefits but requires careful policy adjustments to avoid worsening income inequality. Fiscal consolidation tends to widen income inequality compared with monetary policy tightening. Therefore, policymakers can deploy targeted support to cushion the impact on vulnerable households. As argued by IMF (2023), cutting non-targeted spending more aggressively and at the same time increasing transfers to vulnerable households effectively prevents an increase in consumption inequality.

Finally, we find monetary and fiscal tightening in advanced economies have significant spillovers for EMDEs. Specifically, a fiscal contraction in advanced economies reduces output and inflation via trade by causing EMDE currencies to appreciate. Instead, monetary policy tightening in advanced economies reduces output in EMDEs by tightening financial conditions and may result in sizable EMDE exchange rate depreciation, potentially intensifying downside risks.

There are some important considerations we leave for future research. As public debt remains well-above pre-pandemic levels and budget constraints become increasingly binding, a lower fiscal deficit can help put debt on a more sustainable path. Importantly, fiscal consolidation can reduce the risk of fiscal dominance, in turn, improving the effectiveness of macro policies (Bianchi and Melosi, 2022, Bianchi, Faccini and Melosi, 2023 and Leeper, 1991). Lower government spending improve the country's external position, especially for commodity importers who suffered from the recent large commodity price shock. Moreover, fiscal tightening affords central banks the possibility to raise interest rates by less and keep them elevated for a shorter time period, reducing financial stability risks. Lower government debt levels further promote financial stability in countries with significant sovereign debt-bank asset linkages and the possibility of costly debt default. A model with these features is likely to make a stronger case for fiscal tightening in the current conjuncture. Furthermore, it would be instructive to consider the role for nonlinearities when assessing the strength of alternative monetary and fiscal policy mixes in a high-inflation environment (see e.g., Harding, Linde, and Trabandt, 2021, 2023) Finally, it would be interesting to analyze the game-theoretic incentives to pursue alternative tightening fiscal and monetary mixes a model with several countries.

Appendix A. Details on the TANK Open Economy New Keynesian Model

The open economy model closely follows the Erceg and Lindé (2013) variant of the Erceg, Guerrieri and Gust (2006) SIGMA model. The model consists of two countries (or regions) and allows for endogenous investment, hand-to-mouth or Keynesian households, sticky wages as well as sticky prices, trade adjustment costs, and incomplete financial markets across the two countries. Given the isomorphic structure of the two economies in the model, our exposition below largely focuses on the structure of one of the two countries (or regions).

The model also features a financial accelerator channel which closely parallels earlier work by Bernanke, Gertler, and Gilchrist (1999) and Christiano, Motto, and Rostagno (2008). Given that the mechanics underlying this particular financial accelerator mechanism are well-understood, we simplify the exposition in this Appendix by focusing on a special case of our model which abstracts from the financial accelerator. However, we conclude our model description with a brief description of how the model is modified to include the financial accelerator (Section A.6).

A.1. Firms and Price Setting

A.1.1. Production of Domestic Intermediate Goods

There is a continuum of differentiated intermediate goods (indexed by $i \in [0,1]$) in each economy, each of which is produced by a single monopolistically competitive firm. In the domestic market, firm i faces a demand function that varies inversely with its output price $P_{Dt}(i)$ and directly with aggregate demand at home Y_{Dt}:

$$Y_{Dt}(i) = \left[\frac{P_{Dt}(i)}{P_{Dt}}\right]^{\frac{-(1+\theta_p)}{\theta_p}} Y_{Dt}, \tag{A.1}$$

where $\theta_p > 0$, and P_{Dt} is an aggregate price index defined below. Similarly, firm i faces the following export demand function:

$$X_t(i) = \left[\frac{P^*_{Mt}(i)}{P^*_{Mt}}\right]^{\frac{-(1+\theta_p)}{\theta_p}} M^*_t, \tag{A.2}$$

where $X_t(i)$ denotes the quantity demanded of domestic good i in the foreign economy, $P^*_{Mt}(i)$ denotes the price that firm i sets in the foreign market, P^*_{Mt} is the import price index abroad, and M^*_t is an aggregate of the economy's imports (we use an asterisk to denote the foreign country's variables).

Each producer utilizes capital services $K_t(i)$ and a labor index $L_t(i)$ (defined below) to produce its respective output good. The production function is assumed to have a constant-elasticity of substitution (CES) form:

$$Y_t(i) = \left[\omega_K^{\frac{\rho}{1+\rho}} K_t(i)^{\frac{1}{1+\rho}} + \omega_L^{\frac{\rho}{1+\rho}} \left(Z_t L_t(i)\right)^{\frac{1}{1+\rho}}\right]^{1+\rho}. \tag{A.3}$$

The production function exhibits constant-returns-to-scale in both inputs, and Z_t is a country specific shock to the level of technology. Firms face perfectly competitive factor markets for hiring capital and labor. Thus, each firm chooses $K_t(i)$ and $L_t(i)$, taking as given both the rental price of capital R_{Kt} and the aggregate wage index W_t (defined below). Firms can costlessly adjust either factor of production, which implies that each firm has an identical marginal cost per unit of output, MC_t. The (log-linearized) technology shock is assumed to follow a stationary AR(2) process:

$$\Delta z_t = \rho_{z,1}\Delta z_{t-1} - \rho_{z,2} z_{t-1} + \epsilon_{z,t}. \tag{A.4}$$

The prices of the intermediate goods are determined by Calvo-style staggered contracts (see Calvo, 1983). In each period, a firm selling its goods in the domestic market faces a constant probability, $1-\xi_t$, of being able to re-optimize its price $\left(P_{Dt}(i)\right)$. This probability of receiving a signal to reoptimize is independent across firms and time. If a firm is not allowed to optimize its prices, we follow Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2003), and assume that the firm must reset its domestic price as a weighted combination of the lagged and steady state rate of inflation $P_{Dt}(i) = \pi_{t-1}^{\iota_p}\pi^{\iota_p} P_{Dt-1}(i)$ for the non-optimizing firms. This formulation allows for structural persistence in price-setting if ι_p exceeds zero.

When a firm i is allowed to reoptimize its price in period t, the firm maximizes:

$$\max_{P_{Dt}(i)} \mathrm{E}_t \sum_{j=0}^{\infty} \psi_{t,t+j}\xi_p^j \left[\prod_{h=1}^{j} \pi_{t+h-1}\left(P_{Dt}(i) - MC_{t+j}\right) Y_{Dt+j}(i)\right]. \tag{A.5}$$

The operator E_t represents the conditional expectation based on the information available to agents at period t. The firm discounts profits received at date $t+j$ by the state-contingent discount factor $\psi_{t,t+j}$; for notational simplicity, we have suppressed all of the state indices.[14] The first-order condition for setting the contract price of good i is:

$$\mathrm{E}_t \sum_{j=0}^{\infty} \psi_{t,t+j}\xi_p^j \left[\frac{\prod_{h=1}^{j} \pi_{t+h-1}(i) P_{Dt}(i)}{(1+\theta_p)} - MC_{t+j}\right] Y_{Dt+j}\,(i) = 0.$$

(A.6)

For the goods sold abroad, we assume local currency pricing (LCP). Although the price-setting problem for the exporting firms is isomorphic to the problem for the firms selling goods on the domestic market, the LCP assumption implies that the price of foreign import goods $P_{M,t}^*$ will deviate from the producer currency price as follows (in log-linear form)

$$\delta_t^* = -p_{M,t}^* - s_t + p_{X,t}, \tag{A.7}$$

where $p_{X,t} = p_{D,t}$. The deviations from the law of one price are due to price stickiness for the exported goods.

A.1.2. Production of the Domestic Output Index

[14] We denote $\xi_{t,t+j}$ to be the price in period t of a claim that pays one dollar if the specified state occurs in period $t+j$ (see the household problem below); then the corresponding element of $\psi_{t,t+j}$ equals $\xi_{t,t+j}$ divided by the probability that the specified state will occur.

Because households have identical Dixit-Stiglitz preferences, it is convenient to assume that a representative aggregator combines the differentiated intermediate products into a composite home-produced good Y_{Dt}:

$$Y_{Dt} = \left[\int_0^1 Y_{Dt}\,(i)^{\frac{1}{1+\theta_p}} di \right]^{1+\theta_p}. \tag{A.8}$$

The aggregator chooses the bundle of goods that minimizes the cost of producing Y_{Dt}, taking the price $P_{Dt}(i)$ of each intermediate good $Y_{Dt}(i)$ as given. The aggregator sells units of each sectoral output index at its unit cost P_{Dt}:

$$P_{Dt} = \left[\int_0^1 P_{Dt}\,(i)^{\frac{-1}{\theta_p}} di \right]^{-\theta_p}. \tag{A.9}$$

We also assume a representative aggregator in the foreign block who combines the differentiated domestic products $X_t(i)$ into a single index for foreign imports:

$$M_t^* = \left[\int_0^1 X_t\,(i)^{\frac{1}{1+\theta_p}} di \right]^{1+\theta_p}, \tag{A.10}$$

and sells M_t^* at price $P_{M,t}^*$:

$$P_{Mt}^* = \left[\int_0^1 P_{Mt}^*\,(i)^{\frac{-1}{\theta_p}} di \right]^{-\theta_p}. \tag{A.11}$$

A.1.3. Production of Consumption and Investment Goods

Final consumption goods are produced by a representative consumption goods distributor. This firm combines purchases of domestically-produced goods with imported goods to produce a final consumption good (C_{At}) according to a constant-returns-to-scale CES production function:

$$C_{At} = \left(\omega_C^{\frac{\rho_C}{1+\rho_C}} C_{Dt}^{\frac{1}{1+\rho_C}} + (1-\omega_C)^{\frac{\rho_C}{1+\rho_C}} (\varphi_{Ct} M_{Ct})^{\frac{1}{1+\rho_C}} \right)^{1+\rho_C}. \tag{A.12}$$

where C_{Dt} denotes the consumption good distributor's demand for the index of domestically produced goods, M_{Ct} denotes the distributor's demand for the index of foreign-produced goods, and φ_{Ct} reflects costs of adjusting consumption imports. The final consumption good is used by both households and by the government.[15] The form of the production function mirrors the preferences of households and the government sector over consumption of domestically-produced goods and imports. Accordingly, the quasi-share parameter ω_C may be interpreted as determining the preferences of both the private and public sector for domestic relative to foreign consumption goods, or equivalently, the degree of home bias in consumption expenditure. Finally, the adjustment cost term φ_{Ct} is assumed to take the quadratic form:

$$\varphi_{Ct} = \left[1 - \frac{\varphi_{M_C}}{2} \left(\frac{\frac{M_{Ct}}{C_{Dt}}}{\frac{M_{Ct-1}^{agg}}{C_{Dt-1}^{agg}}} - 1 \right)^2 \right]. \tag{A.13}$$

This specification implies that it is costly to change the proportion of domestic and foreign goods in the aggregate consumption bundle, even though the level of imports may jump costlessly in response to changes

[15] Thus, the larger-scale model constrains the import share of government consumption to equal that of private consumption.

in overall consumption demand. We assume that the adjustment costs for each distributor depend on distributors' current import ratio $\frac{M_{Ct}}{C_{Dt}}$ relative to the economy-wide ratio in the previous period $\frac{M_{Ct-1}^{agg}}{C_{Dt-1}^{agg}}$ so that adjustment costs are external to individual distributors.

Given the presence of adjustment costs, the representative consumption goods distributor chooses (a contingency plan for) C_{Dt} and M_{Ct} to minimize its discounted expected costs of producing the aggregate consumption good:

$$\min_{C_{Dt+k,}M_{Ct+k,}} \mathbb{E}_t \sum_{k=0}^{\infty} \psi_{t,t+k}(P_{Dt+k}C_{Dt+k} + P_{Mt+k}M_{Ct+k}) + P_{Ct+k}\left[C_{A,t+k} - \left(\omega_C^{\frac{\rho_C}{1+\rho_C}} C_{Dt+k}^{\frac{1}{1+\rho_C}} + (1-\omega_C)^{\frac{\rho_C}{1+\rho_C}} (\varphi_{Ct+k}M_{Ct+k})^{\frac{1}{1+\rho_C}}\right)^{1+\rho_C}\right] \quad \text{(A.14)}$$

The distributor sells the final consumption good to households and the government at a price P_{Ct}, which may be interpreted as the consumption price index (or equivalently, as the shadow cost of producing an additional unit of the consumption good).

We model the production of final investment goods in an analogous manner, although we allow the weight ω_I in the investment index to differ from that of the weight ω_C in the consumption goods index.[16]

A.2. Households and Wage Setting

We assume a continuum of monopolistically competitive households (indexed on the unit interval), each of which supplies a differentiated labor service to the intermediate goods producing sector (the only producers demanding labor services in our framework) following Erceg, Henderson and Levin (2000). A representative labor aggregator (or employment agency) combines households labor hours in the same proportions as firms would choose. Thus, the aggregator's demand for each household's labor is equal to the sum of firms' demands. The aggregate labor index L_t has the Dixit-Stiglitz form:

$$L_t = \left[\int_0^1 \left(\zeta N_t(h)\right)^{\frac{1}{1+\theta_w}} dh\right]^{1+\theta_w} \quad \text{(A.15)}$$

where $\theta_w > 0$ and $N_t(h)$ is hours worked by a typical member of household h.

The parameter ζ is the size of a household of type h, and effectively determines the size of the population in the home country. The aggregator minimizes the cost of producing a given amount of the aggregate labor index, taking each household's wage rate $W_t(h)$ as given, and then sells units of the labor index to the production sector at their unit cost W_t:

$$W_t = \left[\int_0^1 W_t(h)^{\frac{-1}{\theta_w}} dh\right]^{\theta_w} \quad \text{(A.16)}$$

The aggregator's demand for the labor services of a typical member of household h is given by

[16] Government spending is assumed to fall exclusively on consumption, so that all investment is private investment.

$$N_t(h) = \left[\frac{W_t(h)}{W_t}\right]^{-\frac{1+\theta_W}{\theta_W}} L_t/\zeta \tag{A.17}$$

We assume that there are two types of households: households that make intertemporal consumption, labor supply, and capital accumulation decisions in a forward-looking manner by maximizing utility subject to an intertemporal budget constraint (FL households, for "forward-looking"); and the remainder that simply consume their after-tax disposable income (HM households, for "hand-to-mouth" households). The latter type receives no capital rental income or profits, and choose to set their wage to be the average wage of optimizing households. We denote the share of FL households by $1 - \varsigma$ and the share of HM households by ς.

We consider first the problem faced by FL households. The utility functional for an optimizing representative member of household *h* is

$$\mathbb{E}_t \sum_{j=0}^{\infty} \beta^j \left\{ \begin{array}{c} \frac{1}{1-\sigma}\left(C_{t+j}^O(h) - \aleph C_{t+j-1}^O - C^O \nu_{ct+j}\right)^{1-\sigma} \\ + \frac{\chi_0 Z_{t+j}^{1-\rho}}{1-\chi}\left(1 - N_{t+j}(h)\right)^{1-\chi} + \mu_0 F\left(\frac{MB_{t+j+1}(h)}{P_{Ct+j}}\right) \end{array} \right\} \tag{A.18}$$

where the discount factor β satisfies $0 < \beta < 1$. As in Smets and Wouters (2003, 2007), we allow for the possibility of external habit formation in preferences, so that each household member cares about its consumption relative to lagged aggregate consumption per capita of forward-looking agents C_{t-1}^O.

The period utility function depends on each member's current leisure $1 - N_t(h)$, his end-of-period real money balances, $\frac{MB_{t+1}(h)}{P_{Ct}}$, and a preference shock, ν_{ct}. The subutility function $F(.)$ over real balances is assumed to have a satiation point to account for the possibility of a zero nominal interest rate; see Eggertsson and Woodford (2003) for further discussion.[17] The (log-linearized) consumption demand shock ν_{ct} is assumed to follow an AR(1) process:

$$\nu_{ct} = \rho_\nu \nu_{ct-1} + \varepsilon_{\nu_c,t} \tag{A.19}$$

Forward-looking household h faces a flow budget constraint in period t which states that its combined expenditure on goods and on the net accumulation of financial assets must equal its disposable income:

$$P_{Ct}(1+\tau_{Ct})C_t^O(h) + P_{It}I_t(h) + MB_{t+1}(h) - MB_t(h) + \int_s \xi_{t,t+1}B_{Dt+1}(h) - B_{Dt}(h) + P_{Bt}B_{Gt+1}(h) + S_t\frac{P_{Bt}^*B_{Ft+1}(h)}{\phi_{bt}} = (1-\tau_{Nt})W_t(h)N_t(h) + \Gamma_t(h) + TR_t(h) + (1-\tau_{Kt})R_{Kt}K_t(h) + P_{It}\tau_{Kt}\delta K_t(h) - P_{Dt}\phi_{It}(h) + S_tB_{Ft}(h) + B_{Gt}(h) \tag{A.20}$$

Consumption purchases are subject to a sales tax of τ_{Ct}. Investment in physical capital augments the per capita capital stock $K_{t+1}(h)$ according to a linear transition law of the form:

$$K_{t+1}(h) = (1-\delta)K_t(h) + I_t(h) \tag{A.21}$$

where δ is the depreciation rate of capital.

[17] For simplicity, we assume that μ_0 is sufficiently small that changes in the monetary base have a negligible impact on equilibrium allocations, at least to the first-order approximation we consider.

Financial asset accumulation of a typical member of FL household h consists of increases in nominal money holdings $\left(MB_{t+1}(h) - MB_t(h)\right)$ and the net acquisition of bonds. While the domestic financial market is complete through the existence of state-contingent bonds B_{Dt+1} , cross-border asset trade is restricted to a single non-state contingent bond issued by the government of the foreign economy.[18]

The terms B_{Gt+1} and B_{Ft+1} represent each household member's net purchases of the government bonds issued by the domestic and foreign governments, respectively. Each type of bond pays one currency unit in the subsequent period, and is sold at price (discount) of P_{Bt} and P_{Bt}^*, respectively. S_t is the nominal exchange rate. To ensure the stationarity of foreign asset positions, we follow Turnovsky (1985) by assuming that domestic households must pay a transaction cost when trading in the foreign bond. The intermediation cost depends on the ratio of economy-wide holdings of net foreign assets to nominal GDP, $P_{Dt}Y_{Dt}$, and are given by:

$$\phi_{bt} = exp\left(-\Gamma\left(\frac{B_{Ft+1}}{P_{Dt}Y_{Dt}}\right)\varphi_t\right) \tag{A.22}$$

If the domestic economy is in an overall net lender position internationally, then a household will earn a lower return on any holdings of foreign bonds; conversely, if the domestic economy is a net debtor position, the domestic households pay a higher return on their foreign liabilities. Given that the domestic government bond in the domestic economy and foreign bond have the same payoff, the price faced by home residents net of the transaction cost is identical, so that $P_{Bt} = \frac{P_{Bt}^*}{\phi_{bt}}$. The effective nominal interest rate on domestic bonds (and similarly for foreign bonds) hence equals $i_t = 1/P_{Bt} - 1$. As discussed in the main text, the specification of the risk premium will lead to a linearized risk-premium observationally equivalent to that derived in Gabaix and Maggiore (2015) framework.

Each member of FL household h earns after-tax labor income, $(1 - \tau_{Nt})W_t(h)N_t(h)$, where τ_{Nt} is a stochastic tax on labor income. The household leases capital at the after-tax rental rate $(1 - \tau_{Kt})R_{Kt}$, where τ_{Kt} is a stochastic tax on capital income. The household receives a depreciation write-off $P_{It}\tau_{Kt}\delta$ per unit of capital. Each member also receives an aliquot share $\Gamma_t(h)$ of the profits of all firms and a lump-sum government transfer, $TR_t(h)$ (which is negative in the case of a tax). Following Christiano, Eichenbaum and Evans (2005), we assume that it is costly to change the level of gross investment from the previous period, so that the acceleration in the capital stock is penalized:

$$\phi_{It}(h) = \frac{1}{2}\phi_I \frac{(I_t(h) - I_{t-1})^2}{I_{t-1}} \tag{A.23}$$

In every period t, each member of FL household h maximizes the utility functional (A.18) with respect to its consumption, investment, (end-of-period) capital stock, money balances, holdings of contingent claims, and holdings of domestic and foreign bonds, subject to its labor demand function (A.17), budget constraint (A.20), and transition equation for capital (A.21). In doing so, a household takes as given prices, taxes and transfers, and aggregate quantities such as lagged aggregate consumption and the aggregate net foreign asset position.

Forward-looking (FL) households set nominal wages in staggered contracts that are analogous to the price contracts described above. In particular, with probability $1 - \xi_w$, each member of a household is allowed to reoptimize its wage contract. If a household is not allowed to optimize its wage rate, we assume each household member resets its wage according to:

[18] The domestic contingent claims B_{Dt+1} are in zero net supply from the standpoint of the domestic economy as a whole.

$$W_t(h) = \omega_{t-1}^{\iota_\omega}\omega^{1-\iota_\omega}W_{t-1}(h) \quad \text{(A.24)}$$

where ω_{t-1} is the gross nominal wage in inflation rate in period $t-1$, i.e. W_t/W_{t-1}, and $\omega = \pi$ is the steady state rate of change in the nominal wage (equal to gross price inflation since steady state gross productivity growth is assumed to be unity). Dynamic indexation of this form introduces some element of structural persistence into the wage-setting process. Each member of household h chooses the value of $W_t(h)$ to maximize its utility functional (A.18) subject to these constraints.

Finally, we consider the determination of consumption and labor supply of the hand-to-mouth (HM) households. A typical member of a HM household simply equates his nominal consumption spending, $P_{Ct}(1+\tau_{Ct})C_t^{HM}(h)$, to his current after-tax disposable income, which consists of labor income plus lump-sum transfers from the government:

$$P_{Ct}(1+\tau_{Ct})C_t^{HM}(h) = (1-\tau_{Nt})W_t(h)N_t(h) + TR_t(h): \quad \text{(A.25)}$$

The HM households are assumed to set their wage equal to the average wage of the forward-looking households. Since HM households face the same labor demand schedule as the forward-looking households, this assumption implies that each HM household works the same number of hours as the average for forward-looking households.

A.3. Monetary and Fiscal Policy

Monetary policy regimes in the model differ for the U.S. and the euro area and are discussed earlier in Section II. The government does not need to balance its budget each period, and the aggregate end of period *t* debt D_{Gt+1} law of motion evolves according to:

$$D_{Gt+1} = P_{Ct}G_t + TR_t^O + TR_t^{HM} - \tau_{N,t}W_tL_t - \tau_{Ct}P_{Ct}C_t - \tau_{Kt}(R_{Kt} - \delta P_{It})K_t + (1+i_{Gt-1})D_{Gt} - (MB_{t+1} - MB_t)$$

(A.26)

where C_t is total private consumption and i_{Gt} is the effective interest rate on outstanding government debt. Equation (A.27) aggregates the capital stock, money and bond holdings, and transfers and taxes over all households so that, for example, $TR_t^O = \int_0^O TR_t^O(h)dh$. The taxes on capital τ_{Kt}, consumption τ_{Ct} and labor income $\tau_{N,t}$, as well as the ratio of real transfers to (trend) GDP to hand to mouth households, $tr_t^{HM} = \frac{TR_t^{HM}}{P_tY}$, are also assumed to be fixed.[19] Government purchases have no direct effect on the utility of households, nor do they affect the production function of the private sector.

[19] Given that the central bank uses the nominal interest rate as its policy instrument, the level of seigniorage is determined by nominal money demand.

The debt accumulation equation (A.26) allows for long-term government debt following Krause and Moyen (2016).[20] In log-linearized form, their model implies that i_{Gt} is determined as follows. First, the effective interest rate on newly issued debt is given by,

$$i_{Gt}^{new} = \vartheta_{new} i_t + (1 - \vartheta_{new}) E_t i_{Gt+1}^{new},$$

where $\vartheta_{new} = (i + \vartheta)/(1 + i)$ and ϑ is the probability of the stochastic bond maturing in the next quarter and *i* is the steady state short-term nominal interest rate. Now, the debt stock is only gradually maturing, so the effective interest rate on the debt stock is only gradually updated according to

$$i_{Gt} = \vartheta_{long} i_{Gt}^{new} + \left(1 - \vartheta_{long}\right) i_{Gt-1},$$

where ϑ_{long} =1-(1-λ)/(1+π) which approximatively equals λ when π is low (we have π=0.005 in our calibration). Notice that this approach allows us to nest a framework with one-period debt by setting λ=0, since then i_{Gt} equals i_t.

The process for the (log of) government spending is given by an AR(1) process:

$$(g_t - g) = \rho_G (g_{t-1} - g) + \varepsilon_{g,t}; \tag{A.27}$$

where $\varepsilon_{g,t}$ is independently normally distributed with zero mean and standard deviation σ_G.

We assume that policymakers adjust the labor income tax rate to stabilize the debt/GDP ratio and the deficit, according to:

$$\tau_{N,t} - \tau_N = \upsilon_1\left(\tau_{N,t-1} - \tau_N\right) - (1 - \upsilon_1)[\upsilon_2(b_{Gt} - b_G) + \upsilon_3(\Delta b_{Gt+1} - \Delta b_{Gt})], \tag{A.28}$$

where $b_{Gt} = B_{Gt}/(4\overline{P}_t Y)$, i.e. government debt as a share of annualized nominal trend output.

A.4. Resource Constraint and Net Foreign Assets

The domestic economy's aggregate resource constraint can be written as:

$$Y_{Dt} = C_{Dt} + I_{Dt} + \phi_{It} + \frac{\zeta^*}{\zeta} M_t^*; \tag{A.29}$$

[20] The central element of their approach is an approximation of the maturity structure of public debt in terms of a stochastic, long-term, government bond. Each period, an individual bond of this type pays the interest determined when the bond was issued or matures with a given probability, in which case it pays back the face value plus interest. Technically, the bond is a callable perpetuity with stochastic call date, which is independent across bonds. Since the government issues a large number of these bonds, the fraction of bonds maturing each period is identical to the call probability. Private agents are assumed to hold the same, representative, portfolio of the bonds. The stochastic bond allows to calibrate the average maturity of outstanding debt to that observed in the data.

where ϕ_{It} is the adjustment cost on investment aggregated across all households. The final consumption good is allocated between households and the government:

$$C_{At} = C_t + G_t; \tag{A.30}$$

where C_t is (per capita) private consumption of FL (optimizing) and HM households:

$$C_t = (1-\varsigma)C_t^O + \varsigma C_t^{HM}. \tag{A.31}$$

Total exports may be allocated to either the consumption or the investment sector abroad:

$$M_t^* = M_{Ct}^* + M_{It}^*. \tag{A.32}$$

The evolution of net foreign assets can be expressed as:

$$\frac{P_{B,t}^* B_{F,t+1}}{\phi_{bt}} = B_{F,t} + P_{Mt}^* \frac{\zeta^*}{\zeta} M_t^* - P_{Mt} M_t. \tag{A.33}$$

This expression can be derived from the budget constraint of the FL households after imposing the government budget constraint, the consumption rule of the HM households, the definition of firm profits, and the condition that domestic state-contingent non-government bonds (B_{Dt+1}) are in zero net supply.

Finally, we assume that the structure of the foreign economy is isomorphic to that of the domestic economy.

A.5. Production of capital services

The model is amended to include a financial accelerator mechanism into both country blocks of our benchmark model following the basic approach of Bernanke, Gertler and Gilchrist (1999). Thus, the intermediate goods producers rent capital services from entrepreneurs (at the price R_{Kt}) rather than directly from households. Entrepreneurs purchase physical capital from competitive capital goods producers (and resell it back at the end of each period), with the latter employing the same technology to transform investment goods into finished capital goods as described by eqs. (A.21) and (A.23). To finance the acquisition of physical capital, each entrepreneur combines his net worth with a loan from a bank, for which the entrepreneur must pay an external finance premium (over the risk-free interest rate set by the central bank) due to an agency problem. Banks obtain funds to lend to the entrepreneurs by issuing deposits to households at the interest rate set by the central bank, with households bearing no credit risk (reflecting assumptions about free competition in banking and the ability of banks to diversify their portfolios). In equilibrium, shocks that affect entrepreneurial net worth i.e., the leverage of the corporate sector induce fluctuations in the corporate finance premium.[21]

A.6. Calibration and Solution Method

The model is calibrated at a quarterly frequency. The country size parameter is either set to low share $\zeta = 0.001$ in the case for small open economies, or $\zeta = 1/3$; approximately matching the US's share in world output in the case when home economy was large. The trade share of the small open economy is set to 35 percent of its GDP resembling an openness (export plus imports to GDP) of 70 percent. In the large home economy case

[21] We follow Christiano, Motto and Rostagno (2008) by assuming that the debt contract between entrepreneurs and banks is written in nominal terms (rather than real terms as in Bernanke, Gertler and Gilchrist, 1999). For further details about the setup, see Bernanke, Gertler and Gilchrist (1999), and Christiano, Motto and Rostagno (2008). An excellent exposition is also provided in Christiano, Trabandt and Walentin (2011).

trade share was calibrated close to US data for the large Home economy. These pin down the trade share parameters ω_C and $\omega_I, \rho_C = \rho_I = 2.75\ \theta_p = 0.1,$, which together with our price markup ￼is consistent with a long-run price elasticity of demand for imported consumption and investment goods of [1.5]$\varphi_{M_C} = \varphi_{M_I} = 1\ \phi_b$, which slightly damps the near-term relative price sensitivity. The financial intermediation parameter $\Gamma$is set to a very small value (0.001) in the case of advanced countries, which is sufficient to ensure the model has a unique steady state. For the emerging market economy case Γ took a larger value of 0.1, so NFA has a significant impact on the country risk premium in this case.

The relative risk aversion parameter σ is set to a benchmark value in the literature (2), while the habit persistence parameter in consumption $\aleph$ is set to 0.8 (following empirical evidence). The utility parameter χ_0 is set so that labor market activity comprises half of the household's time endowment, while the Frisch elasticity of labor supply is targeted to equal 1/2, which implies setting $\chi = 4.$ Real balances are kept small by setting the parameter μ_0 on the subutility function at an arbitrarily low value (so that variation in real balances do not affect equilibrium allocations). We set the share of HM agents $\varsigma = 0.55;$ implying that these agents account for about one third of aggregate private consumption spending (the latter is much smaller than the population share of HM agents because the latter own no capital). This is consistent with Johnson, Parker, and Souleles (2006) and Parker et al. (2013) who find evidence of a substantial response of household spending, particularly for liquidity-constrained households, to the temporary U.S. tax rebates of 2001 and 2008, using micro data from the Consumer Expenditure Survey. On the macro side, Galí, López-Salido, and Vallés (2007) presents evidence from structural VARs that government spending shocks tend to boost private consumption, and show how the inclusion of rule-of-thumb agents in their DSGE model helps to account for this behavior. Nonetheless, a smaller share of HM agents will particularly lower the impact of fiscal stimulus.

The parameter determining investment adjustment costs $\phi_I = 3$ following the evidence in Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2007). The depreciation rate of capital is set at 0.025 (consistent with an annual depreciation rate of 10 percent). The parameter ρ in the CES production function of the intermediate goods producers is set to -1$;$ implying a zero-elasticity of substitution between capital and labor $(1+\rho)/\rho$, i.e. a Leontief production function technology. The quasi-capital share parameter $\omega_K = 0.3$ - together with the price markup parameter of $\theta_P = 0.1$ - is chosen to imply a steady state investment to output ratio of about 20 percent. In the augmented version of the model with a financial accelerator, our calibration of parameters follows Bernanke, Gertler and Gilchrist (1999). In particular, the monitoring cost, μ, expressed as a proportion of entrepreneurs' total gross revenue, is set to 0.12. The default rate of entrepreneurs is 3 percent per year, and the variance of the idiosyncratic productivity shocks to entrepreneurs is 0.28.

The Calvo domestic price and import/export price contract duration parameter is set to be $\xi_p = \xi_m = 0.67$, while the wage contract duration parameter is $\xi_w = 0.75.$ The relatively steep Phillips curves were motivated by recent post-pandemic estimations (e.g. Hodge et al (2023). We set the degree of price indexation ι_p to unity and wage and import price indexation parameters $\iota_w = \iota_m = 0.5$ in the advanced economy cases, for emerging markets indexation is set to be more present with $\iota_w = \iota_m = 1$ In line with Smets and Wouters (2007) we set the wage markup is $\theta_W = 1/3.$[22] The parameters of the monetary rules are set to standard values, i.e. the interest smoothing parameter 0.92 and the employment growth parameter $\gamma_{\Delta x}$= 0.25. When we consider a managed float for EMEs we add a coefficient of 5 for the change in the nominal exchange rate. For the response to core

[22] Given strategic complementarities in wage-setting, the wage markup in influences the slope of the wage Phillips Curve.

inflation γ_π we set a coefficient of 1.5. With the discount factor set at $\beta = 0.99875$, and the inflation target at 2 percent, the steady state nominal interest rate is 2.5 percent.

The parameters pertaining to fiscal policy are intended to roughly capture the revenue and spending sides of advanced economies, but make some key parameters different for EMDEs. The share of government spending on goods and services is set equal to 19 (25) percent of steady state output in the Home and Foreign economy. The government debt to GDP ratio, b_G, is set to roughly 130 (100) percent of annualized GDP. The ratio of transfers to GDP is set to 15 percent. The steady state sales (i.e., VAT) tax rate τ_C is set to 7 (20) percent, while the capital tax τ_K is set to 0.21 (0.26) in the Home (Foreign) country and we allow for full tax-deduction of capital depreciation (i.e., $\delta_\tau = \delta$). Given the annualized steady state real interest rate (of 0.5 percent), the government's intertemporal budget constraint then implies that the average labor income tax rate τ_N equals 0.30 (0.32) percent in the home (Foreign) economy in steady state. We assume an unaggressive tax adjustment rule (equation A.29) by setting $\upsilon_1 = 0.985$ and $\upsilon_2 = \upsilon_3 = 0.015$. Finally, following Krause and Moyen (2016), we set ϑ=0.055, consistent with a 4.5 year steady state maturity structure of government debt.

To analyze the behavior of the model, we log-linearize the model's equations around the non-stochastic steady state. Nominal variables are rendered stationary by suitable transformations. To solve the unconstrained version of the model, we compute the reduced-form solution of the model for a given set of parameters using the numerical algorithm of Anderson and Moore (1985), which provides an efficient implementation of the solution method proposed by Blanchard and Kahn (1980).

Table A.1: TANK Model Parameters

Parameters	Symbol	Value
Relative country size	ζ	SOE: 0.001, Large Home: 1/3
Trade share		SOE Large Home
	Trade share	0.35 0.14
	$\omega_C \omega_I$	0.48 0.15
		0.82 0.22
Trade price elasticity	$\frac{1+\rho_C}{\rho_C} = \frac{1+\rho_I}{\rho_I}$	1.37
Price markup	θ_p	0.1
Import adjustment cost	$\varphi_{M_C} = \varphi_{M_I}$	1
Financial intermediation cost abroad	Γ	AE: 0.001, EME: 0.1
Relative risk a version	σ	2
Habit persistence	$\aleph$	0.8
Leisure in utility	χ_0	1
Share of work to time endowment	s_e	0.5
Labor utility curvature parameter	χ	4
Real money balance utility	μ_0	0.001
Share of hand-to-mouth agents	ς	0.55
Investment adjustment cost	ϕ_I	3
Capital depreciation (10% per year)	δ	0.025
Elasticity of substitution between intermediate goods	ρ	-1
Quasi-capital share	ω_K	0.3
Monitoring cost	μ	0.12
Default rate for entrepreneurs	$F(\overline{\omega})$	3 percent / year
Variance of idiosyncratic productivity shock	$var(log\omega)$	0.28
Calvo domestic price contract duration	ξ_p	0.67
Calvo Import/export contract duration	ξ_m	0.67
Calvo wage contract duration	ξ_w	0.75
Price indexation	ι_p	1
Wage and import price indexation	$\iota_m = \iota_w$	AE: 0.5, EME: 1
Wage markup	θ_W	1/3
Interest rate smoothing	γ	0.92
Employment growth	$\gamma_{\Delta E}$	0.25
Employment gap	γ_e	0
Inflation gap		1.5
Change in Exchange Rate	$\gamma_{\Delta e}$	Managed Floating EME: 5
Discount factor	β	0.99875
Bond maturing probability	ϑ	0.055
Tax adjustment rule	$\upsilon_1, \upsilon_2, \upsilon_3$	$\upsilon_1 = 0.985,\ \upsilon_2 = \upsilon_3 = 0.015$
Steady state gov't debt/GDP (%)	b_G	Home AE 129, EME: 65, Foreign 98
Gov't consumption/GDP (%)	g_y	Home: 0.19, Foreign: 0.25
Steady state transfers/GDP (%)	tr_t^O, tr_t^{HM}	$tr_t^O = 6.75, tr_t^{HM} = 8.25$
Steady state labor income tax rate (%)	τ_N	Home: 0.3, Foreign: 0.32
Steady state consumption tax rate (%)	τ_C	Home: 0.07, Foreign: 0.2
Steady state capital tax rate (%)	τ_K	Home: 0.21, Foreign: 0.262
Steady state inflation, inflation target (annual, %)	$\bar{\pi}$	2
Steady state nominal interest rate (annual, %)	i	2.5

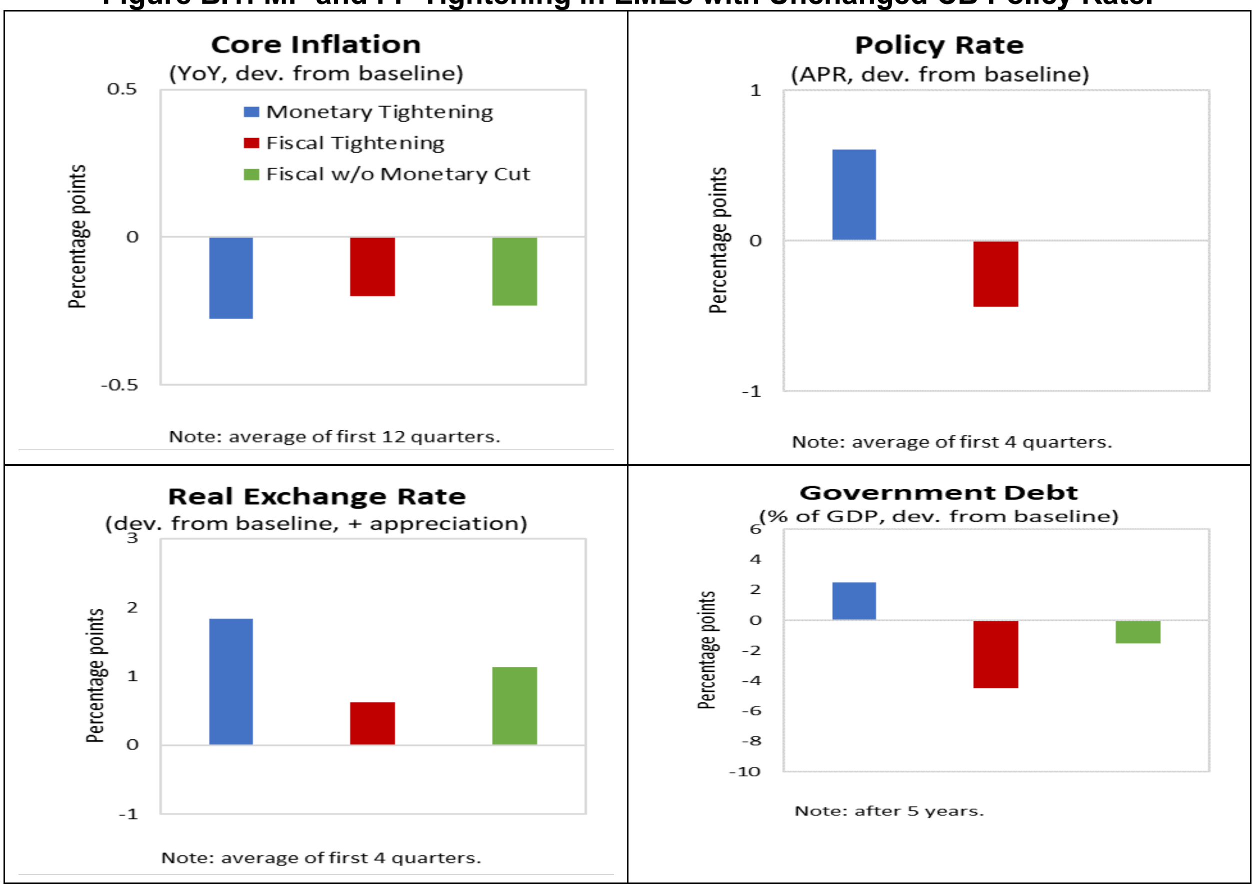
Appendix B. Robustness Results

In this appendix we report additional robustness results referred to in the main text.

B.1 Effects of Fiscal Policy when CB Welcomes Consolidation

In the main text, we considered for illustrative purpose the effects of either fiscal or monetary tightening. But in practice, countries are likely to adopt a combination of the two , i.e., a monetary-fiscal policy mix. Figure B.1 below illustrates a policy mix when the CB welcomes the fiscal consolidation and leaves the policy rate path unchanged.

Figure B.1: MP and FP Tightening in EMEs with Unchanged CB Policy Rate.



Source: IMF staff calculations.

The blue (monetary policy only) and red (fiscal policy only) bars in Figure B.1 are identical to those in Figure 6, whereas the green shows the effects of a monetary-fiscal mix which leave the policy rate path unaffected (so the height of the bar is not visible in the upper right panel). Since the model is linear, the green bar can simply be obtained by weighting the blue and red bars, and because the decline in the policy rate is slightly lower for fiscal tightening than how much the policy rate increases under a monetary policy tightening, the weight on fiscal policy to calculate the green bar is slightly above 0.5.

The figure conveys the important less that if monetary policy does not cut the policy rate when fiscal policy consolidates, less fiscal tightening has an even larger effects on core inflation.

B.2 The Effects of Tax- versus Spending-Based Tightening

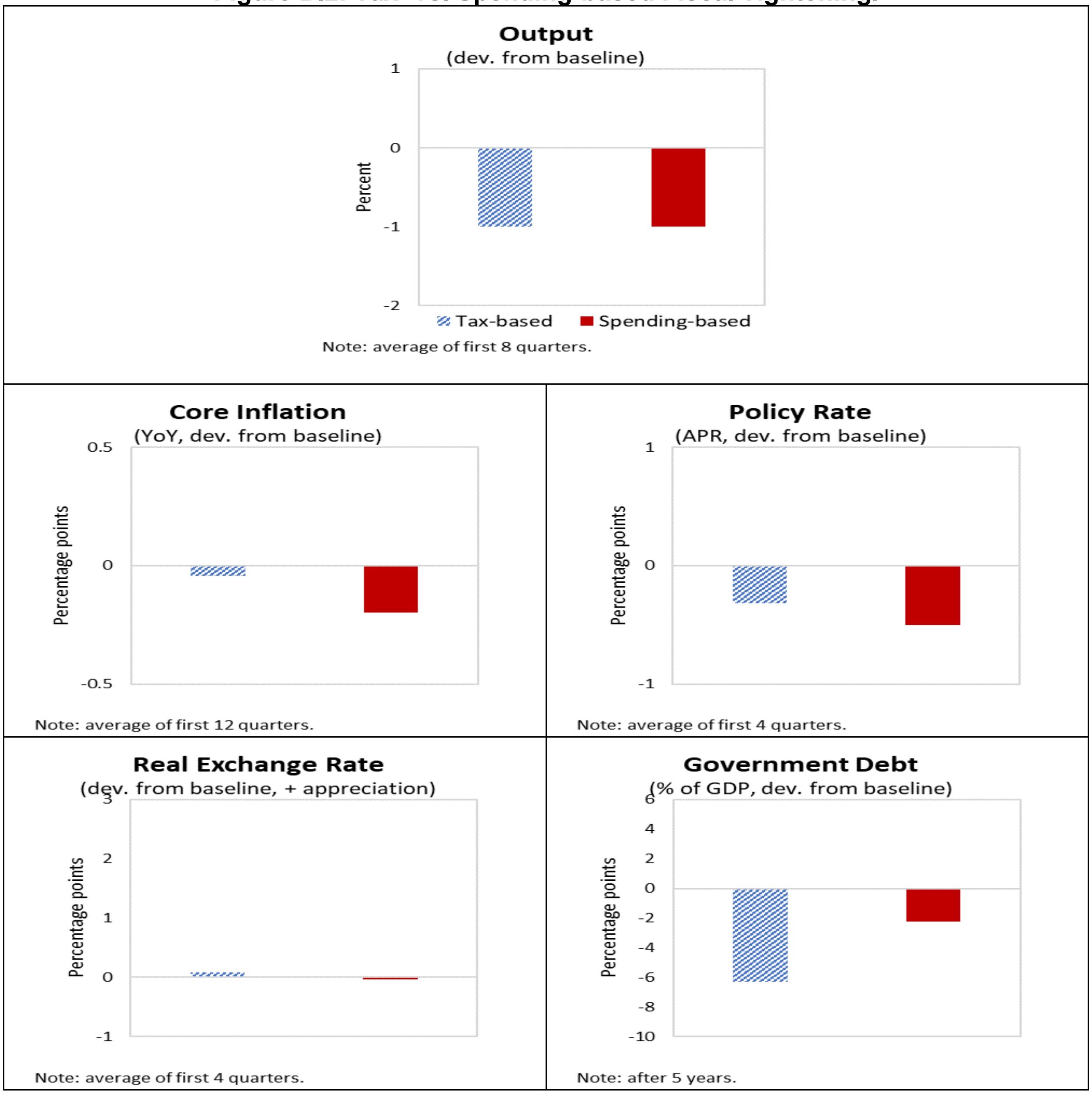
In the main text, we focused on spending-based fiscal tightening in the form of lower government consumption. Figure B.3 below compares the effects of tax- versus the spending-based fiscal tightening in our model. The alternative policy actions are calculated in the case when many countries consolidate so the real exchange rates move little.

The red (spending cuts) bars in Figure B.2 are identical to those in Figure 7, whereas the blue dotted bars show the results for a combined hike of labor income and VAT taxes that results in the same-sized decline in output the first two years. We consider a combination of tax rates as it in practice may be hard to change one tax base substantially relative to another. Even so, both tax instruments we consider reduces core inflation in the TANK model.

Figure B.2 shows that a spending-based fiscal tightening is notably more effective curbing inflation than tax hikes (in the form of a combination of labor income and consumption sales taxes).[23] The reason is that tax hikes have direct supply side effects, whereas spending-cuts mainly works through the demand side. A credible revenue-based consolidation lowers debt notably if tax revenue collection is effective, and output effects may be less deleterious than assumed in our model simulation if they restore fiscal credibility and help lower credit spreads and protect long-term growth-enhancing spending that may crowd in private investment.

[23] Of course, sizeable cuts in government investment may transmit differently than cuts in government consumption. See Lemoine and Linde (2023) for a recent discussion.

Figure B.2: Tax- vs. Spending-based Fiscal Tightening.



Source: IMF staff calculations.

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