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Fiscal and Monetary Policy Coordination, Macroeconomic Stability, and Sovereign Risk Premia

In standard macroeconomic models, equilibrium stability and uniqueness require monetary policy to actively target inflation and fiscal policy to ensure long-run debt sustainability. We show analytically that these requirements change, and depend on the cyclicality of fiscal policy, when government debt is risky. In that case, budget deficits raise interest rates and crowd out consumption. Consequently, countercyclical fiscal policies reduce the parameter space supporting stable and unique equilibria and are feasible only if complemented with more aggressive debt consolidation and/or active monetary policy. Stability is more easily achieved, however, under procyclical fiscal policies.

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During the Great Recession, governments worldwide engaged in massive fiscal expansions to keep their economies afloat, especially since monetary instruments have been effectively depleted. In some cases, these

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Keynesian-style fiscal policies have resulted in a surge of government indebtedness and widening sovereign bond yields, mostly reflecting concerns regarding the sustainability of public finances. In more critical cases, the fiscal response to the crisis did more harm than good, as the risk of sovereign default became too high and eventually led to a collapse of sovereign bond markets. This begs the question: how do the requirements for a sustainable path for sovereign debt affect the use of fiscal policy in stabilizing macroeconomic conditions?

We address this question through the lens of the canonical New Keynesian closed economy model in which a fiscal authority (or "government") follows a feedback rule that relates the primary balance to changes in government debt and aggregate output, and a monetary authority (or "central bank") that follows a standard Taylor rule (Taylor 1993). Leeper (1991) has already shown that a stable equilibrium exists when the response of the primary balance to an increase in debt is sufficient to maintain debt growth below the long-run real interest rate, and that uniqueness is ensured when this "passive fiscal policy" is paired with an "active monetary policy," which ensures that the nominal interest rate moves by more than one-for-one with inflation.[1] We depart from the canonical model in one important way. To capture the recently observed changes in the demand elasticity for government bonds, we introduce a sovereign risk premium which forms a wedge between the bond rate and risk-free rate. The risk premium rises with expected sovereign default, which itself is a function of government indebtedness, and remains constant otherwise.

When the sovereign risk premium depends on the level of debt, the well-established stability and uniqueness requirements from Leeper (1991) change markedly and depend strongly on the government's endogenous fiscal response to the business cycle. Showing this result analytically and numerically is our main contribution. In particular, we find that, in the presence of sovereign risk, a stable and unique equilibrium might be unattainable when the government maintains a countercyclical fiscal stance, even if fiscal policy is passive and monetary policy active. This is due to a *crowding-out* effect of sovereign risk on consumption that is exacerbated under a countercyclical fiscal stance. Intuitively, when a shock adversely hits the economy and the primary surplus falls, the stock of government debt rises. This drives up the sovereign risk premium and the interest rate. Consequently, agents save more and consume less, causing output and inflation to fall. Given the countercyclical nature of fiscal policy, the government then automatically raises the deficit further, which again drives up debt and the risk premium, causing consumption and output to fall even more, and so on. By signaling its commitment to debt sustainability and pursuing a more aggressive debt consolidation policy, the government is able to avoid this self-reinforcing cycle of rising debt and falling output, and keep long-term financing costs low. The required debt consolidation efforts rise with the responsiveness of the sovereign risk premium to government indebtedness.

1. According to the Fiscal Theory of the Price Level, stability and uniqueness can also be ensured when fiscal policy is insufficient to deliver long-run debt sustainability, only if the central bank allows the price level to keep the real value of government debt outstanding consistent with the intertemporal government budget constraint (see Leeper 1991, Sims 1994, Woodford 1998, 2001, among others).

The required "passiveness," or debt consolidation effort, of fiscal policy that delivers equilibrium stability depends, not only on the severity of the sovereign debt crisis, but also on monetary policy. If monetary policy is active, the rise in the sovereign risk premium and consequent fall in inflation is met by a reduction in the policy rate, which partially offsets the crowding-out effect. However, the less responsive is the central bank to changes in inflation, for instance when the zero lower bound is binding, the weaker is this monetary offset. Keeping the risk premium low then requires greater debt reduction by the government. In Leeper (1991), only limited coordination between fiscal and monetary policy is necessary: given a passive fiscal stance, it is not the "activeness" of monetary policy that matters for stability, only that monetary policy is indeed active. However, with a debt-elastic sovereign risk premium, we find that the interdependence between fiscal and monetary policy is much stronger and closer coordination between the government and central bank is warranted.

When the government maintains a procyclical fiscal stance, the stability and uniqueness requirements under a debt-elastic sovereign risk premium are *relaxed*. Particularly, when output contractions are followed by an increase in the primary surplus, government debt falls following an adverse shock to output. In that case, the risk premium and interest rate fall, and consumption rises, which offsets the initial output contraction. The procyclical nature of fiscal policy thus not only eases the task of sustaining government debt by keeping the risk premium low, which makes it possible to obtain stability even if fiscal policy is not passive, it also helps control inflation by essentially substituting for monetary policy, which opens up the possibility for determinacy even if monetary policy is not active.

A corollary of our results is that short-run deficits matter when the risk premium is sensitive to the level of government debt. When the debt-elasticity of the risk premium is large, the government must take immediate action and signal its commitment to control debt dynamics. If it does not, then the onus of ensuring stable macroeconomic conditions falls entirely upon the central bank. Our results therefore formalize the need for greater measures of fiscal austerity during times of sovereign debt crises and also questions the desirability of fiscal expansions when public finances are critically weak.

The present paper is closely related to the literature on the relationship between macroeconomic stability and government debt nonneutrality. For instance, Canzoneri and Diba (2005) and Linnemann and Schabert (2010) show that the conditions for equilibrium stability change when government bonds can be used for transactions. In these studies, an increase in the amount of government bonds outstanding has a positive, rather than negative, effect on output and inflation through a reduction in the liquidity premium. Fiscal policy is therefore able to accommodate monetary policy in controlling inflation, and determinacy can be achieved even when monetary policy is not active. Piergallini (2005) and Leith and von Thadden (2008) show that similar results can be derived in overlapping generations models in which government bonds generate wealth effects. Furthermore, Schabert and van Wijnbergen (2014) investigate the implications of debt nonneutrality arising from sovereign default risk using an otherwise standard New Keynesian model for a small open economy. The authors show that, in the presence of sovereign risk, the government must respond more aggressively to changes in debt to deliver a stable and unique steady state if the central bank actively targets inflation. Although these results are similar to ours, they are driven by a different mechanism. Particularly, whereas in our model the sovereign risk premium crowds out consumption and output, sovereign risk is expansionary in Schabert and van Wijnbergen due to its negative effect on the effective real return on government bonds. While we acknowledge the possibility of sovereign risk having positive effects on inflation (at least in the short run), we believe the adverse effects on financial market conditions associated with rising sovereign risk premia dominate the overall implications for output and inflation dynamics (see also Corsetti et al. 2013).

The remainder of the paper is organized as follows. In the following section, we investigate the empirical significance of the debt-elastic sovereign risk premium, review the relevant literature, and study its relation with the fiscal policy stance using the Irish debt crisis as a case study. In Section 2, we describe the model, its main building blocks and the calibration of the structural parameters. In Section 3, we derive the conditions for equilibrium stability and uniqueness, and show the implications of the sovereign risk premium and the cyclicality of fiscal policy. Finally, Section 4 concludes and offers directions for future work.

1. SOVEREIGN RISK PREMIA AND VICIOUS DEBT CYCLES

The notion of sovereign risk has long been ignored within the New Keynesian paradigm. Although the requirements for a sustainable path for government debt, and the implications for fiscal and monetary policy, have been studied in great detail (see Sargent and Wallace 1981, Leeper 1991, Sims 1994, Woodford 1998, among others), generally no mention is made regarding the perceived riskiness of government bonds. In fact, in most theoretical analyses, the return on government bonds is assumed to be at par with the risk-free interest rate. Under these assumptions, the possibility of explosive debt dynamics may arise solely due to insufficient *long-term* growth in the budget surplus (including seigniorage revenue) with respect to the accumulation of government debt (Bohn 2008).

However, a sovereign debt crisis could unfold more rapidly due to sudden shifts in the degree of investors' risk aversion, as evidenced by the European sovereign debt crisis. Such shifts generate a wedge, or *sovereign risk premium*, between the government bond rate and the risk-free rate which generally is highly sensitive to underlying fiscal fundamentals. To support this paper's findings on how the presence of such a sovereign risk premium affects the requirements for a stable and unique rational expectations equilibrium, we first discuss the dynamics of sovereign risk premia in Europe during the sovereign debt crisis, and review insights from the literature that can explain what drives these dynamics. Next, we use the Irish debt crisis as an example to illustrate how fiscal policy can avoid (or escape from) vicious debt cycles when confronted with debt sustainability concerns.

1.1 Stylized Facts and Empirical Evidence

We study the dynamics of the sovereign risk premium by focusing on the spread between the 10-year government bond yield and the yield on a similar German bond. According to Remolona, Scatigna, and Wu (2007), the bond spread consists of two components: the default premium, which compensates investors for *expected* losses from sovereign default, and the risk premium, which compensates for bearing the risk of *unexpected* losses from default. It is beyond the scope of this paper to extract from the bond spread the component associated to the risk premium. However, as shown by Remolona, Scatigna, and Wu, the bulk of the size and volatility of the spread is determined by the risk premium, even if such spreads are relatively low, which allows us to ignore the default premium component for now. We therefore use the bond spread as a proxy for the risk premium in the empirical analysis that follows. In the theoretical analysis below, however, we account for both the default and risk premium components of the sovereign spread.

Figure 1 plots the sovereign risk premium against the stock of government debt (as a share of GDP), between 2000 and 2011. Years following 2011 were deliberately left out, as these were characterized by unusually accommodative monetary policy. What is apparent from the figure is that, before 2008, demand for government bonds has essentially been "inelastic" as changes in the debt ratio did not provoke strong movements in the risk premium (see black circles). In line with these observations, most New Keynesian models have assumed a perfectly inelastic demand for government bonds, thereby implying a constant (and usually zero) sovereign risk premium.

This assumption, however, no longer applies to the years following 2008, when the financial and economic crisis prompted large-scale fiscal expansions in many euro area countries. As the public sector became substantially more indebted (e.g., the Irish debt ratio rose from 24% in 2007 to 120% in 2012), concerns regarding the sustainability of fiscal policy mounted, as reflected by an increase in the sovereign risk premium (white diamonds in Figure 1). During the crisis, some countries faced a relatively low risk premium elasticity, whereas others faced a more convex relationship between government indebtedness and the risk premium, as illustrated by the variation in the scale of the vertical axes. Yet, the chronicles of the euro crisis reveal an important stylized fact: government debt is priced in a nonlinear way, with low and inelastic risk premia at relatively low debt ratios, and high and elastic risk premia at relatively high debt ratios.

The nonlinear and convex relationship between sovereign risk premia and government indebtedness, suggested by Figure 1, has received broad empirical recognition. For instance, Bayoumi, Goldstein, and Woglom (1995), using survey data on yields of U.S. bonds issued at the state level relative to the yield of a comparable New Jersey bond (chosen to be the benchmark), find that, at the mean level of debt in the sample, yields rise by 23 basis points for every percentage point increase in the

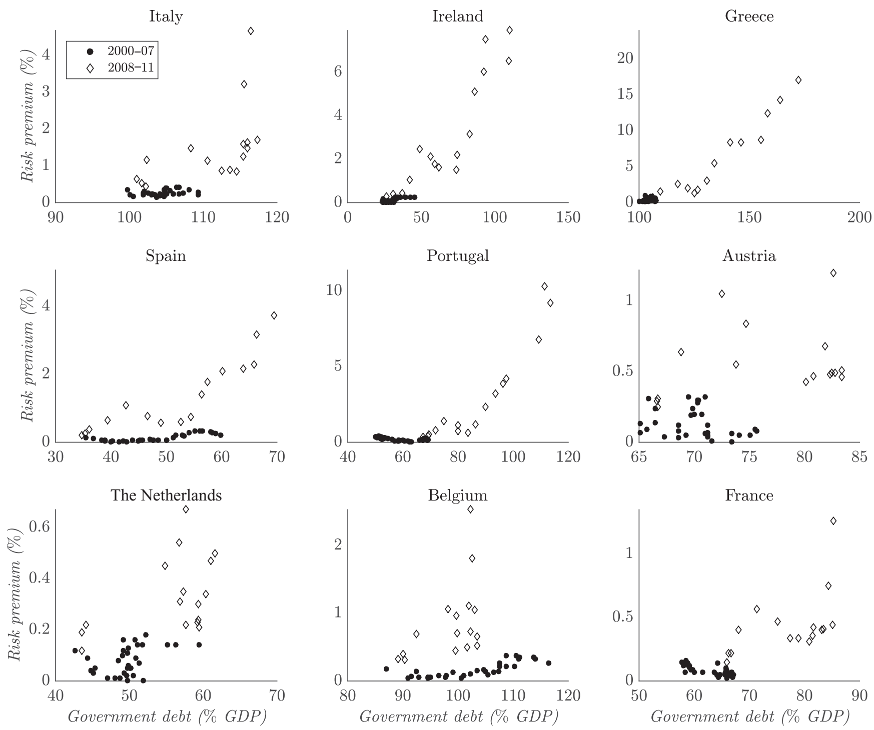

FIG. 1. Government Debt Ratio versus Sovereign Risk Premia.

NOTES: The figure shows quarterly data for general government debt as a percentage of GDP (horizontal axis) and the sovereign risk premium (vertical axis), which is measured as the difference between the yield on a 10-year government bond and the yield on a similar German bond, between 2000Q1 and 2011Q4.
SOURCE: Eurostat.

debt to gross state product ratio. Yet, at debt levels one standard deviation above the mean, yields rise by 35 basis points, and at 25% above the highest debt level in the sample, state governments may even become rationed from credit. Similarly, Haugh, Ollivaud, and Turner (2009) report evidence of stronger interest rate effects of fiscal imbalances at higher levels of indebtedness. According to their estimates, successive one standard deviation increases in the debt service ratio lead to an increase in the sovereign risk premium of 16, 40, 71, and 107 basis points. Such nonlinear effects are found to be stronger for countries with a poor fiscal track record. Also, Ardagna, Caselli, and Lane (2007), using a panel of OECD countries, examine the effects of a country's debt position on long-term interest rates and find that a significant and positive relationship can be found only for those countries facing above-average debt levels.

An explanation for the nonlinear effects of government debt (and other fiscal variables) on sovereign risk premia is provided by, for example, Jaramillo and Weber

(2013). Focusing on emerging economies, they show that fiscal variables become more relevant in the assessment of sovereign default risk in times of more elevated risk aversion. Specifically, when moving from a low to high risk aversion state, the change in the 10-year domestic bond yield following a 1 percentage point increase in expected gross public debt rises from 2 to 6 basis points. Similar results are provided by Borri and Verdelhan (2011), while Baldacci and Kumar (2010) find that the relationship between risk aversion and bond prices apply to advanced economies as well. Also, Barrios et al. (2009), Sgherri and Zoli (2011), Bernoth and Erdogan (2012), and Afonso, Arghyrou, and Kontonikas (2015), using a sample of euro area countries, show that sovereign risk premia have been more sensitive to changes in fiscal imbalances during the recent financial crisis than before the crisis. The literature thus suggests that the intensified sensitivity of sovereign risk premia to loose fiscal policy warrants caution in the use of debt-financed fiscal stimuli in times of economic and debt crises, during which investors are more likely to be risk averse.

1.2 The Irish Experience

The Irish debt crisis may offer some guidance in determining what should be the appropriate fiscal response to crises when confronted with a heavy debt burden. The Irish experience is of particular relevance to our case, since it clearly shows how a sudden surge in the sovereign risk premium requires an acute change in the fiscal stance toward aggressive debt consolidation in order to guarantee macroeconomic stability.

Ireland experienced a collapse of its banking sector following the financial crisis of 2008, which was aggravated because of the country's reliance on external financing sources. To prevent large spillovers to the real economy, the government responded by recapitalizing key financial institutions to the order of 20% of GDP. A notable feature of the bank bailouts was a 2-year blanket bank guarantee, which was issued in the Autumn of 2008. These bank bailouts led to a severe deterioration of the budget deficit and thereby threatened the sustainability of public finances. Consequently, as the stock of Irish government debt kept rising and the costs of bank bailouts remained uncertain, the risk premium on Irish bonds increased. In 2010, the risk of a possible Irish default was fueled by tensions caused by the Greek crisis and the expiration of the Irish bank guarantee. By August 2010, Ireland was effectively shunned from financial markets.

To get an idea of how rapidly the perceived riskiness of Irish bonds changed during the crisis, we estimate the risk premium elasticity with respect to the Irish debt ratio, that is, the slope of the curve shown in Figure 1, over 5-year rolling windows between 2000Q1 and 2016Q3. In particular, we use quarterly data of the risk premium, which we denote by Ξ_t, and the debt ratio, b_t, obtained from Eurostat, to estimate the following linear regression model:

$$\Xi_t = \chi b_t + u_t, \tag{1}$$

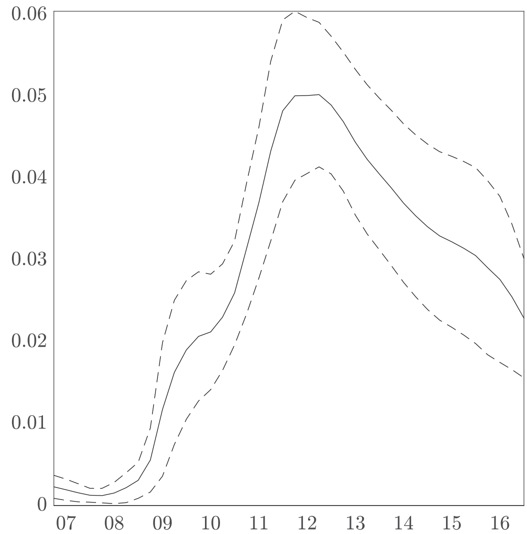

FIG. 2. Development of the Irish Risk Premium Elasticity, χ.

NOTES: The figure shows 5-year rolling window estimates for the Irish risk premium elasticity, χ, see equation (1). Dates mark the end of the sample window. Solid line = point estimates, dashed lines = 95% confidence interval.

where χ denotes the risk premium elasticity and u_t the residual.

According to Figure 2, which shows the time-varying estimates of χ, the risk premium was largely unresponsive to changes in the Irish debt position before the crisis, yet became much more sensitive to debt changes during the crisis. Given the rapid deterioration of Ireland's public finances at the time, and in line with the above-cited empirical literature, the change in the risk premium was most likely driven by fiscal sustainability concerns. The higher sovereign risk premium made a vicious debt cycle possible, in which increases in debt lead to higher sovereign borrowing costs, a stronger accumulation of debt, greater debt sustainability concerns and further increases in borrowing costs.

To stem bond market fears and bring down the risk premium, the Irish government announced large-scale fiscal consolidation plans between 2008 and 2010 of around € 30 bn (20% of Irish GDP) and received financial support from the European Commission, the European Central Bank, and the International Monetary Fund between 2011 and 2014. To illustrate this sharp change in the fiscal stance, we estimate the following fiscal response function:

$$s_t = c + \gamma_b b_{t-1} + \gamma_y \left(\frac{y_{t-1} - y_{t-5}}{y_{t-1}} \right) + u_t. \tag{2}$$

The response function relates the government primary budget surplus (as a share of GDP), s_t, to lagged values of the debt ratio and GDP growth. y_t denotes real GDP.

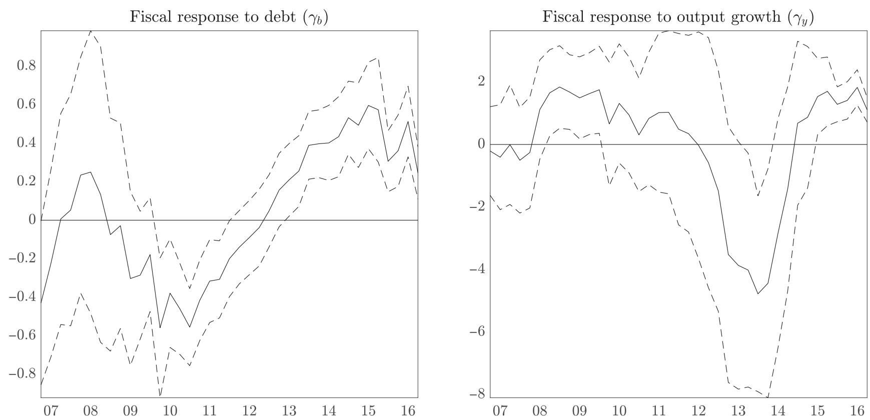

FIG. 3. Development of the Irish Fiscal Response to Government Indebtedness and Output Growth.

NOTES: The figure shows 5-year rolling window estimates for γ_b (left panel) and γ_y (right panel), see equation (2). Solid line = point estimates, dashed lines = 95% confidence interval.

The parameters γ_b and γ_y characterize the fiscal stance with regards the debt position and business cycle, respectively. Again, we estimate (2) over 5-year rolling windows between 2002 and 2016 using quarterly data from Eurostat in order to gauge the behavior of the Irish fiscal stance over time. The estimates are displayed in Figure 3.

As shown in the left panel of the figure, the Irish budget surplus and debt level moved in *opposite* directions during the crisis, indicating a loose fiscal policy stance. Indeed, a negative estimate of γ_b implies that the growth rate of debt is fueled by higher deficits, which raises the prospect of explosive debt dynamics. However, at the height of the crisis, the Irish government pursued a more aggressive debt consolidation policy, as suggested by the rise in γ_b. Due to the legacy of bank bailouts and low economic growth, reducing (the growth rate of) debt remained difficult and so γ_b did not become positive until 2013. Nevertheless, signaling its commitment to vigorous fiscal austerity proved sufficient to reduce the risk premium, and the risk premium elasticity (see Figure 2), and thereby escape the vicious debt cycle. By 2015, the risk premium had almost reached precrisis levels and debt sustainability concerns were eased.

It was most likely a change in the Irish fiscal stance, supported by the involvement of the EC, ECB, and IMF, that brought down the risk premium. The reduction in the risk premium (elasticity) was not, by itself, a result of a more accommodative monetary stance in the euro area, at least not initially. Although the ECB was able to bring down sovereign bond yields through its announcement of the Outright Monetary Transactions program in 2012, the risk premium in Ireland started to fall already in 2011. Moreover, due to its relatively small share in euro area GDP (2%), it is unlikely that Ireland would have been able to push the ECB for a monetary backstop to its fiscal predicaments. The panel on the right of Figure 3 shows that, besides responding more aggressively to changes in government debt, the surplus also responded less, and even procyclically, to changes in real GDP growth after 2010. This change in the cyclical stance of fiscal policy during times of elevated risk premia corroborates well with our theoretical results, to which we turn next.

2. THE MODEL

For our main analysis, we use the canonical New Keynesian closed economy model, which is presented in this section. We start by focusing on the public sector, which consists of a fiscal authority, or "government," and a monetary authority, or "central bank." Particular attention is devoted to the way we model the sovereign risk premium. In line with the empirical evidence discussed in the previous section, this risk premium is a function of fiscal fundamentals. Our aim is to reveal how the presence of the risk premium affects the feasible set of fiscal and monetary policies that deliver stable and unique equilibria. We close this section with a brief description of the household and firm sector, the market clearing and equilibrium conditions, and the calibration of the model's structural parameters.

2.1 The Public Sector and Sovereign Risk Premium

In the standard New Keynesian model, government bonds are typically modeled as being riskless. In contrast, we consider a government that can default on its bonds. Therefore, these bonds are subject to a default probability, which we denote by $\delta_t \in [0, 1]$. This default probability gives rise to a sovereign bond spread that forms a wedge between the rate earned on a sovereign bond, $R_{b,t}$, and the risk-free rate set by the central bank, R_t.

Modeling sovereign default. Sovereign default is modeled as follows. Following Davig, Leeper, and Walker (2011) and Bi (2012), we assume that a sovereign default event may arise due to the presence of a so-called "fiscal limit" which determines the maximum amount of government debt, say $\overline{b}$, that is politically (or economically) feasible. If changes in the fiscal (or monetary) policy stance cause the existing stock of government debt to exceed the fiscal limit, the government defaults on its outstanding debt. On the other hand, debt is fully honored when the stock of government debt is below $\overline{b}$. Although agents do not know $\overline{b}$ prior to entering a sovereign bond contract ($\overline{b}$ is observed only when the bond matures), they know its distribution and, since they are forward-looking, form expectations about future sovereign default probabilities. Specifically, let $h(\overline{b})$ be the known probability density function of $\overline{b}$. The sovereign default probability is then given by

$$\delta_t = \int_0^{b_{t-1}} h(\overline{b})d\overline{b}, \tag{3}$$

where b_t denotes the stock of government bonds issued in period t, in real terms, as a share of aggregate output.[2] Equation (3) implies that, even if the economy has not yet reached the fiscal limit, the mere *possibility* of getting there can affect today's bond price: the higher is the probability of reaching the fiscal limit, the lower is the price.

Since the fiscal limit is stochastic and depends on the state of the economy, explicitly modeling its conditional distribution can be quite cumbersome. Also, the fiscal limit implies nonlinearities within the model, which renders a linear approximation unsuitable to study the model's equilibrium properties. We do not take up the task to solve these problems here, yet instead circumvent them by assuming that $\overline{b}$ is determined exogenously, an approach taken by many recently published studies on the implications of sovereign risk in DSGE models (see Corsetti et al. 2013, Daniel and Shiamptanis 2013, Locarno, Notarpietro, and Pisani 2013, Roeger and in 't Veld 2013, Schabert and van Wijnbergen 2014, and Aloui and Eyquem 2017).

In accordance with the empirical literature, the sovereign spread that arises due to the presence of the default probability consists of two components: a *default premium*, which compensates investors for the expected loss from default, and a *risk premium*, which reflects how investors price the risk of unexpected losses. In particular, we postulate the following no-arbitrage condition for the sovereign bond spread:

$$\frac{R_{b,t}}{R_t} = \left\{ \frac{E_t\left[U_{c,t+1}\left(P_t/P_{t+1}\right)\right]}{E_t\left[\left(1-\delta_{t+1}\right)U_{c,t+1}\left(P_t/P_{t+1}\right)\right]} \right\} \Xi_t, \tag{4}$$

where E_t is the rational expectations operator, $U_{c,t}$ the marginal utility of consumption, and P_t the aggregate price index. The term in curly brackets on the right-hand side of (4) reflects the default premium, which is equal to the ratio between the expected marginal utility of saving in the absence and presence of sovereign default. The variable Ξ_t reflects the risk premium component of the bond spread and captures sudden shifts in the perceived riskiness of sovereign debt. As discussed in Section 1, and as evidenced by Figure 1, such shifts in the perceived riskiness of sovereign debt may arise in times of sovereign debt crises and cause the bond spread to become more sensitive to fiscal fundamentals.

Note that it is the risk premium component of the bond spread that will drive our results. The default premium has, up to first order, no real effects due to Ricardian equivalence. Particularly, a reduction in household wealth due to default would be perfectly offset by a decline in the expected present discounted value of future tax obligations.[3]

2. Here, the default probability function is specified as being conditional on outstanding government debt as a share of steady-state output, that is, b_{t-1}. Of course, other factors might influence variations in the default probability as well, such as expectations of future fiscal variables, output growth, the interest rate, and inflation (see Gale and Orszag 2003, for an extensive review). The choice of (3) as our preferred default function is based on analytical convenience; choosing an alternative specification, that includes other default determinants, does not cause any qualitative harm to our results.

3. Up to second order, however, the default premium may have real effects through variations in the covariance between the investor's stochastic discount factor and default events, see Borri and Verdelhan (2011).

Equation (4) is consistent with the empirical literature on the determinants of sovereign bond spreads. For instance, using data on sovereign credit default swap (CDS) spreads for 26 emerging market economies, Remolona, Scatigna, and Wu (2007) show that sovereign spreads can be decomposed into a default premium and a risk premium, as assumed here. The authors calculate the default premium as the product of the default probability (as implied by credit ratings) and the average loss-given default (based on historical average recovery rates). The risk premium is then calculated as the difference between the sovereign CDS spread and the default premium. This decomposition of sovereign spreads, and the significance of the risk premium component, has been confirmed by others as well (González-Rozada and Yeyati 2008, Remolona, Scatigna, and Wu 2008, Borri and Verdelhan 2011, Longstaff et al. 2011, Broner, Lorenzoni, and Schmukler 2013) and forms an important feature in many bond-pricing models (Arellano and Ramanarayanan 2012, Hatchondo, Martinez, and Roch 2012, Lizarazo 2013).

Modeling the risk premium. Although the risk premium may vary across time for several reasons, here we assume investors demand greater protection against unexpected changes in default risk in times when fiscal fundamentals are particularly weak. Specifically, we postulate that the risk premium is an increasing function of government indebtedness:

$$\Xi_t = (E_t \delta_{t+1})^{\chi} , \tag{5}$$

where χ denotes the risk premium elasticity. If $\chi > 0$, we say the risk premium is *debt-elastic* and investors demand additional compensation to bear sovereign risk, above and beyond what is provided by the default premium alone. This assumption is in line with Borri and Verdelhan (2011), who show that, in bad times when consumption is low and stochastic discount factors high, investors become more risk averse and require, not only a default premium, but also a risk premium for the risks they bear. The greater is the likelihood of a default, the higher is the required expected return. The debt-elastic risk premium in (5) captures such changes in the degree of risk aversion. When, on the other hand, $\chi = 0$, the risk premium is said to be *debt-inelastic*.

The risk premium Ξ_t that enters the no-arbitrage condition (4) allows us to capture the effects of sovereign default in the standard New Keynesian model in a way that accords with empirical evidence. Our approach offers a number of advantages. First, a risk premium of the type we consider can be analyzed linearly. In order to carry out a determinacy analysis of the model and compare the results with those of Leeper (1991), we need to work with a linear model. Generally, in rational expectations models of the type we consider, sovereign default becomes neutral as soon as the model is linearized. The reason is that the no-arbitrage condition (4) fully insulates households from shocks to the default rate. If agents were to have access to risky government bonds *only*, then the no-arbitrage condition is absent and sovereign default no longer is neutral, even without the risk premium. In this case, however, sovereign default has a direct expansionary effect as it reduces the effective return on government bonds which stimulates consumption. This channel of sovereign risk is at odds with existing empirical evidence. For instance, De Paoli et al. (2011) and Hebert and Schreger (2017), among others, show that sovereign default entails nontrivial economic costs, and is therefore likely to be contractionary. Moreover, Remolona, Scatigna, and Wu (2007) and Haugh, Ollivaud, and Turner (2009) show that higher sovereign risk premia move positively with investors' risk aversion, which implies that sovereign risk and (precautionary) savings are positively correlated. Hence, the risk premium function introduced here not only breaks the neutrality of sovereign default in the linear model, it also preserves the positive relationship between government indebtedness and sovereign spreads, as shown in Figure 1, such that an increase in sovereign risk crowds out (rather than crowds in) consumption. This channel of sovereign risk is demonstrated most prominently by Corsetti et al. (2013), who take a similar approach in modeling the sovereign risk premium.

Second, it turns out that our model fits well with the literature that derives sovereign default from micro principles. Bi (2012), for instance, uses a DSGE model to simulate a stochastic Laffer curve that determines the ability of the government to collect tax revenue and thereby the maximum amount of debt that can be repaid. Since the Laffer curve is stochastic and state-dependent, the full nonlinear model must be solved. The model predicts that the price of government bonds is an increasing and nonlinear function of government indebtedness. This result is consistent with the empirical evidence on the relationship between sovereign bond spreads and government indebtedness that we discussed in Section 1 and which is captured by the risk premium Ξ_t in our model.

Modeling the government. The remaining characteristics of the government are as follows. The government issues nominal, one-period government bonds, B_t, and levies a lump-sum tax, τ_t, in order to cover a constant level of public consumption, g, and repay outstanding debt plus interest. Let $S_t \equiv P_t(\tau_t - g)$ be the nominal primary budget surplus. Government debt then accumulates due to the difference between gross public debt and the primary surplus:

$$B_t = (1 - \delta_t) R_{b,t-1} B_{t-1} - S_t. \tag{6}$$

Dividing (6) by P_t and then solving forward recursively yields the intertemporal government budget constraint:

$$(1 - \delta_t) R_{b,t-1} \frac{B_{t-1}}{P_t} = \sum_{n=0}^{\infty} \left\{ \prod_{m=0}^{n} [(1 - \delta_{t+m+1}) r_{b,t+m}]^{-1} \right\} \frac{S_{t+n}}{P_{t+n}}, \tag{7}$$

where $r_{b,t} \equiv R_{b,t}(P_t/P_{t+1})$ denotes the real bond rate and where we have imposed the following no-Ponzi scheme condition which prevents the government from rolling-over its debt indefinitely:

$$\lim_{k\to\infty} \left\{ \prod_{m=0}^{k-1} [(1-\delta_{t+m+1}) r_{b,t+m}]^{-1} \right\} \frac{B_{t+k}}{P_{t+k}} = 0. \tag{8}$$

According to the intertemporal government budget constraint (7), a feasible set of fiscal and monetary policy is one which ensures that real outstanding public liabilities (left-hand side) equals the discounted sum of current and future primary surpluses (right-hand side).

The trajectory of the primary surplus $\{S_{t+k}\}_{k=0}^{\infty}$ would ordinarily be shaped by many economic and political considerations. Rather than developing a full-blown political economy model that features such considerations, we assume that the real primary surplus as a share of output, $s_t \equiv S_t/(P_t y)$, moves endogenously with changes in the lagged debt ratio, $b_{t-1} \equiv B_{t-1}/(P_{t-1} y)$, and aggregate output, y_t:

$$s_t = \gamma_b \left(b_{t-1} - b^*\right) + \gamma_y \left(y_t - y^*\right) + s, \tag{9}$$

where b^* and y^* denote target values for government debt and output, respectively, and are assumed to equal the corresponding steady-state values.[4] The constant term s appearing in (9) reflects the steady-state value of the budget surplus and ensures a positive debt ratio in steady state.

The parameter γ_b reflects the government's effort to consolidate outstanding debt within a given period. In order to facilitate our discussion, we adopt the terminology from Leeper (1991) and introduce the following definition characterizing fiscal policy:

Definition 1. *Fiscal policy is called "passive" if $\gamma_b > r_b - 1$. Otherwise, fiscal policy is said to be "active."*

The parameter r_b denotes the steady-state value of the real bond rate. Hence, when fiscal policy is passive, the government prevents debt from growing at a rate that exceeds the cost of borrowing, and thereby ensures that debt gradually converges to some sustainable level in the long run. When, on the other hand, fiscal policy is active, an increase in the level of debt will not be met by a sufficient rise in the primary surplus, which opens up the possibility of explosive debt dynamics.[5]

4. Fiscal rules similar to (9) have been used extensively in the empirical literature to test for the sustainability of public debt and estimate the cyclical stance of fiscal policy in both advanced and emerging market economies (Gavin and Perotti 1997, Galí and Perotti 2003, Greiner, Koeller, and Semmler 2007, Mendoza and Ostry 2008, Debrun and Kapoor 2010, Ghosh et al. 2013). In the theoretical literature, such fiscal rules are often used to describe government behavior (Linnemann 2006). Although most models restrict the government to respond only to lagged variables (to reflect political constraints that might delay the implementation of fiscal policy), we allow the contemporary level of output to enter the fiscal rule for analytical convenience. However, replacing y_t with y_{t-1} does not alter the main results of the paper.

5. Note that a passive fiscal stance does not necessarily rule out sovereign default: default might arise regardless of whether fiscal policy is passive, for instance, because the economy has reached the fiscal limit $\overline{b}$.

The parameter γ_y reflects the government's stance with regards the business cycle and therefore indicates the cyclicality of fiscal policy, which we characterize as follows:

DEFINITION 2. *When $\gamma_y > 0$, fiscal policy is called "countercyclical." When $\gamma_y < 0$, fiscal policy is called "procyclical."*

A countercyclical fiscal stance essentially indicates that the government uses automatic stabilizers to suppress fluctuations in output: during recessions, when output falls below target, the primary surplus falls *automatically*, whereas during economic prosperity, the primary surplus rises. Procyclical fiscal policies, on the other hand, tend to intensify the business cycle as output contractions (expansions) are met by an increase (decrease) in the primary surplus. Whereas existing literature has mostly focused on the effects of fiscal stabilization policy on short-run dynamics (see, e.g., Galí 1994, Fatás and Mihov 2001, Debrun and Kapoor 2010), we will show later on that the built-in fiscal response to the business cycle can play a pivotal role in the determination of long-run equilibrium outcomes as well.

Modeling the central bank. The central bank sets the policy rate in order to target inflation, which is denoted by $\pi_t \equiv P_t/P_{t-1}$, according to the following rule:

$$\frac{R_t}{R} = \left(\frac{\pi_t}{\pi^*}\right)^{\alpha_\pi}, \tag{10}$$

where α_π measures the aggressiveness with which the central bank responds to deviations of inflation form target, π^*. Following Leeper, the monetary stance is characterized by the following definition:

DEFINITION 3. *Monetary policy is called "active" if $\alpha_\pi > 1$. Otherwise, monetary policy is said to be "passive."*

Under active monetary policy, the central bank is able to ensure price level determinacy by moving the *nominal* interest rate by more than one-for-one with inflation, such that any positive shock to inflation is offset by an increase in the *real* interest rate. Generally speaking, an active monetary stance satisfies the Taylor-principle.

2.2 *Households and Firms*

An infinitely lived, representative household chooses the optimal level of consumption, c_t, number of hours worked, n_t, and nominal holdings of government bonds, B_t, in order to maximize expected life-time utility, given by

$$E_t \sum_{k=0}^{\infty} \beta^k \left(\frac{c_{t+k}^{1-\sigma}}{1-\sigma} - \frac{n_{t+k}^{1+\varphi}}{1+\varphi} \right) \tag{11}$$

with $\beta \in (0, 1)$ the household's discount factor, $1/\sigma$ ($\sigma > 0$) the intertemporal elasticity of substitution, and $1/\varphi$ ($\varphi > 0$) the Frisch elasticity of labor supply. The household pays lump-sum taxes, τ_t, to the government and receives labor income, $W_t n_t$ with W_t the nominal wage, and real dividends, ψ_t, from intermediate goods firms. The *ex post* flow budget constraint of the household is given by

$$B_t + P_t c_t + P_t \tau_t = (1 - \delta_t) R_{b,t-1} B_{t-1} + W_t n_t + P_t \psi_t. \tag{12}$$

Subject to (12) and the no-Ponzi scheme condition (8), the household maximizes (11) which delivers the following first-order conditions:

$$\frac{n_t^{\varphi}}{c_t^{-\sigma}} = w_t, \tag{13}$$

$$c_t^{-\sigma} = \beta E_t \left[(1 - \delta_{t+1}) r_{b,t} c_{t+1}^{-\sigma} \right]. \tag{14}$$

Equation (13) determines the household's optimal labor supply decision by relating the marginal rate of substitution between consumption and leisure to the real wage rate $w_t \equiv W_t / P_t$. The Euler equation (14) determines the household's optimal savings decision by relating expected consumption growth to the (discounted and effective) real return on government bonds.

The firm sector is straightforward (see Appendix A.1 for more details). A representative final good firm, who is a price-taker, assembles differentiated intermediate goods to produce the final good using a standard constant elasticity of substitution production function. Intermediate goods are produced by a large number of monopolistic firms using labor (supplied by households) and a constant returns to scale production technology. Intermediate goods firms can set prices in excess of marginal costs, yet face a price-setting constraint à-la Calvo (1983): in every period, only a share, $1 - \theta \in (0, 1)$, of firms can reset prices, while remaining firms keep prices unchanged. The optimal price-setting condition is based on a profit-maximization problem, which is derived in Appendix A.1.

2.3 Market Clearing and Equilibrium

In equilibrium, the economy's aggregate resource constraint, $y_t = c_t + g$, must be satisfied and the government bond market clears. Furthermore, labor market clearing implies $n_t = \int_0^1 y_t(i) di = y_t \mathcal{D}_t$, where $\mathcal{D}_t \equiv \int_0^1 (P_t(i)/P_t)^{-\epsilon} di$ is a measure of price dispersion.

Equilibrium is then given by a sequence of c_{t+k}, n_{t+k}, y_{t+k}, w_{t+k}, b_{t+k}, π_{t+k}, Ξ_{t+k}, R_{t+k}, $R_{b,t+k}$, and s_{t+k} that satisfies the default probability function (3), the no-arbitrage condition (4), the risk premium function (5), the public's budget constraint (6), the fiscal and monetary policy rules (9) and (10), the household's first-order conditions (13) and (14), the firm's optimal reset price condition (see Appendix A.1), the market clearing conditions, and exogenous processes for government consumption g and the fiscal limit $\overline{b}$, for all k.

TABLE 1
BENCHMARK CALIBRATION

Parameter	Description	Calibration
β	Discount factor	0.9926
$1/\sigma$	Elasticity of intertemporal substitution	1
$1/\varphi$	Frisch elasticity of labor supply	1/3
θ	Probability of nonprice adjustment	0.75
b	Steady-state debt ratio (annualized)	0.6
c/y	Steady-state private consumption share	0.8
g/y	Steady-state government consumption share	0.2
τ/y	Steady-state tax revenue	0.22

2.4 Calibration

The model is calibrated based on a quarterly frequency for t. For many parameters of the model, we take those values that are most commonly found in the literature. For an overview, see Table 1.

We set the discount rate equal to $\beta = 0.9926$, such that the (annual) equilibrium net bond rate equals about $r_b - 1 = 3\%$. As in Galí and Monacelli (2008), the intertemporal elasticity of substitution is assumed to be $\sigma = 1$, such that household utility depends on the log of consumption. Also, we assume $\varphi = 3$, which implies a Frisch elasticity of $1/3$, and set $\theta = 0.75$, consistent with an average price contract of 1 year. Furthermore, the steady-state debt ratio is given the value of $b = 0.6$ (on an annual basis), while private and public consumption as a share of output in steady state are set to $c/y = 0.8$ and $g/y = 0.2$, which corresponds to long-run averages of OECD countries. The government's flow budget constraint (6) then implies steady-state tax revenue of around $\tau/y = 0.22$. Values for the policy parameters, γ_b, γ_y, and α_π, are chosen within realistic ranges when we explore the set of feasible fiscal and monetary policies.

In order to calibrate the risk premium elasticity, χ, we rely on existing empirical evidence on the effects of government debt on sovereign bond spreads (see Haugh, Ollivaud, and Turner 2009, for an overview) and the time-varying estimates for Ireland shown in Figure 2. For our numerical analyses, we vary χ between 0.02 and 0.08 for the case when the risk premium is assumed debt-elastic.

3. REQUIREMENTS FOR EQUILIBRIUM STABILITY AND UNIQUENESS

In this section, we discuss the fiscal and monetary policy requirements for long-run debt sustainability and price level determinacy. We start by reducing a linearized version of the model presented in the previous section to a manageable system of four equations. This allows us to derive analytical expressions for the stability and uniqueness requirements imposed on the parameters γ_b and α_π. We then discuss these requirements for the case in which the sovereign risk premium is debt-inelastic. This case serves as a benchmark and, as shall be shown, reproduces the results of Leeper (1991). We also explain how the government's output stabilization objective, which plays no role in Leeper's analysis, affects the government's ability to ensure long-run debt sustainability. Finally, we discuss how the stability requirements change when the sovereign risk premium is debt-elastic.

3.1 Dynamics of the Model

The model is linearized around a deterministic steady state, in which prices are fully flexible ($\theta \to 0$) and inflation zero ($\pi = 1$), using a first-order Taylor approximation. Let variables without a t subscript denote the corresponding steady-state value and define $\hat{x}_t \equiv (x_t - x)/x$ as the percentage deviation of any generic variable x_t from its steady state. Using the auxiliary variable $\hat{\pi}_t^{'} = \hat{\pi}_t$, the model can then be reduced to the following 4×4 system of linear difference equations (see Appendix A.2 for a brief derivation):

$$A_0 \begin{bmatrix} E_t \hat{\pi}_{t+1} \\ E_t \hat{c}_{t+1} \\ \hat{b}_t \\ \hat{\pi}_t^{'} \end{bmatrix} = A_1 \begin{bmatrix} \hat{\pi}_t \\ \hat{c}_t \\ \hat{b}_{t-1} \\ \hat{\pi}_{t-1}^{'} \end{bmatrix}, \tag{15}$$

where

$$A_0 \equiv \begin{bmatrix} 1 & \sigma & -\chi b & 0 \\ \beta & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix},$$

$$A_1 \equiv \begin{bmatrix} \alpha_\pi & \sigma & 0 & 0 \\ 1 & -\Psi & 0 & 0 \\ -\frac{1}{\beta} & -\gamma_y \frac{c/y}{b} & \frac{1+\chi b}{\beta} - \gamma_b & \frac{1}{\beta}\alpha_\pi \\ 1 & 0 & 0 & 0 \end{bmatrix},$$

and where $\Psi \equiv (1-\theta)(1-\theta\beta)/\theta(\varphi c/y + \sigma) > 0$.

The system of endogenous variables described by (15) consists of two forward-looking (jump) variables, $\hat{c}_t$ and $\hat{\pi}_t$, one predetermined (state) variable, $\hat{b}_t$, and an auxiliary variable $\hat{\pi}_t^{'}$. As shown by Blanchard and Kahn (1980), the matrix $A \equiv A_0^{-1} A_1$ should then contain exactly one stable eigenvalue (i.e., smaller than modulus one) and two unstable eigenvalues (i.e., larger than modulus one) to guarantee a stable and unique equilibrium (the eigenvalue corresponding to $\hat{\pi}_t^{'}$ equals unity by construction). If there are three unstable eigenvalues, then the trajectory of government debt is explosive and an equilibrium in which agents are willing to hold government bonds does not exist. With zero or one unstable eigenvalues, the system has infinitely many solutions as it admits the possibility of sunspot shocks making the price level sequence indeterminate.

3.2 Reproducing Leeper (1991)

The conditions under which a stable and unique equilibrium can be supported when the sovereign risk premium is debt-inelastic (i.e., when $\chi = 0$) are given by the following proposition:

PROPOSITION 1. *Given $\chi = 0$, a fiscal rule of the form (9) and a monetary rule of the form (10), sufficient conditions for a stable and unique rational expectations equilibrium are either*

$$\gamma_b > \frac{1}{\beta} - 1 \quad \textit{and} \quad \alpha_\pi > 1, \tag{16}$$

or

$$\gamma_b < \frac{1}{\beta} - 1 \quad \textit{and} \quad \alpha_\pi < 1 \tag{17}$$

provided that $\gamma_b < 1/\beta \min(\Psi/\sigma, 1)$ and $\alpha_\pi > 0$.

PROOF. See Appendix A.3. □

The intuition underlying Proposition 1 is discussed next and illustrated by Figure 4, which shows the number of unstable eigenvalues of A as a function of the fiscal and monetary policy stance (which are governed by γ_b and α_π). The vertical dashed line crosses the horizontal axis at $1/\beta - 1$, which is equal to $r_b - 1$ under steady state (see equation (14)), and so partitions the parameter space into active fiscal policy to the left and passive fiscal policy to the right of the dashed line. The horizontal dashed line crosses the vertical axis at 1, such that monetary policy is active above the line and passive below. In the dark-gray area, matrix A has zero unstable eigenvalues, which suggests that expectations are not well-anchored and that the price level is not uniquely determined ("Indeterminate"). In the two light-gray areas, there are two unstable eigenvalues and so equilibrium is both stable and unique ("Stable and Unique"). In the white area, there are three unstable eigenvalues, which means that a combination of fiscal and monetary policy within this region is not feasible ("Nonexistence").

As shown by Figure 4, there are two regions in which fiscal and monetary policy deliver a stable and unique equilibrium. In the top-right region, fiscal policy is passive, that is, $\gamma_b > r_b - 1$, while monetary policy is active, that is, $\alpha_\pi > 1$. To see how this combination of fiscal and monetary policy delivers stable and unique equilibria, consider a positive shock to output. The rise in output leads to an increase in demand for labor, which raises marginal costs and hence inflation. Given the active stance of monetary policy, the central bank responds by raising the nominal interest rate by more than one-for-one with the change in inflation, causing the real interest rate

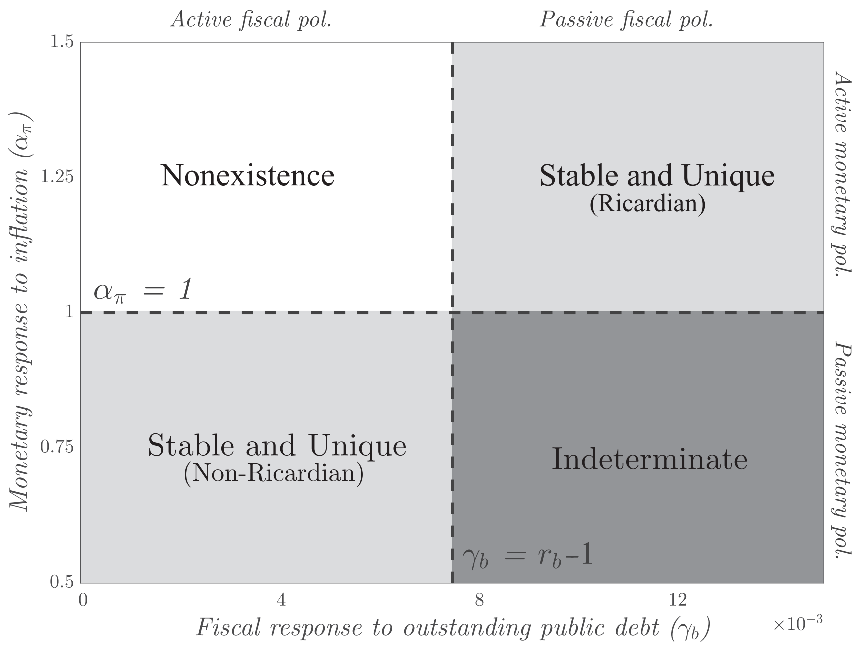

FIG. 4. The "Fiscal-Monetary Dichotomy."

NOTES: The figure displays the model's equilibrium properties as a function of γ_b and α_π for $\chi = 0$.

to go up. By the household's Euler equation (14), consumption then falls, which gradually returns output, labor demand, and marginal costs back to their respective steady states. Thus, through active monetary policy the central bank successfully pins down expectations and controls inflation. Meanwhile, the higher interest rate drives up public interest expenses, which raises the budget deficit and government debt. Since fiscal policy is passive, the government responds by raising the primary surplus by enough to offset the rise in interest costs and prevent the stock of debt from ever-accumulating. Passive fiscal policy thus achieves long-run debt sustainability. This regime of passive fiscal and active monetary policy, typically referred to as the "Ricardian regime" (following Woodford 2001), usually prevails in conventional dynamic macroeconomic models. We therefore refer to the region associated with this policy regime as *Ricardian*.

When fiscal policy is active and insufficient to prevent explosive debt dynamics, that is, when $\gamma_b < r_b - 1$, condition (17) of Proposition 1 suggests that a stable and unique equilibrium can still be achieved if the central bank does not actively target inflation, yet adopts a passive monetary policy, that is, if $\alpha_\pi < 1$. This result corresponds to the lower-left region of Figure 4. Under active fiscal policy, changes in the public's interest expenses are insufficiently offset by the primary surplus and so debt can grow without bounds. To prevent such explosive dynamics, the central bank must allow the price level P_t to jump to whatever level is necessary to keep the real value of outstanding government liabilities consistent with the intertemporal government budget constraint (7). This regime of active fiscal and passive monetary policy, which we refer to as *non-Ricardian*, relates to the "Fiscal Theory of the Price Level" in which the price level is effectively determined by public finances (see Leeper 1991, Sims 1994, Woodford 1998, 2001, among others).

Furthermore, Figure 4 shows that, when monetary and fiscal policy are both passive (lower-right region), equilibrium is indeterminate, which indicates that fiscal solvency is obtained for an infinite number of price level sequences. When both policies are active (upper-left region), no equilibrium exists that supports demand for government bonds, since the government's debt consolidation policy is too weak to avoid explosive dynamics and monetary policy does not accommodate nominal debt growth through adjustments in the price level.

The policy requirements for equilibrium stability and uniqueness under the benchmark case are well-known and identical to those obtained by Leeper. However, the results hold two lesser known insights. First, equilibrium outcomes depend on the mixture of fiscal and monetary policies, yet not on the *relative* policy strengths. For instance, as shown by Figure 4, a stable and unique equilibrium is obtained under the Ricardian regime as long as fiscal policy is passive and monetary policy active. This result holds, regardless of the "passiveness" of fiscal policy or "activeness" of monetary policy. Policy coordination between the government and central bank can therefore be kept at a minimum.[6] We refer to this near policy independence as the *fiscal-monetary dichotomy*. Second, note that the parameter γ_y, which determines the cyclicality of fiscal policy, does not enter the stability and uniqueness requirements in Proposition 1. Therefore, the government's systematic response to changes in output, whether it be counter- or procyclical, is *irrelevant* for the determination of the equilibrium outcome.

The irrelevance of the cyclical stance of fiscal policy for the model's equilibrium properties is evidenced by Figure 5, which shows the number of unstable eigenvalues as a function of γ_b and γ_y, while assuming that monetary policy is active. The horizontal dashed line now partitions the parameter space into counter- and procyclical fiscal policy. When $\alpha_\pi > 1$, we know that $\gamma_b > r_b - 1$ ensures a stable and unique equilibrium. Figure 5 shows that this condition holds regardless of the size and sign of γ_y. Therefore, as long as fiscal policy is passive, and debt sustainability is ensured in the *long run*, can policymakers generate deficits over the *short run* and let automatic stabilizers work fully to absorb adverse aggregate shocks. In other words, both counter- and procyclical policies are feasible under the Ricardian regime of passive fiscal and active monetary policy.

6. In a Ricardian world, all that matters is that the government knows the central bank will actively target inflation, not the aggressiveness or manner with which the central bank pursues its target.

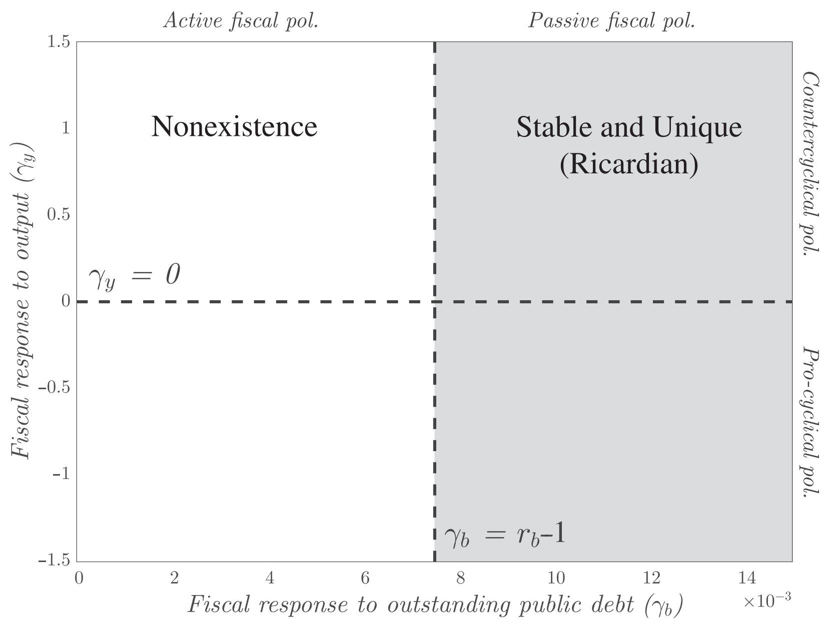

FIG. 5. Feasible and Unfeasible Fiscal Policies (under Active Monetary Policy).

NOTE: The figure displays the model's equilibrium properties as a function of γ_b and γ_y for $\chi = 0$ and $\alpha_\pi = 1.5$.

In the following section, we compare the results from the benchmark case to the case in which the sovereign risk premium rises with the stock of government debt.

3.3 Implications of the Debt-Elastic Sovereign Risk Premium

The policy requirements for equilibrium stability and uniqueness in the presence of a debt-elastic sovereign risk premium are given by the following proposition:

PROPOSITION 2. *Given a fiscal rule of the form (9) and a monetary rule of the form (10), sufficient conditions for a stable and unique rational expectations equilibrium are either*

$$\gamma_b > \frac{1}{\beta} - 1 + \frac{\chi\gamma_y \frac{c}{y}(1-\beta)}{\Psi\left(\alpha_\pi - 1\right)} \quad \textit{and} \quad \alpha_\pi > 1 + \frac{\chi\gamma_y \frac{c}{y}(1-\beta)}{\Psi\left[\gamma_b - \left(\frac{1}{\beta} - 1\right)\right]}, \tag{18}$$

or

$$\gamma_b < \frac{1}{\beta} - 1 + \frac{\chi\gamma_y \frac{c}{y}(1-\beta)}{\Psi\left(\alpha_\pi - 1\right)} \quad \textit{and} \quad \alpha_\pi < 1 + \frac{\chi\gamma_y \frac{c}{y}(1-\beta)}{\Psi\left[\gamma_b - \left(\frac{1}{\beta} - 1\right)\right]} \tag{19}$$

provided that $\gamma_b < 1/\beta \min(\Psi/\sigma, 1)$, $\alpha_\pi > 0$ *and (for* $\chi > 0$*)* $\gamma_y < b(\sigma/\beta)/(c/y)$.

PROOF. See Appendix A.3. □

First, note that for $\chi = 0$, the requirements stated in Proposition 2 reduce to those of the benchmark case under Proposition 1. Second, for $\chi > 0$ and $\gamma_y \neq 0$, the requirements for fiscal policy depend more strongly on monetary policy, and vice versa, as the parameters γ_b and α_π are now a function of each other. Third, the parameter γ_y now enters the requirements for both fiscal and monetary policy, indicating that the cyclical stance of fiscal policy is no longer irrelevant for equilibrium outcomes.

Underlying the change in the stability and uniqueness requirements is a *crowding-out effect* of fiscal policy on consumption that works through the sovereign risk premium Ξ_t. Specifically, when the level of government debt rises, the risk premium goes up due to an increase in the expected default probability, see equation (5), which leads to a higher interest rate $R_{b,t}$. In turn, the higher interest rate induces households to save more and consume less by the Euler equation (14). The higher is χ, the stronger is the rise in the risk premium for a given increase in government debt, and so the greater is the crowding-out effect on consumption. Furthermore, since a reduction in consumption causes output to decline, inflation falls as well. Hence, Ricardian equivalence breaks down and the ability of the central bank to safeguard price stability relies more heavily on the fiscal policy stance and the dynamics of government debt.[7]

When fiscal policy is countercyclical, that is when $\gamma_y > 0$, the budget deficit rises during economic downturns and falls during economic prosperity. Therefore, when a shock causes output to contract, the stock of government debt and the risk premium rises which, as explained earlier, crowds out consumption and thereby *exacerbates* the initial contraction in output. Given the countercyclical nature of fiscal policy, the government automatically responds to the decline in output by reducing taxes further, causing government debt and the risk premium to go up even more, resulting in a further decline in consumption, output and inflation, etc. An equilibrium that supports the demand for government bonds under these conditions might not exist, even if fiscal policy is passive.

A self-reinforcing debt crisis may be avoided by adopting a more aggressive debt consolidation policy under the Ricardian regime. In fact, according to condition (18) of Proposition 2, the higher is χ, the greater must be the government's effort to curtail the level of debt back to target, that is, the higher must be γ_b. The higher debt coefficient γ_b serves as a signal to holders of government bonds of a commitment by the government to keep a firm grip on public finances, like the announcement by the Irish government of major fiscal consolidation plans. Any

7. One could think of the crowding-out effect as reflecting the exposure of the banking sector to sovereign risk. Widespread empirical evidence shows that, due to this exposure, sovereign risk can have significant adverse effects on private borrowing conditions (see, e.g., Borensztein and Panizza 2009, Panetta et al. 2011, Albertazzi et al. 2012, Demirgüç-Kunt and Huizinga 2013, Zoli 2013, Balteanu and Erce 2014, Popov and Van Horen 2015, Bofondi, Carpinelli, and Sette 2017). The parameter χ can then be interpreted as capturing the degree of this pass-through effect.

surge in government indebtedness would then be met by forceful fiscal contractions to constrain the accumulation of debt and keep the sovereign risk premium at bay.[8]

Note that the required amount of debt consolidation in the presence of a debt-elastic sovereign risk premium depends not only on χ, but also on α_π. Intuitively, under the Ricardian regime, in which monetary policy is active, the central bank responds to the rise in the sovereign risk premium and consequent fall in inflation by reducing the policy rate R_t, which reduces $R_{b,t}$ and raises consumption, and thus partially *offsets* the crowding-out effect.[9] However, the lower is α_π, the less the rise in the sovereign risk premium will be neutralized. Therefore, equilibrium might be indeterminate if monetary policy is not active enough due to the self-reinforcing effects of the sovereign risk premium on consumption and inflation. Preventing the risk premium from damaging the economy would then require more aggressive debt consolidation by the government. In fact, the weaker is the central bank's ability to respond to changes in inflation, that is, the lower is α_π, the higher must be γ_b. The interdependence between fiscal and monetary policy indicates that the fiscal-monetary dichotomy breaks down. Consequently, policy coordination between the government and central bank becomes much more relevant in the context of macroeconomic stabilization.[10]

The implications of the debt-elastic sovereign risk premium for the stability and uniqueness requirements under countercyclical fiscal policy are visualized by Figure 6, which, as in Figure 4, shows the properties of the model's steady state as a function of the fiscal and monetary stance. According to the figure, the parameter space that supports a stable and unique equilibrium *contracts* relative to the benchmark case (as reflected by the reduction of the regions related to the Ricardian and non-Ricardian regimes). On the other hand, the likelihood of obtaining either multiple equilibria or nonexistence of equilibrium *rises*. The dashed lines that separate active from passive fiscal and monetary policies are again included to facilitate comparison with the benchmark case. In contrast to the results from the previous section, a stable and unique equilibrium might not be feasible, even if fiscal policy is passive and

8. Under the non-Ricardian regime, the government's debt consolidation policy must be *relaxed* as the sovereign risk premium becomes more responsive to debt changes. Considering that sovereign debt crises typically display more, rather than less, fiscal austerity, we consider the Ricardian regime to be the more relevant case from a policy perspective.

9. As shown by Attinasi, Checherita-Westphal, and Nickel (2011), the European Central Bank's main refinancing operations have contributed to narrowing sovereign risk premia during the recent financial crisis.

10. The crowding-out effect of sovereign risk also depends on the degree of price stickiness and the sensitivity of the private sector to interest rate shocks. Intuitively, the greater is the share of firms unable to adjust their price (i.e., the higher is θ), the stronger will be the contraction in output for a given fall in aggregate demand. Hence, prices stickiness amplifies the adverse effects of sovereign risk. Furthermore, the lower is the coefficient of relative risk aversion (denoted by σ), the greater is the consumption response to changes in the real interest rate (see (14)) and hence the stronger will be the crowding-out effect. Incidentally, these robustness checks (available upon request) confirm that our results do not hinge on log preferences.

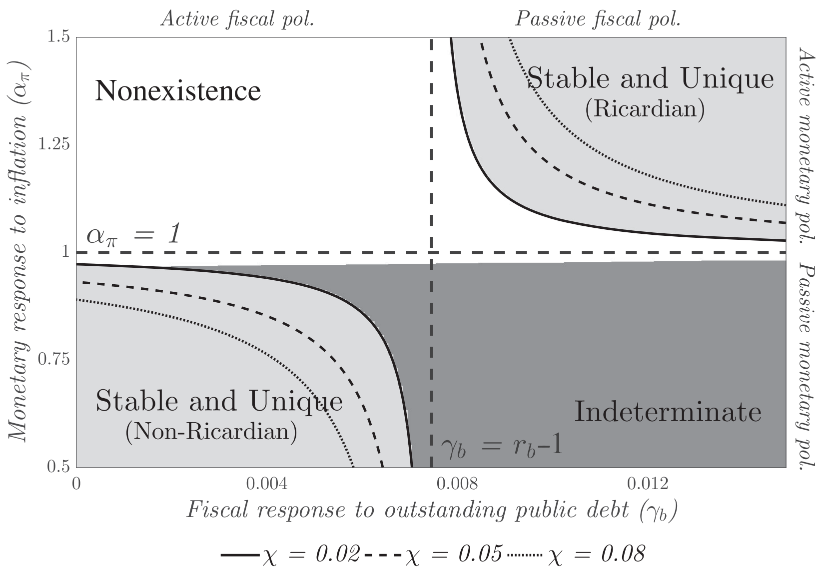

FIG. 6. Implications of the Debt-Elastic Sovereign Risk Premium ($\chi > 0$) under Countercyclical Fiscal Policy ($\gamma_y > 0$).
NOTES: The figure displays the model's equilibrium properties as a function of γ_b and α_π for $\chi > 0$.

monetary policy active. Furthermore, the figure suggests that higher values for χ result in smaller stability and uniqueness regions.[11]

When fiscal policy is procyclical, that is when $\gamma_y < 0$, the stability and uniqueness requirements under a debt-elastic sovereign risk premium are *relaxed*, as compared to the benchmark case, for both fiscal and monetary policy. Particularly, when the primary surplus rises following an adverse shock to output, the stock of government debt falls, which reduces the risk premium and interest rate, and raises consumption, thereby offsetting the initial output contraction. The procyclical nature of fiscal policy thus not only eases the task of sustaining government debt by keeping interest costs low, which makes it possible to obtain a stable equilibrium even if fiscal policy is not passive, it also helps pin down household expectations by essentially substituting for monetary policy, which opens up the possibility for equilibrium uniqueness even if the central bank violates the Taylor-principle.

Figure 7 again shows the model's equilibrium properties as a function of fiscal and monetary policy in the presence of a debt-elastic sovereign risk premium, yet this time assuming that fiscal policy is procyclical. According to the figure, the stability and uniqueness regions now *expand*, as compared to the benchmark case, whereas the nonexistence and indeterminacy regions *contract*. For a given active monetary policy, it is now possible to obtain a stable and unique equilibrium, even if fiscal

11. Figure A1 in Appendix A.4 shows that higher values for γ_y also contract the stability and uniqueness regions.

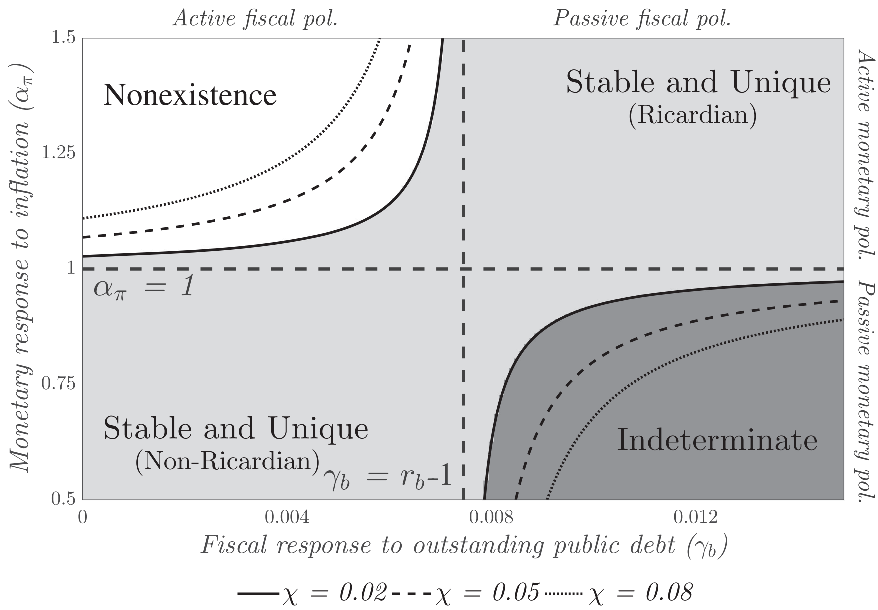

FIG. 7. Implications of the Debt-Elastic Sovereign Risk Premium ($\chi > 0$) under Procyclical Fiscal Policy ($\gamma_y < 0$).
NOTES: See notes under Figure 6.

policy is also active; stability and uniqueness can also be obtained if the government and central bank both pursue passive policies. Furthermore, the figure shows that the size of the stability regions is larger, the greater is χ.[12]

Figures 6 and 7 imply that the cyclical stance of fiscal policy plays a key role in determining the equilibrium outcome when the sovereign risk premium is debt-elastic. Recall that, when the sovereign risk premium is debt-inelastic, agents are always willing to hold government bonds, regardless of the degree of government indebtedness, provided that government debt is sustainable in the long run. The latter merely requires fiscal policy to be passive and therefore allows the government to let automatic stabilizers work fully, pursue countercyclical fiscal policies and run budget deficits from time to time. However, when agents believe the economy is near its fiscal limit, an increase in the budget deficit *today* raises the probability of breaching the fiscal limit *tomorrow*. Hence, short-run debt developments are no longer trivial and the government may find it more difficult to run budget deficits without upsetting bond markets. Instead, the government must take immediate action and signal its commitment to sustain debt, which it can achieve through either a procyclical stance or more aggressive debt consolidation.

12. Figure A1 in Appendix A.4 shows that more negative values for γ_y also expand the stability and uniqueness regions.

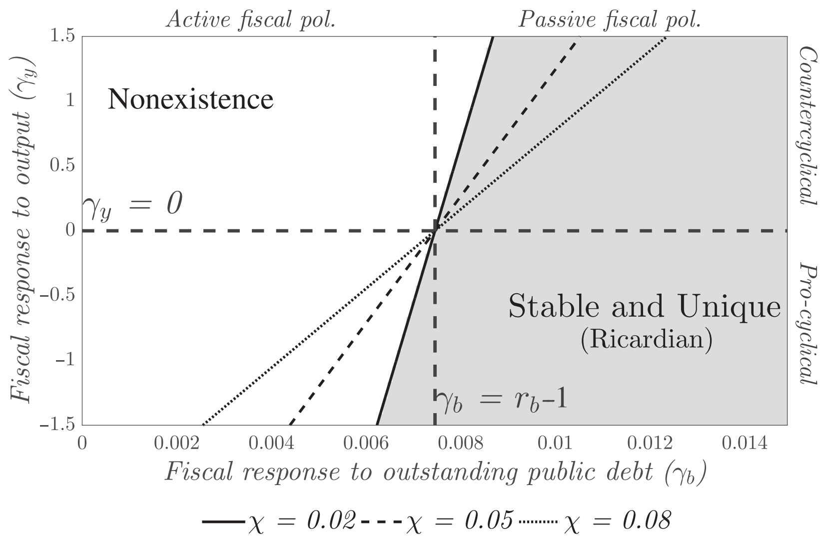

FIG. 8. Feasible and Unfeasible Fiscal Policies (under Active Monetary Policy) when $\chi > 0$.

NOTES: The figure displays the model's equilibrium properties as a function of γ_b and γ_y for $\chi > 0$ and $\alpha_\pi = 1.5$.

The importance of the government's attitude toward the business cycle is visualized by Figure 8. According to the figure, when monetary policy is active, a passive fiscal stance combined with a countercyclical stance might not be feasible. In fact, the stronger is the countercyclical bent of fiscal policy (i.e., the higher is γ_y), the greater must be the fiscal contraction following any given rise in government debt in order to ensure the existence of equilibrium (i.e., the higher must be γ_b). Thus, compared to the benchmark case (Figure 5), the feasible set encompassing countercyclical policies contracts, especially when the bond market is particularly anxious and χ relatively high. On the other hand, the feasible set encompassing procyclical policies expands and a stable equilibrium can be supported, even if fiscal policy is active.

4. CONCLUDING REMARKS

We reviewed the well-established conditions for equilibrium stability and uniqueness from the seminal contribution of Leeper (1991) and showed that these conditions change markedly under debt-elastic sovereign risk premia and depend strongly on the government's endogenous fiscal response to the business cycle. Whereas in Leeper, short-run debt developments do not change the feasible set of fiscal and monetary policies, we show that they can affect the ability to ensure long-run sustainability when demand for government bonds is highly elastic.

Our results suggest that countercyclical policies could come at great cost in terms of widening interest rate spreads and macroeconomic instability. The results therefore provide an interpretation for why some countries, that run large deficits or face severe financial market constraints, tend to pursue procyclical fiscal policies in order to keep interest rate spreads low, as shown empirically by Gavin and Perotti (1997) and Combes, Minea, and Sow (2017). We show that countercyclical fiscal policies can be feasible, provided they are accompanied by sufficiently aggressive debt consolidation policies and/or active inflation-targeting. Alternatively, maintaining the primary balance well below the maximum (politically or economically) feasible level would allow automatic stabilizers to absorb adverse shocks without immediately provoking sharp interest rate hikes.

While our results point toward the importance of fiscal austerity and monetary accommodation during sovereign debt crises, such policies might not always be feasible (or even desirable). For instance, the scope for fiscal austerity might be limited due to political constraints or because the economy has reached the peak of the Laffer curve, whereas monetary policy may be constrained by the zero lower bound. Also, the choice between a fiscal or monetary response to the crisis may have strong implications for welfare (in terms of both the variability and distribution of income). Therefore, a suitable welfare analysis is needed to reveal the optimal mix of fiscal and monetary policy when risk premia are debt-elastic.

We would also like to stress that our model does not allow policymakers to alter their objectives over time. Augmenting the model with regime-switching possibilities might, however, help reveal how "often" countercyclical policies are permissible and to what extent they contribute to macroeconomic stability. Finally, although our reduced-form specification of the sovereign risk premium is helpful in deriving analytical results, omitting potential nonlinear interactions between bond spreads and fiscal fundamentals involves the risk of overlooking important second-order effects (e.g., heightened uncertainty when governments are close to default). Building the sovereign risk premium from microfoundations would help to account for such effects, yet would most likely merely exaggerate our results. We leave these extensions for future work.

APPENDIX A

A.1 Optimal Demand and Price-Setting Conditions

A representative final good firm combines differentiated intermediate goods, $y_t(i)$, purchased from intermediate goods firm $i \in [0, 1]$, to produce the final good, y_t, using the following production technology:

$$y_t = \left(\int_0^1 y_t(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}, \tag{A1}$$

where $\epsilon > 1$ measures the elasticity of substitution between intermediate goods. Minimizing the costs of assembling y_t, subject to (A1), results in the optimal demand schedule for $y_t(i)$ and an expression for the aggregate price index, P_t:

$$y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\epsilon} y_t, \tag{A2}$$

$$P_t = \left(\int_0^1 P_t(i)^{1-\epsilon} di\right)^{\frac{1}{1-\epsilon}}. \tag{A3}$$

Intermediate goods firms, which are owned by the households, face the following linear production technology:

$$y_t(i) = n_t(i). \tag{A4}$$

Subject to (A4), the firm aims to minimize labor costs, which results in a condition that equates real marginal costs, $mc_t(i)$, to the marginal product of hiring one additional unit of labor:

$$mc_t(i) = w_t. \tag{A5}$$

Intermediate goods firms set prices with the aim of maximizing the discounted sum of current and future profits, conditional on the probability of nonprice adjustment (which is governed by θ):

$$E_t \sum_{k=0}^{\infty} \theta^k Q_{t,t+k} \left(\overline{P}_t y_{t,t+k}(i) - W_{t+k} n_{t,t+k}(i)\right),$$

where $\overline{P}_t$ is the optimal reset price[13] and $Q_{t,t+k} \equiv \beta^k (c_{t+k}/c_t)^{-\sigma}/\pi_{t+k}$ is the k-step ahead equilibrium pricing-kernel. Profits are distributed as dividends to the households. Subject to the demand schedule (A2), the production technology (A4) and the optimality condition for labor demand (A5), profit maximization leads to the following optimal reset price:

$$\overline{P}_t = \mathcal{M} \frac{E_t \sum_{k=0}^{\infty} (\theta\beta)^k P_{t+k}^{\epsilon} c_{t+k}^{-\sigma} y_{t+k} mc_{t+k}}{E_t \sum_{k=0}^{\infty} (\theta\beta)^k P_{t+k}^{\epsilon-1} c_{t+k}^{-\sigma} y_{t+k}}. \tag{A6}$$

According to (A6), the optimal reset price is a mark-up $\mathcal{M} \equiv \epsilon/(\epsilon - 1)$ over current and expected real marginal costs. Note that, under flexible prices, $\theta \to 0$ and $\overline{P}_t = P_t$ for all t, such that (A6) collapses to $mc_t = 1/\mathcal{M}$.

13. Due to symmetry among firms, we can ignore the i-index.

A.2 Linearization and State-Space Representation

The full model from Section 2 in linear form is given by:

$$\sigma \hat{c}_t = \sigma E_t \hat{c}_{t+1} - \left(\hat{R}_{b,t} - E_t \hat{\pi}_{t+1}\right), \tag{A7}$$

$$\varphi \hat{n}_t = \hat{w}_t - \sigma \hat{c}_t, \tag{A8}$$

$$\hat{y}_t = \frac{c}{y} \hat{c}_t, \tag{A9}$$

$$\hat{y}_t = \hat{n}_t, \tag{A10}$$

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \hat{w}_t, \tag{A11}$$

$$\frac{\tau}{y} \hat{\tau}_t = \gamma_b b \hat{b}_{t-1} + \gamma_y \hat{y}_t, \tag{A12}$$

$$\hat{R}_t = \alpha_\pi \hat{\pi}_t, \tag{A13}$$

$$\hat{b}_t = \frac{1}{\beta}\left(\hat{b}_{t-1} + \hat{R}_{b,t-1} - \hat{\pi}_t\right) - \frac{\tau/y}{b} \hat{\tau}_t, \tag{A14}$$

$$\hat{R}_{b,t} = \hat{R}_t + \chi b \hat{b}_t, \tag{A15}$$

where $\kappa \equiv (1-\theta)(1-\theta\beta)/\theta$.

To reduce the model, insert (A9) and (A10) into (A8):

$$\hat{w}_t = \left(\varphi \frac{c}{y} + \sigma\right) \hat{c}_t.$$

Insert this new expression for $\hat{w}_t$ into the New Keynesian Phillips curve (A11):

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \left(\varphi \frac{c}{y} + \sigma\right) \hat{c}_t. \tag{A16}$$

Insert (A13) and (A15) into (A7):

$$\sigma \hat{c}_t = \sigma E_t \hat{c}_{t+1} - \left(\alpha_\pi \hat{\pi}_t + \chi b \hat{b}_t - E_t \hat{\pi}_{t+1}\right). \tag{A17}$$

Finally, insert (A9), (A12), (A13), and (A15) into (A14):

$$\hat{b}_t = \frac{1}{\beta}\left(\alpha_\pi \hat{\pi}_{t-1} - \hat{\pi}_t\right) - \gamma_y \frac{c/y}{b} \hat{c}_t + \left(\frac{1+\chi b}{\beta} - \gamma_b\right) \hat{b}_{t-1}. \tag{A18}$$

The reduced system is then given by equations (A16)–(A18). Using the auxiliary variable $\hat{\pi}_t^{'} = \hat{\pi}_t$, we obtain the state-space representation (15) from the main text.

A.3 Proof of Propositions 1 and 2

The 4×4 system of dynamic equations is given by

$$\begin{bmatrix} E_t\hat{\pi}_{t+1} \\ E_t\hat{c}_{t+1} \\ \hat{b}_t \\ \hat{\pi}_t^{'} \end{bmatrix} = \begin{bmatrix} -\frac{\Psi}{\beta} & 0 & \frac{1}{\beta} & 0 \\ 1+\frac{\Psi}{\sigma\beta}-\gamma_y\frac{c}{y}\frac{1}{\sigma}\chi & \frac{1}{\sigma}\chi b\left[\frac{1+\chi b}{\beta}-\gamma_b\right] & \frac{\alpha_\pi}{\sigma}-\frac{1}{\sigma\beta}-\frac{1}{\sigma\beta}\chi b & \frac{\alpha_\pi}{\beta\sigma}\chi b \\ -\gamma_y\frac{c}{b} & \frac{1+\chi b}{\beta}-\gamma_b & -\frac{1}{\beta} & \frac{\alpha_\pi}{\beta} \\ 0 & 0 & 1 & 0 \end{bmatrix} \times \begin{bmatrix} \hat{\pi}_t \\ \hat{c}_t \\ \hat{b}_{t-1} \\ \hat{\pi}_{t-1}^{'} \end{bmatrix},$$

where $\Psi = \kappa(\varphi c/y + \sigma)$. As there is one auxiliary variable, its characteristic polynomial can be written as $H(\lambda) = \lambda G(\lambda)$ with

$$\begin{aligned} G(\lambda) = \lambda^3 - \lambda^2&\left[1+\frac{\Psi}{\sigma\beta}+\left(1-\gamma_y\frac{c}{y}\frac{1}{\sigma}\chi\right)+\left(\frac{1}{\beta}-\gamma_b\right)+\frac{1}{\beta}\chi b+\left(\frac{1}{\beta}-1\right)\right] \\ &+\lambda\left[\left(\frac{1}{\beta}-\gamma_b\right)\left(1+\frac{1}{\beta}+\frac{\Psi}{\sigma\beta}\right)+\frac{1}{\beta}\chi b\left(1+\frac{1}{\beta}\right)+\frac{1}{\beta}\left(1-\gamma_y\frac{c}{y}\frac{1}{\sigma}\chi\right)\right. \\ &\left.+\frac{\Psi}{\sigma\beta}\alpha_\pi\right]-\left[\left(\frac{1}{\beta}-\gamma_b\right)\left(\frac{1}{\beta}+\frac{\alpha_\pi}{\sigma\beta}\right)+\frac{1}{\beta^2}\chi b\right]. \end{aligned}$$

Our aim is to derive sufficient conditions such that $G(\lambda) = 0$ twice for $|\lambda| > 1$ and once for $|\lambda| < 1$.

First, note that as $G(-\infty) = -\infty$ and for $\gamma_b < 1/\beta$ and $\alpha_\pi > 0$, $G(0) < 0$ and $dG(\lambda)/d\lambda > 0$ for $\lambda < 0$, $G(\lambda) < 0$ for $\lambda < 0$. So, the characteristic polynomial has no eigenvalues smaller than zero. As it needs to have one eigenvalue smaller than one, $G(1) > 0$, $G(1) < 0$ allows only two or zero eigenvalues smaller than one. $G(1) > 0$ implies

$$\gamma_b > \frac{1}{\beta} - 1 + \frac{\chi\gamma_y\frac{c}{y}(1-\beta)}{\Psi(\alpha_\pi - 1)} \quad \text{and} \quad \alpha_\pi > 1 + \frac{\chi\gamma_y\frac{c}{y}(1-\beta)}{\Psi\left[\gamma_b - \left(\frac{1}{\beta}-1\right)\right]}, \tag{A19}$$

or

$$\gamma_b < \frac{1}{\beta} - 1 + \frac{\chi\gamma_y\frac{c}{y}(1-\beta)}{\Psi(\alpha_\pi - 1)} \quad \text{and} \quad \alpha_\pi < 1 + \frac{\chi\gamma_y\frac{c}{y}(1-\beta)}{\Psi\left[\gamma_b - \left(\frac{1}{\beta}-1\right)\right]}. \tag{A20}$$

To rule out three eigenvalues smaller than one, note that $d^2G(0)/d\lambda^2$ equals the sum of eigenvalues. If it is larger than 3, there can be only one eigenvalue smaller than one. This implies

$$0 < 2\left(\frac{1}{\beta} - 1\right) + \chi\left[\frac{1}{\beta}b - \gamma_y\frac{c}{y}\frac{1}{\sigma}\right] + \left(\frac{\Psi}{\sigma\beta} - \gamma_b\right),$$

which holds if $\gamma_b < \Psi/(\sigma\beta)$ and $(\sigma\beta)b/(c/y) > \gamma_y$. This proves the proposition.

A.4 Additional Graphs

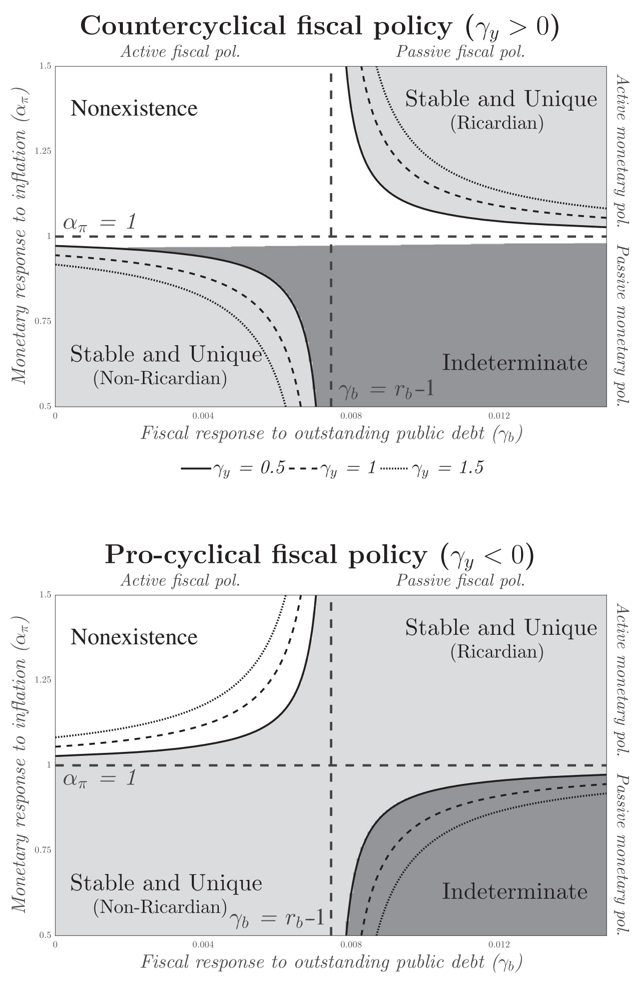

FIG. A1. Implications of the Cyclicality of Fiscal Policy under a Debt-Elastic Sovereign Risk Premium ($\chi > 0$).

LITERATURE CITED

Afonso, Antònio, Michael Arghyrou, and Alexandros Kontonikas. (2015) "The Determinants of Sovereign Bond Yield Spreads in the EMU." ECB Working Paper 1781, European Central Bank.

Albertazzi, Ugo, Tiziano Ropele, Gabriele Sene, and Federico Signoretti. (2012) "The Impact of the Sovereign Debt Crisis on the Activity of Italian Banks." Bank of Italy Occasional Paper 133, Bank of Italy.

Aloui, Rym, and Aurélien Eyquem. (2017) "Debt, Sovereign Risk and Government Spending." Mimeo.

Ardagna, Silvia, Francesco Caselli, and Timothy Lane. (2007) "Fiscal Discipline and the Cost of Public Debt Service: Some Estimates for OECD Countries." *BE Journal of Macroeconomics*, 7, 1–35.

Arellano, Cristina, and Ananth Ramanarayanan. (2012) "Default and the Maturity Structure in Sovereign Bonds." *Journal of Political Economy*, 120, 187–232.

Attinasi, Maria Grazia, Cristina D. Checherita-Westphal, and Christiane Nickel. (2011) "What Explains The Surge in Euro Area Sovereign Spreads during the Financial Crisis of 2007-09?" In *Sovereign Debt: From Safety to Default*, edited by Robert W. Kolb, pp. 407–14. Hoboken, NJ: John Wiley & Sons, Inc.

Baldacci, Emanuele, and Manmohan Kumar. (2010) "Fiscal Deficits, Public Debt, and Sovereign Bond Yields." IMF Working Paper WP/10/184, International Monetary Fund.

Balteanu, Irina, and Aitor Erce. (2014) "Banking Crises and Sovereign Defaults in Emerging Markets: Exploring the Links." Working Papers 1414, Banco de Espana.

Barrios, Salvador, Per Iversen, Magdalena Lewandowska, and Ralph Setzer. (2009) "Determinants of Intra-Euro Area Government Bond Spreads during the Financial Crisis." Economic Papers 388, European Commission.

Bayoumi, Tamim, Morris Goldstein, and Geoffrey Woglom. (1995) "Do Credit Markets Discipline Sovereign Borrowers? Evidence from US States." *Journal of Money, Credit and Banking*, 27, 1046–59.

Bernoth, Kerstin, and Burcu Erdogan. (2012) "Sovereign Bond Yield Spreads: A Time-varying Coefficient Approach." *Journal of International Money and Finance*, 31, 639–56.

Bi, Huixin. (2012) "Sovereign Default Risk Premia, Fiscal Limits, and Fiscal Policy." *European Economic Review*, 56, 389–410.

Blanchard, Olivier Jean, and Charles M. Kahn. (1980) "The Solution of Linear difference Models under Rational Expectations." *Econometrica: Journal of the Econometric Society*, 48, 1305–11.

Bofondi, Marcello, Luisa Carpinelli, and Enrico Sette. (2017) "Credit Supply During a Sovereign Debt Crisis." *Journal of the European Economic Association*, 16, 696–729.

Bohn, Henning. (2008) "The Sustainability of Fiscal Policy in the United States." In *Sustainability of Public Debt*, edited by R. Neck and J. Sturm, pp. 15–49. Cambridge, MA: MIT Press.

Borensztein, Eduardo, and Ugo Panizza. (2009) "The Costs of Sovereign Default." *IMF Staff Papers*, 56, 683–741.

Borri, Nicola, and Adrien Verdelhan. (2011) "Sovereign Risk Premia." AFA 2010 Atlanta Meetings Paper.

Broner, Fernando A., Guido Lorenzoni, and Sergio L. Schmukler. (2013) “Why do Emerging Economies Borrow Short Term?” *Journal of the European Economic Association*, 11, 67–100.

Calvo, Guillermo A. (1983) “Staggered Prices in a Utility-Maximizing Framework.” *Journal of Monetary Economics*, 12, 383–98.

Canzoneri, Matthew, and Behzad Diba. (2005) “Interest Rate Rules and Price Determinacy: The Role of Transactions Services of Bonds.” *Journal of Monetary Economics*, 52, 329–43.

Combes, Jean-Louis, Alexandru Minea, and Moussé Sow. (2017) “Is Fiscal Policy Always Counter-(Pro-) Cyclical? The Role of Public Debt and Fiscal Rules.” *Economic Modelling*, 65, 138–46.

Corsetti, Giancarlo, Keith Kuester, André Meier, and Gernot J. Müller. (2013) “Sovereign Risk, Fiscal Policy, and Macroeconomic Stability.” *Economic Journal*, 123, F99–F132.

Daniel, Betty, and Christos Shiamptanis. (2013) “Pushing the Limit? Fiscal Policy in the European Monetary Union.” *Journal of Economic Dynamics and Control*, 37, 2307–21.

Davig, Troy, Eric M. Leeper, and Todd B. Walker. (2011) “Inflation and the Fiscal Limit.” *European Economic Review*, 55, 31–47.

De Paoli, Bianca, Glenn Hoggarth, Victoria Saporta, and Robert W. Kolb. (2011) “Output Costs of Sovereign Default.” In *Sovereign Debt: From Safety to Default*, edited by Robert W. Kolb, pp. 23–31. Hoboken, NJ: Wiley.

Debrun, Xavier, and Radhicka Kapoor. (2010) “Fiscal Policy and Macroeconomic Stability: Automatic Stabilizers Work, Always and Everywhere.” IMF Working Paper WP/10/111, International Monetary Fund.

Demirgüç-Kunt, Asli, and Harry Huizinga. (2013) “Are Banks Too Big to Fail or Too Big to Save? International Evidence from Equity Prices and CDS Spreads.” *Journal of Banking and Finance*, 37, 875–94.

Fatás, Antonio, and Ilian Mihov. (2001) “Government Size and Automatic Stabilizers: International and Intranational Evidence.” *Journal of International Economics*, 55, 3–28.

Gale, William G., and Peter R. Orszag. (2003) “Economic Effects of Sustained Budget Deficits.” *National Tax Journal*, 56, 463–85.

Galí, Jordi. (1994) “Government Size and Macroeconomic Stability.” *European Economic Review*, 38, 117–32.

Galí, Jordi, and Tommaso Monacelli. (2008) “Optimal Monetary and Fiscal Policy in a Currency Union.” *Journal of International Economics*, 76, 116–32.

Galí, Jordi, and Roberto Perotti. (2003) “Fiscal Policy and Monetary Integration in Europe.” *Economic Policy*, 18, 533–72.

Gavin, Michael, and Roberto Perotti. (1997) “Fiscal Policy in Latin America.” In *NBER Macroeconomics Annual 1997*, Vol. 12, pp. 11–72. Cambridge, MA: MIT Press.

Ghosh, Atish R., Jun I. Kim, Enrique G. Mendoza, Jonathan D. Ostry, and Mahvash S. Qureshi. (2013) “Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies.” *Economic Journal*, 123, F4–F30.

González-Rozada, Martin, and Eduardo Levy Yeyati. (2008) “Global Factors and Emerging Market Spreads.” *Economic Journal*, 118, 1917–36.

Greiner, Alfred, Uwe Koeller, and Willi Semmler. (2007) “Debt Sustainability in the European Monetary Union: Theory and Empirical Evidence for Selected Countries.” *Oxford Economic Papers*, 59, 194–218.

Hatchondo, Juan Carlos, Leonardo Martinez, and Francisco Roch. (2012) "Fiscal Rules and the Sovereign Default Premium." IMF Working Paper WP/12/30, International Monetary Fund.

Haugh, David, Patrice Ollivaud, and David Turner. (2009) "What Drives Sovereign Risk Premiums? An Analysis of Recent Evidence from the Euro Area." OECD Economics Department Working Papers 718, OECD.

Hebert, Benjamin, and Jesse Schreger. (2017) "The Costs of Sovereign Default: Evidence from Argentina." *American Economic Review*, 107, 3119–45.

Jaramillo, Laura, and Anke Weber. (2013) "Bond Yields in Emerging Economies: It Matters what State You are in." *Emerging Markets Review*, 17, 169–85.

Leeper, Eric M. (1991) "Equilibria under 'Active' and 'Passive' Monetary and Fiscal Policies." *Journal of Monetary Economics*, 27, 129–47.

Leith, Campbell, and Leopold von Thadden. (2008) "Monetary and Fiscal Policy Interactions in a New Keynesian Model with Capital Accumulation and Non-Ricardian Consumers." *Journal of Economic Theory*, 140, 279–313. http://ideas.repec.org/a/eee/jetheo/v140y2008i1p279-313.html.

Linnemann, Ludger. (2006) "Interest Rate Policy, Debt, and Indeterminacy with Distortionary Taxation." *Journal of Economic Dynamics and Control*, 30, 487–510.

Linnemann, Ludger, and Andreas Schabert. (2010) "Debt Non-Neutrality, Policy Interactions, and Macroeconomic Stability." *International Economic Review*, 51, 461–74.

Lizarazo, Sandra Valentina. (2013) "Default Risk and Risk Averse International Investors." *Journal of International Economics*, 89, 317–30.

Locarno, Alberto, Alessandro Notarpietro, and Massimiliano Pisani. (2013) "Fiscal Multipliers, Monetary Policy and Sovereign Risk: A Structural Model-Based Assessment." In *Proceedings of the Workshop: The Sovereign Debt Crisis and the Euro Area*, Vol. 15.

Longstaff, Francis A, Jun Pan, Lasse H. Pedersen, and Kenneth J. Singleton. (2011) "How Sovereign is Sovereign Credit Risk?" *American Economic Journal: Macroeconomics*, 3, 75–103.

Mendoza, Enrique G, and Jonathan D. Ostry. (2008) "International Evidence on Fiscal Solvency: Is Fiscal Policy Responsible?" *Journal of Monetary Economics*, 55, 1081–93.

Panetta, Fabio, Ricardo Correa, Michael Davies, Antonio Di Cesare, José-Manuel Marques, Francisco Nadal de Simone, Federico Signoretti, Cristina Vespro, Siret Vildo, and Martin Wieland. (2011) "The Impact of Sovereign Credit Risk on Bank Funding Conditions." CGFS Papers 43, Bank of International Settlements.

Piergallini, Alessandro. (2005) "Equilibrium Determinacy under Monetary and Fiscal Policies in an Overlapping Generations Model." *Economic Notes*, 34, 313–30.

Popov, Alexander, and Neeltje Van Horen. (2015) "The Impact of Sovereign Debt Exposure on Bank Lending: Evidence from the European Debt Crisis." *Review of Finance*, 19, 1825–66.

Remolona, Eli, Michela Scatigna, and Eliza Wu. (2007) "Interpreting Sovereign Spreads." *BIS Quarterly Review*, March, 29–39.

Remolona, Eli M, Michela Scatigna, and Eliza Wu. (2008) "The Dynamic Pricing of Sovereign Risk in Emerging Markets: Fundamentals and Risk Aversion." *Journal of Fixed Income*, 17, 57–71.

Roeger, Werner, and Jan in 't Veld. (2013) "Expected Sovereign Defaults and Fiscal Consolidations." Economic Papers 479, European Commission.

Sargent, Thomas J., and Neil Wallace. (1981) "Some Unpleasant Monetarist Arithmetic." *Federal Reserve Bank of Minneapolis Quarterly Review*, 5, 1–17.

Schabert, Andreas, and Sweder van Wijnbergen. (2014) "Sovereign Default and the Stability of Inflation Targeting Regimes." *IMF Economic Review*, 62, 261–87.

Sgherri, Silvia, and Edda Zoli. (2011) "Euro Area Sovereign Risk during the Crisis." In *Sovereign Debt: From Safety to Default*, edited by Robert W. Kolb, pp. 415–24. Hoboken, NJ: Wiley.

Sims, Christopher A. (1994) "A Simple Model for Study of the Determination of the Price Level and the Interaction of Monetary and Fiscal Policy." *Economic Theory*, 4, 381–99.

Taylor, John B. (1993) "Discretion versus Policy Rules in Practice." In *Carnegie-Rochester Conference Series on Public Policy*, Volume 39, pp. 195–214. Amsterdam: Elsevier.

Woodford, Michael. (1998) "Control of the Public Debt: A Requirement for Price Stability?" In *The Debt Burden and Its Consequences for Monetary Policy*, edited by Guillermo Calvo and Mervyn King, International Economic Association Series, pp. 117–58. London: Palgrave Macmillan.

Woodford, Michael. (2001) "Fiscal Requirements for Price Stability." *Journal of Money, Credit and Banking*, 33, 669–728.

Zoli, Edda. (2013) "Italian Sovereign Spreads: Their Determinants and Pass-Through to Bank Funding Costs and Lending Conditions." IMF Working Paper 13-84, International Monetary Fund.