Fiscal Consolidation in an Open Economy with Sovereign Premia and without Monetary Policy Independence*

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We welfare rank various tax-spending-debt policies in a New Keynesian model of a small open economy featuring sovereign interest rate premia and loss of monetary policy independence. When we compute optimized state-contingent policy rules, our results are as follows: (i) Debt consolidation comes at a short-term pain, but the medium- and long-term gains can be substantial. (ii) In the early phase of pain, the best fiscal policy mix is to cut public consumption spending to address the debt problem and, at the same time, to cut income tax rates to mitigate the recessionary effects of debt consolidation. (iii) In the long run, the best way of using the fiscal space created is to reduce capital taxes.

JEL Codes: E6, F3, H6.

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1. Introduction

Since the global crisis in 2008, and after years of deficits and rising debt levels, public finances have been at the center of attention in most euro-zone periphery countries. Although several policy proposals are under discussion, a particularly debated one is public debt consolidation.[1] Proponents claim this is for good reason: as a result of high and rising public debt, borrowing costs have increased, causing crowding-out problems and undermining government solvency. Opponents, on the other hand, claim that debt consolidation worsens the economic downturn and leads to a vicious cycle at least in the short term. At the same time, as members of the single currency, these countries cannot use an independent monetary policy.

What is the best use of fiscal policy under these circumstances? Is debt consolidation beneficial? Should the debt ratio be stabilized at its currently historically high level or should it be brought down? If brought down, how quickly? Do the answers to these questions depend on which tax–spending policy instruments are used over time?

This paper welfare ranks various fiscal policies in light of the above. The setup is a rather conventional New Keynesian model of a small open economy, where the interest rate at which the country borrows from the world capital market increases with the public debt-to-GDP ratio.[2] We focus on a monetary policy regime in which the small open economy fixes the exchange rate and loses monetary policy independence; this mimics membership in a currency union. Hence, the key national macroeconomic tool left is fiscal policy.

Then, following a rule-like approach to policy, we assume that fiscal policy is conducted via simple and implementable feedback policy rules. In particular, we assume that public spending and the tax rates on consumption, capital, and labor are all allowed to respond to the inherited public debt-to-GDP ratio, as well as to contemporaneous

[1] We will use the terms debt consolidation, fiscal adjustment, and fiscal austerity interchangeably. For a discussion of the tradeoffs faced by policymakers in the case of fiscal adjustment, see, e.g., the EEAG Report on the European Economy (European Economic Advisory Group 2014).

[2] For empirical support of this assumption, see, e.g., European Commission (2012). For the small open-economy model and various deviations from it, see Schmitt-Grohé and Uribe (2003). Further details and extensions are below.

output, as deviations from policy targets.[3] We experiment with various policy target values depending on whether policymakers aim just to stabilize the economy around its status quo or whether they also want to move the economy to a new reformed steady state. The status quo is naturally defined as the solution consistent with the euro-period data. The new reformed steady state, on the other hand, is defined as the case in which the fiscal authorities adjust their policies as much as needed so as to end up with lower debt and zero sovereign interest rate premia; we also consider the case in which the new reformed steady state is the associated Ramsey steady state. In addition, since we do not want our results to be driven by ad hoc differences in feedback policy coefficients across different policy rules, we focus on optimized ones. In other words, we compute simple and implementable policy rules that also maximize households' welfare. In particular, adopting the methodology of Schmitt-Grohé and Uribe (2004b, 2006, 2007), we compute welfare-maximizing rules by taking a second-order approximation to both the equilbrium conditions and the welfare criterion around the new reformed steady state(s).

The model is solved numerically using common parameter values and fiscal-public finance data from the Italian economy during 2001–13. We choose Italy simply because it exhibits most of the features discussed in the opening paragraph above and, at the same time, it continues to participate in the world capital market without receiving foreign aid like other euro-zone periphery countries. It thus seems a natural choice to quantify our model.

Before presenting our results, it is worth pointing out that there is no such thing as "the" debt consolidation: the implications of debt consolidation depend heavily on which policy instrument bears the cost in the early phase of austerity and on which policy instrument is anticipated to reap the benefit in the late phase, once the

[3] For empirical support of such simple rules, see, e.g., European Commission (2011). There is a rich literature on monetary and fiscal feedback policy rules that includes, e.g., Schmitt-Grohé and Uribe (2006, 2007), Kirsanova et al. (2007), Pappa and Vassilatos (2007), Batini, Levine, and Pearlman (2008), Leith and Wren-Lewis (2008), Kirsanova, Leith, and Wren-Lewis (2009), Leeper, Plante, and Traum (2009), Bi (2010), Bi and Kumhof (2011), Cantore et al. (2012), Kirsanova and Wren-Lewis (2012), Herz and Hohberger (2013), Kliem and Kriwoluzky (2014), and Philippopoulos, Varthalitis, and Vassilatos (2015).

debt burden has been reduced and fiscal space has been created.[4] The costs in the early phase are due to spending cuts and/or tax increases, while the opposite holds once fiscal space has been created. Our results (see below) confirm all this. Hence, the choice of fiscal policy instruments matters for lifetime utility and output. This choice also matters for how quickly public debt should be brought down: the more distorting are the fiscal policy instruments used during the early costly phase, the slower the speed of fiscal adjustment should be. Naturally, there is more choice when we allow for policy mixes (for instance, when the policy instrument(s) used in the early costly phase can be different from those used in the late phase of fiscal space) than when we are restricted to use a single instrument all the time.

Our main results are as follows. First, in most cases, debt consolidation is beneficial only if we are relatively far-sighted. For instance, in our baseline computations, debt consolidation is welfare-improving only after the first ten years. In other words, debt consolidation comes at a short-term loss (this loss is bigger if one uses one fiscal instrument only, instead of a fiscal policy mix). Nevertheless, once the short-term pain is over, the gains from debt consolidation get substantial over time. All this means that the argument for, or against, debt consolidation involves a value judgment. On the other hand, we find that debt consolidation is welfare-improving all the time, even in the short term, when we travel to the Ramsey steady state; but, in that steady state, the (optimal) values of the tax rates are far away from their values in the actual data.

Second, under debt consolidation, a general result is that the fiscal authorities should use all available tax–spending instruments during the early costly phase of fiscal austerity and reduce capital tax rates—which are particularly distorting—during the late phase of fiscal space. Actually, the anticipation of a reduction in capital taxes plays a key role in the recovery from fiscal austerity. During

[4]In other words, the debate about the benefits and costs of each instrument used for debt consolidation is essentially a debate about the size of the multiplier of each instrument (see the discussion in the EEAG Report on the European Economy (European Economic Advisory Group 2014)). See also, e.g., Coenen, Mohr, and Straub (2008), Leeper, Plante, and Traum (2009), and Davig and Leeper (2011) on how the impact of current policy depends on expectations of possible future policy regimes.

the early costly phase, the assignment of instruments to intermediate targets (or economic indicators) should be as follows: cut public consumption spending to address the public debt problem, and, at the same time, reduce income (capital and labor) tax rates in order to mitigate the recessionary effects of austerity. Sometimes, consumption tax rates should be also used, if changes in other taxes are restricted. The bottom line is that the choice of the fiscal policy mix is important (as also argued by Wren-Lewis 2010) and that the short-term cost becomes too big if the fiscal authorities pay attention to debt imbalances only.

Third, when we solve the model in the fictional case in which Italy would have followed an independent monetary policy (meaning that now there is also a feedback Taylor-type rule for the nominal interest rate), the main results do not change. Also, to the extent that the feedback policy coefficients, both in fiscal and monetary policy rules, are selected optimally, the welfare gain from switching to flexible exchange rates appears to be negligible, at least in this class of New Keynesian models.

What is the value added of our paper? Papers on fiscal consolidation in an open economy, which are close to ours, include Coenen, Mohr, and Straub (2008), Forni, Gerali, and Pisani (2010a, 2010b), Almeida et al. (2013), Cogan et al. (2013), Erceg and Lindé (2013), and Roeger and in 't Veld (2013).[5] But these papers a priori set the fiscal instruments through which debt consolidation is implemented or the speed/pace of this adjustment. Our work differs mainly because: (i) Following an optimized feedback rule type of approach to policy, we search for the best mix of fiscal action in an open economy facing sovereign interest rate premia and loss of monetary policy independence. In doing this, we put special emphasis on which instruments should bear the cost of consolidation in the early phase and which instruments should reap the benefits in the later phase. (ii) We study transition results depending on whether the government simply stabilizes the economy from exogenous shocks

[5]Papers on debt consolidation in a closed economy include Cantore et al. (2012), Bi, Leeper, and Leith (2013), Pappa, Sajedi, and Vella (2015), and Philippopoulos, Varthalitis, and Vassilatos (2015). Econometric studies on the effects of debt consolidation include, e.g., Perotti (1996), Alesina, Favero, and Giavazzi (2012), and Batini, Gallegari, and Giovanni (2012).

or it also leads the economy to a new reformed steady state with lower debt. (iii) We study what would have happened with monetary policy independence, other things being equal.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 presents the data, parameterization, and the status quo solution. Section 4 discusses how we work. The main results are in section 5. A rich sensitivity analysis is in section 6. Section 7 studies the case with independent monetary policy. Section 8 closes the paper. Algebraic details and additional robustness results are in an online appendix.[6]

2. Model

Consider a small open economy where the interest rate premium is debt elastic (see, e.g., Schmitt-Grohé and Uribe 2003). On other dimensions, our setup is the standard New Keynesian model of an open economy with domestic and imported goods featuring imperfect competition and Calvo-type price rigidities (see, e.g., Galí and Monacelli 2005, 2008, and Benigno and Thoenissen 2008).

The economy is composed of N identical households indexed by $i = 1, 2, \ldots, N$; of N firms indexed by $h = 1, 2, \ldots, N$, each one of them producing a differentiated domestically produced tradable good; and of monetary and fiscal authorities. Similarly, there are $f = 1, 2, \ldots, N$ differentiated imported goods produced abroad. Domestic firms are owned by domestic households and any profits are equally divided to these households. Population, N, is constant over time.

2.1 Aggregation and Prices

2.1.1 Consumption Bundles

The quantity of variety h produced by domestic firm h and consumed by domestic household i is denoted as $c^{H}_{i,t}(h)$. Using a Dixit-Stiglitz aggregator, the composite domestic good consumed by household i,

[6]The appendix is available on the IJCB website (http://www.ijcb.org).

$c^H_{i,t}$, consists of h varieties and is given by the function[7]

$$c^H_{i,t} = \left[\sum_{h=1}^{N} [c^H_{i,t}(h)]^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}, \tag{1}$$

where $\phi > 0$ is the elasticity of substitution across goods.

Similarly, the quantity of imported variety f produced abroad by foreign firm f and consumed by domestic household i is denoted as $c^F_{i,t}(f)$. Using a Dixit-Stiglitz aggregator, the composite imported good consumed by household i, $c^F_{i,t}$, consists of f varieties and is given by the function

$$c^F_{i,t} = \left[\sum_{f=1}^{N} [c^F_{i,t}(f)]^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}. \tag{2}$$

In turn, household i's consumption bundle, $c_{i,t}$, is defined as

$$c_{i,t} = \frac{\left(c^H_{i,t}\right)^{\nu}\left(c^F_{i,t}\right)^{1-\nu}}{\nu^{\nu}(1-\nu)^{1-\nu}}, \tag{3}$$

where ν is the degree of preference for domestic goods (if $\nu > 1/2$, there is a home bias).

2.1.2 *Consumption Expenditure, Prices, and Terms of Trade*

Household i's total consumption expenditure is

$$P_t c_{i,t} = P^H_t c^H_{i,t} + P^F_t c^F_{i,t}, \tag{4}$$

where P_t is the consumer price index (CPI), P^H_t is the price index of home tradables, and P^F_t is the price index of foreign tradables (expressed in domestic currency).

[7]As in, e.g., Blanchard and Giavazzi (2003), we work with summations rather than with integrals. This does not affect the results.

In turn, i's expenditures on home and foreign goods are, respectively,

$$P_t^H c_{i,t}^H = \sum_{h=1}^{N} P_t^H(h) c_{i,t}^H(h) \tag{5}$$

$$P_t^F c_{i,t}^F = \sum_{f=1}^{N} P_t^F(f) c_{i,t}^F(f), \tag{6}$$

where $P_t^H(h)$ is the price of variety h produced at home and $P_t^F(f)$ is the price of variety f produced abroad, both denominated in domestic currency.

We assume that the law of one price holds, meaning that each tradable good sells at the same price at home and abroad. Thus, $P_t^F(f) = S_t P_t^{H*}(f)$, where S_t is the nominal exchange rate (where an increase in S_t implies a depreciation) and $P_t^{H*}(f)$ is the price of variety f produced abroad denominated in foreign currency. A star denotes the counterpart of a variable or a parameter in the rest of the world. Note that the terms of trade are defined as $\frac{P_t^F}{P_t^H}$ $(=\frac{S_t P_t^{H*}}{P_t^H})$, while the real exchange rate is defined as $\frac{S_t P_t^*}{P_t}$.

2.2 Households

Each household i acts competitively to maximize expected discounted lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t U\left(c_{i,t}, n_{i,t}, g_t\right), \tag{7}$$

where $c_{i,t}$ is i's consumption bundle as defined above, $n_{i,t}$ is i's hours of work, g_t is per capita public spending, $0 < \beta < 1$ is the time preference rate, and E_0 is the rational expectations operator.

The period utility function is assumed to be of the form[8]

$$u_{i,t}\left(c_{i,t}, n_{i,t}, g_t\right) = \frac{c_{i,t}^{1-\sigma}}{1-\sigma} - \chi_n \frac{n_{i,t}^{1+\eta}}{1+\eta} + \chi_g \frac{g_t^{1-\zeta}}{1-\zeta}, \tag{8}$$

[8]See also Galí (2008), Galí and Monacelli (2008), and many others in this literature.

where χ_n, χ_g, σ, η, and ζ are standard preference parameters. That is, $1/\sigma$ is the elasticity of intertemporal subsititution and η is the inverse of Frisch labor elasticity.

The period budget constraint of each household i written in real terms is (notice that, for simplicity, we assume a cashless economy; we report that our results do not depend on this):

$$\begin{aligned}
&(1+\tau_t^c)\left[\frac{P_t^H}{P_t}c_{i,t}^H+\frac{P_t^F}{P_t}c_{i,t}^F\right]+\frac{P_t^H}{P_t}x_{i,t}+b_{i,t}\\
&\quad+\frac{S_tP_t^*}{P_t}f_{i,t}^h+\frac{\phi^h}{2}\left(\frac{S_tP_t^*}{P_t}f_{i,t}^h-\frac{SP^*}{P}f_i^h\right)^2\\
&=\left(1-\tau_t^k\right)\left[r_t^k\frac{P_t^H}{P_t}k_{i,t-1}+\widetilde{\omega}_{i,t}\right]+(1-\tau_t^n)\,w_tn_{i,t}\\
&\quad+R_{t-1}\frac{P_{t-1}}{P_t}b_{i,t-1}+Q_{t-1}\frac{S_tP_t^*}{P_t}\frac{P_{t-1}^*}{P_t^*}f_{i,t-1}^h-\tau_{i,t}^l,
\end{aligned}\tag{9}$$

where $x_{i,t}$ is i's domestic investment; $b_{i,t}$ is the real value of i's end-of-period domestic government bonds; $f_{i,t}^h$ is the real value of i's end-of-period internationally traded assets denominated in foreign currency (if negative, it denotes foreign private debt); r_t^k denotes the real return to the beginning-of-period domestic capital, $k_{i,t-1}$; $\widetilde{\omega}_{i,t}$ is i's real dividends received by domestic firms; w_t is the real wage rate; $R_{t-1}\geq 1$ denotes the gross nominal return to domestic government bonds between $t-1$ and t; $Q_{t-1}\geq 1$ denotes the gross nominal return to international assets between $t-1$ and t; $\tau_{i,t}^l$ denotes real lump-sum taxes to each household (if negative, it denotes transfers); and $0\leq\tau_t^c,\ \tau_t^k,\ \tau_t^n\leq 1$ are tax rates on consumption, capital income, and labor income, respectively. Letters without time subscripts denote steady-state values. The parameter $\phi^h\geq 0$ measures adjustment costs related to private foreign assets as a deviation from their steady-state value, f_i^h; these adjustment costs help us to avoid excess volatility and get plausible (in line with the data) short-term dynamics for private foreign assets following a policy reform; further details are in subsection 3.1 below.

The law of motion of physical capital for each household i is

$$k_{i,t}=(1-\delta)k_{i,t-1}+x_{i,t}-\frac{\xi}{2}\left(\frac{k_{i,t}}{k_{i,t-1}}-1\right)^2k_{i,t-1},\tag{10}$$

where $0 < \delta < 1$ is the depreciation rate of capital and $\xi \geq 0$ is a parameter capturing adjustment costs related to physical capital.

Details on the household's problem and the first-order conditions are in appendix 1.

2.3 Firms

Each firm h produces a differentiated good of variety h, enjoying market power on its own good and facing Calvo-type price fixities.

The profit of each firm h in real terms is (see also, e.g., Benigno and Thoenissen 2008)

$$\widetilde{\omega}_t(h) = \frac{P_t^H(h)}{P_t} y_t^H(h) - \frac{P_t^H}{P_t} r_t^k k_{t-1}(h) - w_t n_t(h). \tag{11}$$

All firms use the same technology as represented by the production function

$$y_t^H(h) = A_t [k_{t-1}(h)]^{\alpha} [n_t(h)]^{1-\alpha}, \tag{12}$$

where A_t is an exogenous stochastic total factor productivity (TFP) process whose motion is defined below and $0 < \alpha < 1$.

Profit maximization by firm h is subject to the demand for its product (see appendix 2):

$$y_t^H(h) = C_t^H(h) + X_t(h) + G_t(h) + C_t^{F*}(h) = \left[\frac{P_t^H(h)}{P_t^H}\right]^{-\phi} Y_t^H, \tag{13}$$

so demand for firm h's product, $y_t^H(h)$, comes from domestic households' consumption and investment, $C_t^H(h)$ and $X(h)$ respectively, where $C_t^H(h) = \sum_{i=1}^{N} c_{i,t}^H(h)$ and $X_t(h) = \sum_{i=1}^{N} x_{i,t}(h)$, from the domestic government, denoted as $G_t(h)$, and from foreign households' consumption, $C_t^{F*}(h) = \sum_{i=1}^{N*} c_{i,t}^{F*}(h)$, and where Y_t^H denotes aggregate demand.

In addition, firms are subject to a Calvo-type pricing mechanism. In particular, in each period, each firm h faces an exogenous probability θ of not being able to reset its price. A firm h, which is able to reset its price at time t, chooses its price $P_t^{\#}(h)$ to maximize the sum of discounted expected nominal profits for the next k periods in which it may have to keep its price fixed. This objective is

$$E_t \sum_{k=0}^{\infty} \theta^k \Xi_{t,t+k} \left\{ P_t^{\#}(h)\, y_{t+k}^H(h) - \Psi_{t+k}\left(y_{t+k}^H(h)\right) \right\},$$

where $\Xi_{t,t+k}$ is a discount factor taken as given by the firm (but it equals the household's intertemporal marginal rate of substitution in consumption, in equilibrium), $y_{t+k}^H(h) = \left[\frac{P_t^{\#}(h)}{P_{t+k}^H}\right]^{-\phi} Y_{t+k}^H$ as said above, and $\Psi_t(h)$ is the minimum nominal cost function for producing $y_t^H(h)$ at t so that $\Psi_t'(h)$ is the associated nominal marginal cost.

Details on the firm's problem and the first-order conditions are in appendix 2.

2.4 Government Budget Constraint

The period budget constraint of the government in real and per capita terms is (details are in appendix 3)

$$\begin{aligned} d_t = {} & R_{t-1}\frac{P_{t-1}}{P_t}\lambda_{t-1}d_{t-1} + Q_{t-1}\frac{S_t P_t^*}{P_t}\frac{P_{t-1}^*}{P_t^*}\frac{P_{t-1}}{P_{t-1}^* S_{t-1}}(1-\lambda_{t-1})\,d_{t-1} \\ & + \frac{P_t^H}{P_t}g_t - \tau_t^c\left(\frac{P_t^H}{P_t}c_t^H + \frac{P_t^F}{P_t}c_t^F\right) - \tau_t^k\left(r_t^k\frac{P_t^H}{P_t}k_{t-1} + \widetilde{\omega}_t\right) \\ & - \tau_t^n w_t n_t - \tau_t^l + \frac{\phi^g}{2}[(1-\lambda_t)\,d_t - (1-\lambda)\,d]^2, \end{aligned} \tag{14}$$

where d_t is the real and per capita value of end-of-period total public debt. Thus, total nominal public debt, D_t, can be held by domestic private agents, $\lambda_t D_t$, as well as by foreign private agents, $(1-\lambda_t)\,D_t$, where the fraction $0 \le \lambda_t \le 1$ is exogenously given.[9] The parameter

[9]Public debt differs from foreign debt. The end-of-period public debt, written in total nominal terms, is $D_t = B_t + S_t F_t^g$, where $B_t = \lambda_t D_t = \sum_{i=1}^N B_{i,t}$ is domestic government bonds held by domestic agents and $S_t F_t^g = (1-\lambda_t)\,D_t$ denotes domestic government bonds held by foreign investors. On the other hand, the country's end-of-period net foreign debt, written in total nominal terms, is $S_t(F_t^g - F_t^h) = (1-\lambda_t)\,D_t - S_t F_t^h$, where $F_t^h = \sum_{i=1}^N F_{i,t}^h$ is nominal foreign

$\phi^g \geq 0$ measures adjustment costs related to public foreign debt; these costs are similar to those of the household in equation (9) above (further details are in subsection 2.7 below).

In each period, one of (τ_t^c, τ_t^k, τ_t^n, g_t, τ_t^l, λ_t, d_t) needs to adjust to satisfy the government budget constraint (see subsection 2.7 below).

2.5 Closing the Model: Debt-Elastic Interest Rate Premium

As is well known, to avoid non-stationarity and convergence to a well-defined steady state, we have to depart from the benchmark small open-economy model (see Schmitt-Grohé and Uribe 2003 for alternative ways). Here, we do so by endogenizing the interest rate faced by the domestic country when it borrows from the world capital market, Q_t.[10] In particular, we start by assuming that the country premium between t and $t+1$, namely $Q_t - Q_t^*$, is an increasing function of the end-of-period total nominal public debt as share of nominal GDP, $\frac{D_t}{P_t^H Y_t^H}$, when this share exceeds a certain threshold. In the robustness section below, we will also study the case where the country premium is increasing in the country's net foreign liabilities or debt.[11]

In particular, following, e.g., Schmitt-Grohé and Uribe (2003) and García-Cicco, Pancrazi, and Uribe (2010), we use

$$Q_t = Q_t^* + \psi \left(e^{\left(\frac{D_t}{P_t^H Y_t^H} - \bar{d} \right)} - 1 \right), \tag{15}$$

assets held by domestic agents (if negative, it denotes liabilities). As said, further details are in appendix 3. Note that, by focusing on a single open economy, we do not model the behavior of foreign investors, so we treat $0 \leq \lambda_t \leq 1$ as exogenous.

[10]See also García-Cicco, Pancrazi, and Uribe (2010), Christiano, Trabandt, and Walentin (2011), and many others for endogenous country premia. Note that although endogeneity of the country premium is also used by the literature on sovereign default, the study of the latter is beyond the scope of our paper. As Corsetti et al. (2013) point out, there are two approaches to sovereign default. The first models it as a strategic choice of the government (Eaton and Gersovitz 1981, Arellano 2008, and many others). The second assumes that default occurs when debt exceeds its endogenous limit (Bi 2012 and many others).

[11]As said above, this rather common assumption (namely, that the interest rate at which the country borrows from the rest of the world is increasing in public and/or foreign debt) is supported by a number of empirical studies (see, e.g., European Commission 2012).

where the world interest rate, Q_t^*, is exogenously given, $\overline{d}$ is an exogenous threshold value above which the interest rate on government debt starts rising above Q_t^*, and the parameter ψ measures the elasticity of the interest rate with respect to deviations of total public debt from its threshold value (see subsection 3.1 below for these parameter values).[12]

2.6 Exchange Rate and Fiscal Policy Regimes

To solve the model, we need to specify the exchange rate and the fiscal policy regimes. Concerning exchange rate policy, since the model is applied to Italy over the last decade, we solve it for a case without monetary policy independence. In particular, we assume that the nominal exchange rate, S_t, is exogenously set and, at the same time, the domestic nominal interest rate on domestic government bonds, R_t, becomes an endogenous variable.[13] Concerning fiscal policy, we assume that, along the transition, the residually determined public financing policy instrument is the end-of-period total public debt, D_t (see below for other public financing cases at the steady state).

Before we turn to fiscal policy rules in the next subsection, it is worth clarifying that, along the transition path, nominal rigidities imply that money is not neutral so that monetary policy, and the exchange rate regime in particular, matters to the real economy.

2.7 Fiscal Policy Rules

Without room for monetary policy independence, only fiscal policy can be used for policy action. In this paper, we follow a rule-like approach to policy. We focus on simple rules, meaning that the fiscal authorities react to a small number of easily observable macroeconomic indicators capturing the current state of the economy.

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[12]The value of $\overline{d}$ can be thought of as any value of debt above which sustainability concerns start arising. As we discuss below in subsections 3.1 and 6.1, our qualitative results are robust to the exact value of $\overline{d}$ used, to the extent that each time, the value of ψ is recalibrated.

[13]This is similar to the modeling of, e.g., Erceg and Lindé (2012). Recall that in the case of flexible or managed floating exchange rates, S_t and R_t switch positions, in the sense that S_t becomes an endogenous variable, while R_t is used as a policy instrument usually assumed to follow a Taylor-type rule for the nominal interest rate (see section 7 below).

The magnitude of reaction coefficients (namely, how fiscal policy instruments respond to macroeconomic indicators) will be chosen optimally.

Specifically, we allow the main spending–tax policy instruments (namely, government spending as share of output, s_t^g, and the tax rates on consumption, capital income, and labor income, τ_t^c, τ_t^k, and τ_t^n)[14] to react to the ratio of public liabilities to GDP as a deviation from a target value, $(l_{t-1} - l)$, as well as to the contemporaneous output gap, $\left(y_t^H - y^H\right)$, according to the simple linear rules[15]

$$s_t^g - s^g = -\gamma_l^g \left(l_{t-1} - l\right) - \gamma_y^g \left(y_t^H - y^H\right) \tag{16}$$

$$\tau_t^c - \tau^c = \gamma_l^c \left(l_{t-1} - l\right) + \gamma_y^c \left(y_t^H - y^H\right) \tag{17}$$

$$\tau_t^k - \tau^k = \gamma_l^k \left(l_{t-1} - l\right) + \gamma_y^k \left(y_t^H - y^H\right) \tag{18}$$

$$\tau_t^n - \tau^n = \gamma_l^n \left(l_{t-1} - l\right) + \gamma_y^n \left(y_t^H - y^H\right), \tag{19}$$

where, from the government budget constraint in subsection 2.4, l_{t-1} is defined as

$$l_{t-1} = \frac{R_{t-1}\lambda_{t-1}d_{t-1} + Q_{t-1}\frac{S_t}{S_{t-1}}(1-\lambda_{t-1})d_{t-1}}{\frac{P_{t-1}^H}{P_{t-1}}y_{t-1}^H}$$

and where, in the above rules, l_t, y_t^H, and d_t are written in real and per capita terms, variables without time subscripts denote policy target values, and γ_l^q, $\gamma_y^q \geq 0$ for $q \equiv (g, c, k, n)$ are feedback policy coefficients on public debt to GDP and output targets, respectively. The rest of the fiscal policy instruments (namely, lump-sum government tranfers as share of output, denoted as s_t^l, and the share of domestic public debt in total public debt, λ_t) are assumed to be constant over time and equal to their average values in the data (see subsection 2.8 below).

[14] We focus on "distorting" policy instruments, because using lump-sum instruments (such as τ_t^l in our model) to bring public debt down would be like a free lunch.

[15] For similar rules, see, e.g., Schmitt-Grohé and Uribe (2007), Bi (2010), and Cantore et al. (2012). As said above, see European Commission (2011) for similar fiscal reaction functions used in practice. On the other hand, see Kliem and Kriwoluzky (2014) for a critical approach.

Notice that, in the above rules, a policy target value (such as s^g, τ^c, τ^k, τ^n, l, y^H) will be the steady-state value of the corresponding variable. This value will depend on whether we are in the status quo economy or in a reformed economy. For example, as further discussed in section 4 below, the debt policy target, l, can be either the average public-debt-to-GDP ratio in the data (this will be the benchmark case without reforms where fiscal policy adjusts so as to keep the public debt ratio at its average value) or it can be set to a value less than in the data (this will be the case of debt consolidation where fiscal policy systematically brings public debt down over time).

Also, keep in mind that below we will also allow for persistence in policy instruments, as well as for the case in which the debt policy target is not fixed but follows an $AR(1)$ rule (see section 6 below).

2.8 Exogenous Variables and Shocks

In this subsection, we define the exogenous variables and, among them, the exogenous stochastic processes that drive extrinsic fluctuations in our model.

We assume that foreign imports or, equivalently, domestic exports, c_t^{F*}, are a function of terms of trade, $TT_t \equiv \frac{P_t^F}{P_t^H}$, where both variables are expressed as deviations from their steady-state values:

$$\frac{c_t^{F*}}{c^{F*}} = \left(\frac{TT_t}{TT}\right)^{\gamma}, \tag{20}$$

where $0 < \gamma < 1$ is a parameter. The idea is that foreign imports rise as the domestic economy becomes more competitive (the value of the exogenous c^{F*} is specified in the calibration subsection 3 below).

Regarding the other rest-of-the-world variables, namely, the exogenous part of the foreign interest rate, Q_t^*, and the gross rate of domestic inflation in the foreign country, $\Pi_t^{H*} = \frac{P_t^{H*}}{P_{t-1}^{H*}}$, we assume that they are constant over time and equal to $Q_t^* = 1.0115$ (which is the data average value—see below) and $\Pi_t^{H*} \equiv 1$ at all t.

Regarding the exogenously set policy instruments, we set the nominal exchange rate S_t at 1 (under fixed exchange rates), while the output share of government tranfers, s_t^l, and the fraction of domestic public debt in total public debt, λ_t, are set at their data average values at all t (see subsection 3.1 below).

Finally, in the main part of the paper, stochasticity comes from shocks to TFP, which follows:

$$\log(A_t) = (1-\rho^a)\log(A) + \rho^a \log(A_{t-1}) + \varepsilon_t^\alpha, \tag{21}$$

where $0 < \rho^a < 1$ is a parameter, $\varepsilon_t^a \sim N\left(0, \sigma_a^2\right)$, and, as said above, variables without time subscript denote steady-state values. As we report below in section 6, our main results do not change when we add extra shocks, such as shocks to the world interest rate.

2.9 Decentralized Equilibrium (for Any Feasible Policy)

We now combine all the above equations to present the decentralized equilibrium (DE) which is for any feasible policy. The DE is defined to be a sequence of allocations, prices, and policies such that (i) households maximize utility; (ii) a fraction $(1-\theta)$ of firms maximize profits by choosing an identical price defined as $P_t^{\#}$, while a fraction θ just set prices at their previous period level; (iii) all constraints, including the government budget constraint and the balance of payments, are satisfied; (iv) markets clear; and (v) policymakers follow the feedback rules assumed in subsection 2.7. This DE is given the values of feedback policy coefficients in the policy rules (16)–(19); the exogenous variables, $\{c_t^{F*}, Q_t^*, \Pi_t^{H*}, \epsilon_t,\ s_t^l,\ \lambda_t, A_t\}_{t=0}^{\infty}$, which have been defined in subsection 2.8; and initial conditions for the state variables.

We thus end up with a first-order non-linear dynamic system of thirty-two equations. Algebraic details, the final equilibrium system, and the associated steady state (also used for calibration) are in appendix 4.

2.10 Solution Methodology

We will work as follows. In the next section (section 3), we solve the above model numerically, employing parameter values and data in accordance with the Italian economy over 2001–13. As we shall see, the steady-state solution of this model economy will do well at mimicking the output shares of key macroeconomic variables observed in the Italian data since 2001; hence, we will call it the "status quo steady state." In turn, the next sections will study the transition dynamics, when we depart from this status quo steady state and travel to a new reformed steady state (the latter is defined in section 4.1 below). To compute the transition dynamics, driven by policy reforms (such as debt consolidation policies) and/or exogenous stochastic proccesses (such as TFP shocks), we will take a second-order aproximation of the stochastic problem around the deterministic new reformed steady state.[16] In all policy experiments, the feedback coefficients in the policy rules are computed optimally to maximize the household's welfare.

Further details on the reformed economy and the computational methodology are in section 4 below. The quantitative implementation is in sections 5 and 6. But we first need to solve for the status quo steady state. This is in the next section.

3. Data, Parameterization, and the Status Quo Steady State

This section parameterizes the above model economy using average data from Italy over 2001–13 (the exact end period for each variable may vary depending on data availability) and then presents the resulting steady-state solution. As said, the latter will then serve as a point of departure to study policy reforms.

3.1 Data and Parameter Values

The data are from Eurostat over 2001–13 (in the case of TFP, the data source is Ameco over 1980–2014). The time unit is meant to be a year. In calibrating the model, we assume that the economy is in

[16]A potential criticism might be that an approximate solution might not be reliable because we approximate the equilibrium equations around a new steady state different from the initial one. To address this issue, we have also solved a deterministic version of the model using non-linear, or non-approximate, numerical methods. This means that we repeat the equilibrium equations in each time period until the economy converges to a steady-state position where variable changes are negiligible. We use Dynare for these computations. The key results, namely, the optimal policy mix during the transition, do not change.

the deterministic steady state of the decentralized equilibrium presented above with zero inflation (see appendix 4 for the steady-state system). Recall that, since policy instruments react to deviations of macroeconomic indicators from their steady-state values, feedback policy coefficients do not play any role at the steady state.

The baseline parameter values, as well as the values of the fiscal policy variables, are listed in table 1. As reported in detail in section 6, our results are robust to changes in these parameter values.

The value of the time preference rate, β, follows from setting the gross interest rate at $R = Q = 1.0225$ (the latter is consistent with an interest rate premium of 1.1 percent over the German ten-year bond rate, which is the average value in the data, and with a gross inflation rate equal to one at the steady state).

The value of a implies a labor share, $(1-a)$, equal to 0.62, which is the average value in the Italian data over 2001–13. We employ conventional parameter values, as used by the literature, for the elasticity of intertemporal substitution, $1/\sigma$, the inverse of Frisch labor elasticity, η, and the price elasticity of demand, ϕ, which are as in, e.g., Andrès and Doménech (2006) and Galí (2008). Regarding the preference parameters in the utility function, χ_n is calibrated from the household's labor supply condition, while χ_g is set at 0.1. The price rigidity parameter, θ, is set at 0.5. The value of γ, in equation (20) for foreign imports, is set at 0.9.

In our baseline parameterization, the threshold parameter value of the public-debt-to-GDP ratio above which sovereign interest rate premia emerge, $\overline{d}$, is set at 0.9 (see equation (15)). This value is consistent with evidence provided by, e.g., Reinhart and Rogoff (2010) and Checherita-Westphal and Rother (2012) that, in most advanced economies, the adverse effects of public debt arise when it is around 90–100 percent of GDP. It is also within the range of thresholds for sustainable public debt estimated by the European Commission (2011). In turn, the associated premium parameter, ψ, is calibrated by using equation (15). In other words, assuming a value for the parameter $\overline{d}$, and using data averages over the sample period for the interest rate premium and the ratio of public debt to GDP, the value of ψ follows from equation (15). In our baseline parameterization, the resulting value of ψ is 0.0505, which means that a 1 percentage point increase in the debt-to-GDP ratio leads to an increase in the interest rate premium by 5.05 basis points. Such values are in

Table 1. Baseline Parameter Values and Policy Variables

Parameter	Value	Description
a	0.38	Share of Capital
β	0.9708	Rate of Time Preference
ν	0.5	Home Goods Bias Parameter at Home
δ	0.04	Rate of Capital Depreciation
ϕ	6	Price Elasticity of Demand
η	1	Inverse of Frisch Labor Elasticity
σ	1	Elasticity of Intertemporal Substitution
ν^*	0.5	Home Goods Bias Parameter Abroad
θ	0.5	Price Rigidity Parameter
ψ	0.0505	Interest Rate Premium Parameter
χ_n	3.66	Preference Parameter Related to Work Effort
χ_g	0.1	Preference Parameter Related to Public Spending
$\overline{d}$	0.9	Threshold Parameter of Public Debt as Share of Output
ρ^a	0.9479	Persistence of TFP (1980–2014)
σ_a	0.007636	Standard Deviation of TFP (1980–2014)
γ	0.9	Terms of Trade Elasticity of Foreign Imports
ξ	0.3	Adjustment Cost Parameter on Physical Capital
ϕ^g	0.3	Adjustment Cost Parameter on Foreign Public Debt
ϕ^h	0.3	Adjustment Cost Parameter on Private Foreign Assets/Debt
τ^c	0.1756	Consumption Tax Rate
τ^k	0.3118	Capital Tax Rate
τ^n	0.421	Labor Tax Rate
s^g	0.2222	Government Spending on Goods/Services as Share of GDP
s^l	0.2326	Government Transfers as Share of GDP
λ	0.64	Fraction of Total Public Debt Held by Domestic Agents
$\frac{c^{F*}}{c^F}$	1.01	Exports-to-Imports Ratio

line with empirical findings for OECD countries (see, e.g., Ardagna, Caselli, and Lane 2008). As reported in subsection 6.1 below, our results are robust to changes in $\overline{d}$, to the extent that each time we recalibrate ψ.

The parameters ϕ^h and ϕ^g, measuring adjustment costs associated with changes in private and public foreign assets, respectively (see equations (9) and (14)), are both set to 0.3. As mentioned above, this value gives plausible short-run dynamics for private foreign assets and, in turn, for the country's net foreign debt following a policy reform. Robustness checks for both ϕ^h and ϕ^g are reported in subsection 6.1 below. We also report that a positive value for ϕ^h is needed to give bounded solutions for the welfare when we compute optimized feedback policy rules below. Similarly, the value of ξ measuring capital adjustment costs is set equal to 0.3.

Concerning the exogenous variables, the persistence and standard deviation parameters in the TFP process (21) are set at $\rho^a = 0.9479$ and $\sigma_a = 0.007636$. These values have been estimated by running simple regressions using Ameco data for total factor productivity. As reported below, our results are robust to changes in these parameter values. Regarding the rest-of-the world variables, Π_t^{H*}, Q_t^*, and c_t^{F*}, we set their steady-state values equal to $\Pi^{H*} \equiv 1, Q^* = 1.0115$ (which is the data average) and $\frac{c^{F*}}{c^F} = 1.01$ (which is the ratio of exports to imports in the Italian data).

The steady-state values of fiscal and public finance policy instruments, τ_t^c, τ_t^k, τ_t^n, s_t^g, s_t^l, and λ_t are set at their data averages. In particular, τ^c, τ^k, and τ^n are the effective tax rates on consumption, capital, and labor in the data over 2001–13. Moreover, s^g and s^l, namely, government spending on goods/services and on transfer payments as shares of output, are set at their average values in the data, 0.2222 and 0.2326, respectively. Finally, λ, the fraction of total public debt held by domestic private agents is set at 0.64, which is again its average value in the data during the same period.

3.2 Status Quo Steady State

The steady-state system is in appendix 4. Table 2 presents the numerical solution of this system when we use the parameter values and policy instruments in table 1. In this solution, we treat public debt, d, as the residually determined public financing instrument. In

Table 2. Status Quo Steady-State Solution

Variables	Description	Steady-State Solution	Data
u	Period Utility	0.8217	—
r^k	Real Return to Physical Capital	0.0908	—
w	Real Wage Rate	1.11378	—
n	Hours Worked	0.331281	0.2183
y^H	Output	0.712326	—
TT	Terms of Trade	0.994923	—
$Q-Q^*$	Interest Rate Premium	0.011	0.011
$\frac{TT^{1-\nu}c}{y^H}$	Consumption as Share of GDP	0.6335	0.5961
$\frac{k}{y^H}$	Physical Capital as Share of GDP	3.4872	—
$\frac{TT^{\nu^*}f^h}{y^H}$	Private Foreign Assets as Share of GDP	0.1813	0.1039
$\frac{TT^{1-\nu}d}{y^H}$	Total Public Debt as Share of GDP	1.0965	1.098
$\widetilde{f}$	Country's Net Foreign Debt as Share of GDP	0.2134	0.2109

table 2, we also present some key ratios in the Italian data. Notice that most of the solved ratios, produced endogenously by the model, are meaningful and close to their actual values. For instance, the solution for the country's net foreign debt as share of GDP (denoted as $\widetilde{f}$)[17] is 0.2134; its average value in the data is 0.2109. Also, the solution for total public debt as share of GDP[18] is 1.0965; its average value in the data is 1.098.

In what follows, this steady-state solution will serve as a point of departure to study various policy experiments. Before we move on to reforms, it is worth pointing out that, in the above model, a lower public debt implies a lower sovereign premium, and this

[17] Thus, $\widetilde{f} \equiv \frac{S_t(F_t^g - F_t^h)}{P^H Y^H} = \frac{(1-\lambda_t)D_t - S_t F_t^h}{P_t^H Y_t^H} = \frac{(1-\lambda)TT^{1-\nu}d - TT^{\nu^*}f^h}{y^H}$, where $TT_t \equiv \frac{P_t^F}{P_t^H}$ is the terms of trade. Details are in appendix 4.

[18] This is $\frac{D}{P^H Y^H} \equiv \frac{TT^{1-\nu}d}{y^H}$, where $TT_t \equiv \frac{P_t^F}{P_t^H}$ is the terms of trade. Details are in appendix 4.

leads to higher capital, higher output, and higher welfare; this can rationalize the debt consolidation policies studied in what follows.

4. Description of Policy Experiments

In this section, we define the policy reform studied, how we model debt consolidation, and how we compute optimized feedback policy rules.

4.1 Definition of the Reformed Economy

The main experiment we want to consider in this paper is the case in which the economy departs from the status quo and travels over time to a new reformed state with lower debt. Regarding the status quo, this is provided by the steady-state solution of the model economy calibrated and solved numerically in the previous section (see tables 1 and 2). Regarding the new reformed steady state, this is defined as the case in which the ratio of public debt to GDP is permanently reduced, so that there are no sovereign interest rate premia in the new steady state. In other words, in the new reformed steady state, we set $Q = Q^*$ so that $\frac{TT^{1-\nu}d}{y^H} = \overline{d}$. Specifically, the government reduces the output share of public debt from 1.0965 (which is the status quo solution) to the threshold value of $\overline{d} = 0.9$ corresponding with zero premia. To put it differently, since, in our model, sovereign premia arise whenever the ratio of public debt to output happens to be above the 0.9 threshold, premia are eliminated ($Q = Q^*$) once such debt reduction has been achieved. As said above, we will conduct robustness exercises for the values of the exogenously set threshold, $\overline{d}$. Also, again as a robustness check, we will consider the case in which the new reformed steady state is the Ramsey steady state, meaning that the policy targets are the Ramsey steady-state values.

In addition, we assume that, in the new reformed steady state, the country's net foreign debt position is zero or, equivalently, that the country ends up with a balanced trade.[19] In other words, in the

[19]For a similar practice (namely, to assume a zero net foreign debt position in the steady state and then check its robustness), see, e.g., Mendoza and Tesar (2005).

new reformed steady state, we set the country's net foreign debt as share of output to zero, $\widetilde{f} = 0$. This means that the country's net foreign debt as share of output is permanently reduced from 0.2134 (which is the status quo solution) to zero. Note that this assumption is not important to our qualitative results (its robustness is checked in subsection 6.1 below) but, if the foreign position of the country is left free in the long run with relatively low interest rates ($Q = Q^*$), private agents have an incentive to overborrow and this leads to unrealistically high values of private foreign debt, $f^h < 0$.

Details of the equilibrium conditions of the reformed economy, the steady state implied by these conditions, as well as numerical solutions of the reformed steady state under unrestricted or restricted $\widetilde{f}$, and under alternative public financing scenarios, are provided in appendix 5.

4.2 Public Debt Consolidation and the Intertemporal Tradeoff

It is widely recognized that debt consolidation implies a tradeoff between short-term fiscal pain and medium-term fiscal gain. In our model, during the early phase of the transition, debt consolidation comes at the cost of higher taxes and/or lower public spending. On the other hand, in the medium and long run, a reduction in the debt burden allows, other things being equal, a cut in tax rates and/or a rise in public spending. Thus, one has to value the early costs of stabilization vis-à-vis the medium- and long-term benefits from the fiscal space created.

This intertemporal tradeoff also implies that the implications of consolidation depend heavily on the public financing policy instruments used, namely, which policy instrument adjusts endogenously to accommodate the exogenous change in fiscal policy (see also, e.g., Leeper, Plante, and Traum 2009, and Davig and Leeper 2011). Specifically, these implications depend both on which policy instrument bears the cost of adjustment in the early period of adjustment and on which policy instrument is anticipated to reap the benefit once consolidation has been achieved. In the policy experiments we consider below, we experiment with fiscal policy mixes, which means that the fiscal authority can use various instruments in the transition and in the steady state. Details are in subsection 5.3 below.

4.3 The Reformed Economy vs. a Reference Regime

To evaluate the implications of debt consolidation as defined in subsection 4.1 above, we need to compare them with a reference regime. Here, we find it natural to use as reference regime the case without debt consolidation, other things being equal. In other words, we will study two scenaria regarding policy action. The first, used as a reference, is the scenario without debt consolidation. Here, the role of policy is only to stabilize the economy against shocks. For instance, say that the economy is hit by an adverse temporary TFP shock, which, as the impulse response functions reveal, produces a contraction in output, a rise in the ratio of public debt to output, and a rise in the sovereign premium. Then, the policy questions are which policy instrument to use and how strong the reaction of policy instruments to deviations from targets should be, in order to maximize household's welfare criterion. Note that, in this case, the values of the policy targets in the feedback rules (16)–(19) are given by the status quo steady-state solution. In other words, in this policy scenario, we depart from, and end up at, the status quo steady-state solution of subsection 3.2 above, so that transition dynamics are driven by exogenous shocks only.

The scenario with debt consolidation is richer. Now the role of policy is twofold: to stabilize the economy against the same shocks as above and, at the same time, to improve resource allocation by gradually reducing the debt-to-GDP ratio over time as defined in subsection 4.1. The policy questions are as above in the reference regime, except that now the policy targets in the feedback rules (16)–(19) are given by the steady-state solution of the new reformed economy. In other words, in this case, we depart from the status quo solution with sovereign premia, but we end up at a new reformed steady state with lower (public and foreign) debt. Thus, now there are two sources of transition dynamics: temporary shocks and the deterministic difference between the initial and the new reformed long run (see also Cantore et al. 2012).

4.4 Computational Methodology

Irrespectively of the policy experiments studied, to make the comparison of different policy regimes meaningful, we compute optimized policy rules, so that our results do not depend on ad hoc differences in feedback policy coefficients across different policy rules. The welfare criterion is the household's expected discounted lifetime utility (see equations (7)–(8) above).

We work as follows: First, we take a second-order approximation of the equilibrium conditions, as well as of household's expected discounted lifetime utility, around the deterministic reformed steady state (see appendix 5 for the latter).[20] This is a function of feedback policy coefficients in the policy rules and initial values for the state variables. Secondly, we select the feedback policy coefficients so as to maximize the conditional mean of household's expected discounted lifetime utility, where conditionality refers to the initial conditions chosen; the latter are given by the status quo steady-state solution (see subsection 3.2 above). Thus, the initial values of the endogenous and exogenous predetermined variables are set equal to their status quo values. If necessary, the ranges of the feedback policy coefficients or, equivalently, the values of the policy instruments themselves will be restricted to give determinate solutions and/or meaningful values for policy instruments (e.g., tax rates less than one and non-negative nominal interest rates). All this is similar to Schmitt-Grohé and Uribe (2004b, 2006, 2007).[21] As said above, we work similarly in the case without debt consolidation (where we depart from, and return to, the same status quo steady state), which serves as a reference regime.

5. Macroeconomic Implications of Fiscal Consolidation

In this section, we present the main results. The emphasis will be on the case of the reformed economy as defined in subsection 4.1

[20]Thus, we take a second-order approximation to both the equilibrium conditions and the welfare criterion. As is known, this is consistent with risk-averse behavior on the part of economic agents and can also help us to avoid possible spurious welfare results that may arise when one takes a second-order approximation to the welfare criterion combined with a first-order approximation to the equilibrium conditions (see, e.g., Gali 2008 and Benigno and Woodford 2012).

[21]Specifically, to compute a second-order accurate approximation of both the conditional welfare and the decentralized equilbrium, as functions of feedback policy coefficients, we use the perturbation method of Schmitt-Grohé and Uribe (2004b). In turn, we use a MATLAB function (such as fminsearch.m) to compute the values of the feedback policy coefficients that maximize this approximation.

Table 3. Steady-State Utility and Output in the Reformed Economy

Residual Fiscal Instrument	Steady-State Utility	Steady-State Output
s^g	0.9125	0.82367
τ^c	0.9227	0.82367
τ^k	0.9311	0.834774
τ^n	0.9290	0.83139
s^l	0.9180	0.817941

above, but, for reasons of comparison, we will also present results for the reference case without debt consolidation. Recall that in the case of debt consolidation, transition dynamics are driven both by a temporary supply shock and by deterministic changes in fiscal policy instruments aiming at debt reduction and elimination of the sovereign premium over time.

5.1 Steady-State Utility and Output in the Reformed Economy

The steady state of the reformed economy with debt consolidation is as defined in the previous section, while details are in appendix 5. Thanks to the fiscal space created by debt reduction, public spending can rise or a tax rate can be reduced residually.

Table 3 summarizes steady-state utility and output under alternative public financing scenarios in this reformed economy (for the full numerical solutions, see appendix 5). In the first row of table 3, the assumption is that it is public spending that takes advantage of debt reduction, in the sense that, once the debt burden has been reduced, public spending can increase relative to its value in the status quo solution. In the next three rows, the fiscal space is used to finance cuts in one of the three tax rates. The last row reports, for comparison, the case in which it is lump-sum tranfers, s^l, that rise. The best outome (both in terms of utility and output) is achieved when the fiscal space is used to finance a cut in capital tax rates. This is as expected and is consistent with the Chamley-Judd normative result. Therefore, in what follows, we will use the capital tax rate, τ^k, as the residually determined fiscal policy instrument in the steady state of the reformed economy with debt consolidation.

5.2 Determinacy and Bounds on Policy Coefficients

As is known, local determinacy, or implementability, depends crucially on the values of feedback policy coefficients in the rules (16)–(19) above. This is also the case in our model. Our experiments show that economic policy can ensure determinacy when at least one of the fiscal policy instruments (s_t^g, τ_t^c, τ_t^k, τ_t^n) reacts to public liabilities between critical minimum and maximum values, where these bounds vary depending on which fiscal policy instrument is used. In other words, determinacy requires restrictions on the magnitude of γ_l^q, where $q \equiv (g, c, k, n)$.[22] By contrast, the values of γ_y^q, measuring the reaction of fiscal policy instruments to the output gap, are not found to be critical to determinacy.

Nevertheless, although not important for determinacy, we set bounds on the feedback reaction of the capital tax rate to the output gap, γ_y^k, so that the implied capital tax rate is within $0.11 < \tau_t^k < 0.51$ in the transition. In other words, since the average value of τ_t^k in the data is 0.31, we limit attention to changes in τ_t^k that are less than minus/plus 20 percentage points than in the data. We set these bounds because if the capital tax rate were left unrestricted, the policymaker would find it optimal to set it at a very low value, as one would expect given the Chamley-Judd logic. Our bounds exclude this possibility. Note that such practice is usual in the related literature; for instance, when they compute optimized rules, Schmitt-Grohé and Uribe (2007) and Kliem and Kriwoluzky (2014) impose similar intervals for monetary and fiscal policy, respectively.

5.3 Optimal Fiscal Policy Mix

We can now study optimal policy mixes when we depart from the status quo steady state and travel towards the reformed steady state

[22]For example, when we use one fiscal instrument at a time, the ranges of fiscal reaction to public liabilities are $0.027 < \gamma_l^g < 2.72$, $0.048 < \gamma_l^c < 4.34$, $0.064 < \gamma_l^k < 2.96$, and $0.063 < \gamma_l^n < 1.56$ for s_t^g, τ_t^c, τ_t^k, and τ_t^n, respectively. When we switch on all fiscal instruments, these ranges become narrower.

Table 4. Optimal Fiscal Reaction to Debt and Output with Debt Consolidation

Fiscal Instruments	Optimal Reaction to Debt	Optimal Reaction to Output
s_t^g	$\gamma_l^g = 0.5009$	$\gamma_y^g = 0$
τ_t^c	$\gamma_l^c = 0$	$\gamma_y^c = 0$
τ_t^k	$\gamma_l^k = 0.0031$	$\gamma_y^k = 2.2569$
τ_t^n	$\gamma_l^n = 0.0753$	$\gamma_y^n = 2.1360$

Notes: (i) τ_t^k is the residual instrument at the reformed steady state. (ii) At all t, $R_t \geq 1$, $0 < s_t^g, \tau_t^c, \tau_t^k, \tau_t^n < 1$. (iii) Restriction on γ_y^k so as $0.11 < \tau_t^k < 0.51$. (iv) Lifetime utility $V_0 = 79.9864$.

as defined in subsection 4.1 above. Policymakers are allowed to use different instruments in the transition and in the steady state.[23] In particular, in the reformed steady state, given the evidence in table 3, we assume that it is the capital tax rate that takes advantage of the fiscal space created once the debt burden has been reduced and sovereign premia have been eliminated; as said, a cut in the capital tax rate is the most efficient way of using this fiscal space. On the other hand, in the transition to this reformed steady state, all available fiscal instruments, and at the same time, are allowed to be used, as in the policy rules (16)–(19). Since feedback policy coefficients are chosen optimally, this will also tell us how to assign different policy instruments to different macroeconomic indicators. Results for the optimal mix during the transition to the reformed steady state are reported in table 4.

The values of the optimized feedback policy coefficients in table 4 imply a clear-cut assignment of instruments to targets. Government spending should be used to address the public debt problem, while income (capital and labor) taxes should be used to address the output problem. On the other hand, it is better to avoid changes in consumption tax rates (the optimized feedback coefficients in the

[23]Results in the special case in which the fiscal authority is restricted to use one fiscal instrument at a time are in appendix 5. These results can help to undestand the working of the model. Here, we only present the optimal mix, where instruments can be used simultaneously, to save on space.

rule for the consumption tax rate are practically zero in this case). These signs and magnitudes of the feedback policy coefficients mean that government spending should be reduced in order to bring public debt down, while, at the same time, the capital and labor tax rates should also be cut so as to stimulate the real economy in an attempt to increase the denominator in the debt-to-output ratio (impulse response functions are shown below).

Table 5 also reports some associated statistics (like elasticities and min/max values).[24] As can be seen, in the short term, public spending should fall by a lot vis-à-vis its data value so as to bring public debt down, and, at the same time, capital and labor tax rates should also fall by a lot vis-à-vis the data to stimulate the real economy. Then, over time, they return to their data average values (this is also shown by impulse response functions below). In subsection 5.6 below, we also report results when the use of policy instruments is restricted.

5.4 Welfare over Time with, and without, Debt Consolidation

Setting the feedback policy coefficients as in table 4, the associated expected discounted utility over various time horizons is reported in the first row of table 6. Studying what happens to welfare over various time horizons can be useful because, for several (e.g., political-economy) reasons, economic agents can be short-sighted. It can also help us to understand the possible conflicts between short-, medium-, and long-term effects from debt consolidation. The second row in table 6 reports results without debt consolidation, other things being equal. Thus, we again compute the best policy mix, meaning that all fiscal policy instruments at the same time are allowed to react to debt and output gaps but now the debt and output targets in the policy rules remain as in the status quo solution (see subsection 4.3 above). Finally, the last row in table 6 gives the welfare gain, or loss, of debt consolidation expressed in permanent consumption equivalent units. A positive number means that welfare would increase with debt consolidation, and vice versa: a negative number means that welfare would decrease with debt consolidation.

[24] The elasticities report the percentage change in the fiscal instrument with respect to a 1 percent change in the macroeconomic indicator, other things equal.

Table 5. Statistics Implied by Table 4

	Elasticity to Liabilities	Elasticity to Output	Min/Max	Five Periods Average	Ten Periods Average	Twenty Periods Average	Data Average
s_t^g	−2.52%	0%	0.1073/0.2352	0.1204	0.1383	0.1694	0.2222
τ_t^c	0%	0%	0.1756/0.1756	0.1756	0.1756	0.1756	0.1756
τ_t^k	0.01%	5.13%	0.1443/0.3118	0.1901	0.2165	0.2470	0.3118
τ_t^n	0.2%	3.61%	0.2956/0.4379	0.3383	0.3607	0.3851	0.421

Notes: See notes in table 4.

Table 6. Welfare over Different Time Horizons with, and without, Debt Consolidation

	Two Periods	**Four Periods**	**Ten Periods**	**Twenty Periods**	**Thirty Periods**
With Consolidation	1.3576	2.8154	7.4589	15.1321	22.1331
Without Consolidation[a]	(1.6251)	(3.1791)	(7.4481)	(13.4127)	(18.1904)
Welfare Gain/Loss	−0.0862	−0.0717	0.001	0.0959	0.1310

[a]The values of the optimized feedback policy coefficients without debt consolidation are $\gamma_l^g = 0.2622$, $\gamma_l^c = 0.3303$, $\gamma_l^k = 0.5819$, $\gamma_l^n = 0.2510$, $\gamma_y^g = 0.3157$, $\gamma_y^c = 0.5772$, $\gamma_y^k = 0$, $\gamma_y^n = 0.0162$.
Notes: See notes in table 4.

The results in table 6 reveal that, other things being equal, debt consolidation improves welfare only if we are relatively far-sighted. In particular, expected discounted utility is higher with debt consolidation only when we care beyond the first ten years. Reversing the argument, debt consolidation comes at a short-term cost.[25] Once the short-term pain is over, the welfare gain in consumption equivalents is substantial.[26]

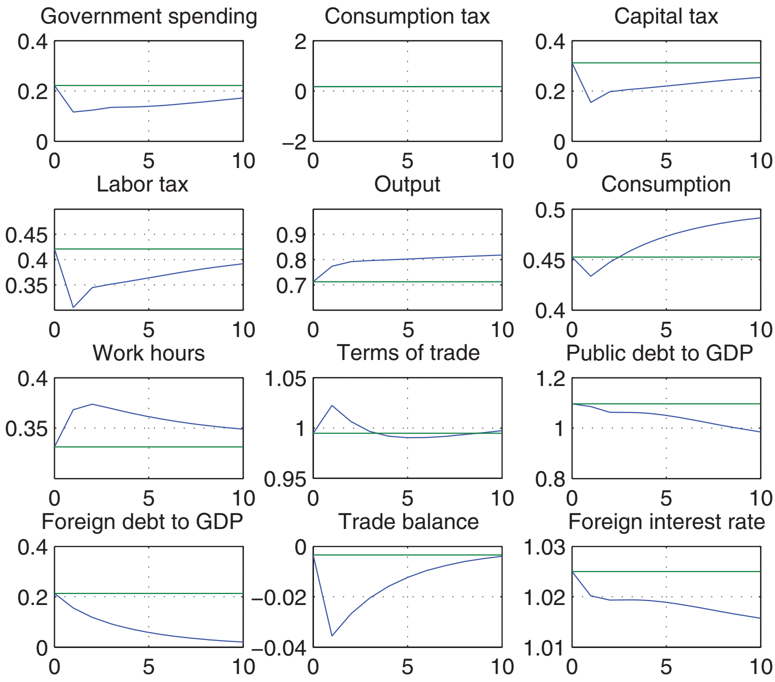
5.5 Impulse Response Functions with Debt Consolidation

To get a clearer picture of the above results, we also present the implied impulse response functions illustrating the time paths of the fiscal policy instruments used for consolidation, as well as some key macroeconomic variables. They are shown in figure 1. As can be seen, public spending should fall, while, at the same time, capital

[25]It should be pointed out that the rise in welfare is partly driven by the fact that debt consolidation and elimination of sovereign premia in the reformed long-run equilibrium allow a higher value of the time preference rate than in the pre-reformed long-run solution in section 3 (in particular, the calibrated value of β was 0.978 in the status quo steady state in section 3, while it is 0.9886 without premia). We report that the main results do not change when we allow for persistence in the change of the time preference rate as it rises from 0.978 to 0.9886. Actually, when we allow the related autoregressive parameter to be optimally chosen, along the feedback policy coefficients, its optimal value is close to zero, meaning that it is better to adopt as soon as possible the higher value of the time preference rate. Results are available upon request.

[26]Prescott (2002) finds welfare gains of similar magnitude when Japan or France adopt the tax policy or the production efficiency of the United States.

Figure 1. IRFs under Debt Consolidation with the Optimal Fiscal Mix



Note: IRFs are in levels and converge to the reformed steady state, while the solid horizontal line indicates the point of departure (status quo value).

and labor tax rates should be cut, for the reasons discussed above. This optimal mix allows a gradual reduction in the ratio of public debt to GDP, in the ratio of foreign debt to GDP, and in the interest rate premium. Private consumption falls in the short term, as a consequence of debt consolidation, but recovers soon. Hours of work need to rise (or leisure to fall) for some time. All variables converge to their new, reformed values over time.

5.6 Further Restrictions on the Use of Fiscal Policy Instruments

One could argue that the values of tax–spending policy instruments cannot differ substantially from those in the historical data (for various political-economy reasons). Therefore, we now redo the main computations, restricting the magnitude of feedback coefficients in the policy rules so that all tax–spending policy instruments cannot change by more than, say, 10 percentage points from their averages in the data. The new results are reported in appendix 5. Although, obviously, feedback policy coefficients are now smaller, the best fiscal policy mix again implies that we should earmark public spending for the reduction of public debt and, at the same time, cut taxes to mitigate the recessionary effects of debt consolidation. The only difference is that now, since cuts in income (capital and labor) taxes are restricted, we should also cut consumption taxes.

In the same appendix (appendix 5), we compare results when the fiscal authorities use the optimal fiscal mix with results when they are restricted to using one fiscal instrument at a time only. The message from the new impulse response functions is that the reduction in public debt is more gradual when we use all fiscal instruments, and this allows a smaller fall in private consumption, than when the fiscal authorities are restricted to using one instrument at a time only. This is intuitive: a policy mix gives more choices.

6. Sensitivity Analysis

This section checks the sensitivity of the above results. We start with changes in parameter values and then study robustness to more substantial modeling changes. To save on space, we will selectively provide some results only (a full set of results is available upon request from the authors).

6.1 Changes in Parameter Values

We start with the value of the public debt threshold parameter, $\overline{d}$, in the interest rate premium equation (15). Recall that so far we have set $\overline{d} = 0.9$. Our qualitative results do not depend on this value. For instance, in appendix 6, we present the main results with $\overline{d} = 0.8$ and $\overline{d} = 1$. In this case, as said above, we need to recalibrate the value of ψ so as to hit the data again; the new values are, respectively, $\psi = 0.0319$ and $\psi = 0.108$.

Our results are also robust to changes in the assumed value of net foreign debt in the steady state of the reformed economy. Recall that so far we have solved for the reformed economy assuming a zero net foreign debt position at steady state, $\widetilde{f} = 0$. Our main results remain unchanged when we instead set $\widetilde{f} = 0.1$ and $\widetilde{f} = 0.2109$ in the reformed steady state (where 0.2109 is the average value of the country's foreign debt in the data). Results for these two cases are presented in appendix 7.

Our qualitative results are also robust to changes in other model parameters. For instance, we have experimented with changes in the values of the Calvo parameter in the firm's problem, θ, and the adjustment cost parameters on foreign private assets/debt, ϕ^h; foreign public debt, ϕ^g; and physical capital, ξ. We report that our main results do not change when we set θ at, say, 0, 0.1, or 0.9 (we also report that as price stickiness, θ, rises, the optimal fiscal reaction to public debt becomes milder), when $0.2 \leq \phi^h \leq 0.5$, and when $0 \leq \xi \leq 2$, while the value of ϕ^g has not been found to be important. Similarly, our results remain unchanged for $0.8 \leq \gamma \leq 0.99$, which measures the sensitivity of exports to changes in the terms of trade in equation (20). Also, our main results do not depend on the value of χ_g, namely, how much agents value public consumption spending in the utility function. The values of the labor supply parameters, χ_n and η, are not crucial either; nevertheless, we report that when $\eta = 0.5$, the reaction of the labor tax rate to the debt target is zero, i.e., $\gamma_l^n = 0$, while when $\eta = 2$, we get $\gamma_l^n = 0.3761$. That is, as η (namely, the inverse of the Frisch elasticity) rises, the reaction of the labor tax rate to the debt target becomes stronger, which, in turn, means that the net cut in the labor tax rate should be smaller. As said, the above results are available upon request.

6.2 Changes in Policy Variables

Our results are also robust to the specific way we model the fiscal policy instruments. For instance, the main results remain unaffected when we allow for persistence in the feedback policy rules, (16)–(19), in the sense that—for example, in the case of the consumption tax rate—we use

$$\tau_t^c = (1 - \rho^{\tau^c})\tau^c + \rho^{\tau^c}\tau_{t-1}^c + \gamma_l^c\left(l_{t-1} - l\right) + \gamma_y^c\left(y_t^H - y^H\right), \quad (22)$$

where $0 \leq \rho^{\tau^c} \leq 1$ is an autoregressive policy parameter and the initial value of the policy instrument is its data average value as reported in tables 1 and 2. Actually, we have also allowed ρ^{τ^c} to be optimally chosen, jointly with the other feedback policy coefficients, and the main results again do not change. Interestingly, the optimized values of these autoregressive policy parameters are found to be relatively small, meaning that it is better to adjust the policy instrument(s) relatively soon.

Also, following several related papers (see, e.g., Coenen, Mohr, and Straub 2008, Forni, Gerali, and Pisani 2010b, and Erceg and Lindé 2013), we have experimented with time-varying debt policy targets. Thus, instead of using a constant-over-time debt policy target, l, as in equations (16)–(19) above, we assume that the target, defined now as l_t^*, follows an $AR(1)$ process of the form

$$l_t^* = \left(1 - \rho^l\right) l + \rho^l l_{t-1}^*, \tag{23}$$

where $0 \leq \rho^l \leq 1$ is an autogressive policy parameter and the initial value of the target is given by its data average value in tables 1 and 2. We report that our main results remain the same under this new specification.

Our results are also robust to adding more macroeconomic indicators in the feedback policy rules (like inflation or terms of trade). We have also experimented with changes in some exogenous policy instruments, which have been kept constant so far, like the fraction of public debt held by domestic agents relative to foreign investors, λ. The latter has so far been kept constant and equal to its average value on the data, 0.64. When we experiment with $\lambda = 0.54$ and $\lambda = 0.74$, the results do not change.

6.3 Allowing for New Shocks

Our results are also robust to allowing for a more volatile economy. This can be captured by increasing the standard deviation of the existing TFP shock and/or by adding new shocks. Specifically, regarding new shocks, we have experimented with adding shocks to the fiscal policy rules in subsection 2.7, to the time-varying debt policy target presented in subsection 6.2 above, or to the world interest rate in equation (15). The main results again do not change. In particular, regarding shocks to the world interest rate, and following the specification of García-Cicco, Pancrazi, and Uribe (2010), we augment equation (15) by

$$Q_t = Q_t^* + \psi \left(e^{\left(\frac{D_t}{P_t^H Y_t^H} - \overline{d} \right)} - 1 \right) + \left(e^{\varepsilon_t^{\mu_t^q - 1}} - 1 \right), \qquad (24)$$

where

$$\log \left(\mu_t^q \right) = \rho^q \log \left(\mu_{t-1}^q \right) + \varepsilon_t^q, \qquad (25)$$

where $0 \leq \rho^q \leq 1$ is a parameter and ε_t^q is an iid shock. In our experiments, we set 0.9845 for ρ^q and 0.0487 for the standard deviation of ε_t^q.[27] The new results are reported in appendix 8. As can be seen, the main messages remain the same. This is not suprising: the key driver of transition dynamics is policy reforms, such as debt consolidation, rather than cyclical fluctuations generated by exogenous shocks.

6.4 Transition to the Ramsey Steady State

So far, we have studied the optimal transition of the economy from the status quo to an arbitrarily reformed steady state. A potential criticism (see, e.g., Schmitt-Grohé and Uribe 2009, chapter 3) might be that the accuracy of approximation (in our paper, first and second order) is poor because when the policymaker chooses the feedback policy coefficients in such cases, he/she may want to use his/her choices in order to influence the mean of variables, rather than to stabilize the economy around the assumed steady state. A way of checking whether this affects the main results is to approximate the economy around the Ramsey steady state, meaning that the steady-state policy targets in the feedback rules (16)–(19) are the Ramsey steady-state values of the corresponding variables.

Therefore, this subsection examines the optimal transition of the economy from the status quo to the Ramsey steady state and compares this with the case studied so far, in which we computed the optimal transition to an arbitrarily reformed steady state. By optimal transition, we again mean that we select the feedback policy coefficients so as to maximize the household's welfare criterion as

[27] These estimates follow from OLS regressions of (25) where μ_t^q denotes the deviation of the ten-year German bond rate from its average value on the data. The data for the ten-year German bond are from Eurostat, 2001–13.

above. The difference is that now the steady state, around which we approximate, is the steady state of the Ramsey second-best policy problem.[28]

The first step is to solve the Ramsey second-best policy problem. In this problem, when we use the so-called dual approach, the government chooses the time paths of all endogenous variables of the DE system plus the fiscal policy instruments taken as given at the DE level (see, e.g., Schmitt-Grohé and Uribe 2006 for a related problem). For simplicity, and following the same authors, we solve for the so-called timeless Ramsey equilibrium, which means that the optimality conditions in the initial periods do not differ from those in later periods. Besides, to make the comparison with the previous cases meaningful, we again assume, as we have done so far in the steady state of the arbitrarily reformed economy, that, in the steady state of the Ramsey problem, the ratio of public debt to GDP is set at 0.9 and that the country's net foreign debt position is zero.[29] Details of the Ramsey policy problem are in appendix 9.

When we solve this Ramsey problem numerically using Dynare, the resulting steady-state solution (reported in appendix 9) gives us an unrealistically high consumption tax rate and an equally large labor subsidy, i.e., $\tau^n < 0$. This is a well-known property of the Ramsey problem, when the policymaker also has access to consumption taxes (see the early papers by Lansing 1999, Coleman 2000, and many others since then).[30] In addition, our DE economy does not seem to converge to this unrestricted Ramsey steady state. To overcome these problems, and given the difficulty of setting negative labor tax rates in reality, we solve the Ramsey problem by not allowing the government to choose the labor tax rate, which is now constrained to remain fixed at, say, zero ($\tau^n = 0$). Actually, most of

[28]Schmitt-Grohé and Uribe (2006, 2007) and Kliem and Kriwoluzky (2014), on the other hand, select the feedback policy coefficients so as to minimize the distance from the Ramsey solution.

[29]Actually, setting some debt values at exogenous values is necessary to get a well-defined steady-state system in the Ramsey problem. See also, e.g., Schmitt-Grohé and Uribe (2004a). We provide details in appendix 9.

[30]Another related well-known property is that, at least in the baseline neoclassical growth model without market frictions, the Ramsey government can implement the first-best allocation if the policymaker has access to consumption, labor, and capital taxes.

Table 7. Ramsey Steady-State Solution with $\tau^n = 0$

Variables	Description	Steady-State Solution
u	Period Utility	1.0950
y^H	Output	1.1162
TT	Terms of Trade	1.01
τ^k	"Optimal" Capital Tax Rate	0.0500
τ^c	"Optimal" Consumption Tax Rate	0.810199
$Q - Q^*$	Interest Rate Premium	0
$TT^{1-\nu}\frac{c}{y^H}$	Consumption as Share of GDP	0.5443
$\frac{k}{y^H}$	Physical Capital as Share of GDP	5.8387
$\frac{TT^{\nu^*}f^h}{y^H}$	Private Foreign Assets as Share of GDP	0.3240
$\frac{TT^{1-\nu}d}{y^H}$	Total Public Debt as Share of GDP	0.9
$\widetilde{f}$	Total Foreign Debt as Share of GDP	0

the above-mentioned literature on Ramsey policy with consumption taxes works similarly. The steady-state solution of this "restricted" Ramsey problem is reported in table 7.

As can be seen, the implied utility and output are higher in the Ramsey steady state than in all other cases studied so far. This is as expected. It is also worth noticing that, in this solution, the capital tax rate is very low (but not zero since there are several market imperfections in the model) and the consumption tax rate is well defined (although high, as one would expect for the reasons discussed above).

The next step is to compute the optimal transition from the status quo steady state in table 2 to the Ramsey steady state in table 7. Results for the optimal fiscal policy mix and the associated welfare over different time horizons are reported in tables 8 and 9, respectively. These two tables need to be compared with tables 4 and 6, respectively. As can be seen, the main results are not affected. Namely, it is again optimal to earmark public spending for the reduction of public debt and, at the same time, to use the tax rates for the stimulation of the real economy. The difference is that since changes in the labor tax are now restricted (the Ramsey labor tax rate has

Table 8. Optimal Fiscal Reaction to Debt and Output with Debt Consolidation and a Ramsey Steady State

Fiscal Instruments	Optimal Reaction to Debt	Optimal Reaction to Output
s_t^g	$\gamma_l^g = 0.6515$	$\gamma_y^g = 0.0102$
τ_t^c	$\gamma_l^c = 0$	$\gamma_y^c = 1.9621$
τ_t^k	$\gamma_l^k = 0$	$\gamma_y^k = 0.6183$
τ_t^n	$\gamma_l^n = 0.0086$	$\gamma_y^n = 0.0002$

Notes: See notes (i)–(iii) in table 4. (iv) $V_0 = 92.4789$. (v) Optimal degree of persistence in fiscal instruments, $\rho = 0.2533$.

Table 9. Welfare over Different Time Horizons with, and without, Debt Consolidation and a Ramsey Steady State

	Two Periods	Four Periods	Ten Periods	Twenty Periods	Thirty Periods
With Consolidation	1.7351	3.3455	8.2102	16.6584	24.6462
Without Consolidation[a]	(1.6251)	(3.1791)	(7.4481)	(13.4127)	(18.1904)
Welfare Gain/Loss	0.0378	0.0346	0.0761	0.1888	0.2789

[a]The values of the optimized feedback policy coefficients without debt consolidation are as in table 6.
Notes: See notes in table 8.

been set to zero), it is also optimal to make use of the consumption tax rate. Namely, it is optimal, in the short term, to cut not only the capital tax rate but also the consumption tax rate; in later periods, the consumption tax rate rises substantially, converging to its high Ramsey steady-state value in table 7. Observe that now, as shown in table 9, the case with debt consolidation is superior to the reference case without debt consolidation over all time horizons, even in the short term. Thus, an intuitive general message is that a proper use of fiscal policy can mitigate (in our case, avoid) the short-term pain from debt consolidation. But, of course, as is typically the case, the optimal Ramsey values for the fiscal policy instruments are far away from their values in the data.

Table 10. Optimal Fiscal Reaction to Debt and Output with Debt Consolidation and when the Premium Depends on Foreign Debt

Fiscal Instruments	Optimal Reaction to Debt	Optimal Reaction to Output
s_t^g	$\gamma_l^g = 0.5322$	$\gamma_y^g = 0.0005$
τ_t^c	$\gamma_l^c = 0$	$\gamma_y^c = 0.2912$
τ_t^k	$\gamma_l^k = 0$	$\gamma_y^k = 2.9810$
τ_t^n	$\gamma_l^n = 0.283$	$\gamma_y^n = 2.9578$

Notes: See notes (i)–(iii) as in table 4. (iv) $V_0 = 79.9909$.

6.5 The Interest Rate Premium as a Function of Net Foreign Debt

So far, we have assumed that the sovereign interest rate premium in equation (15) is a function of the ratio of public debt to GDP. We now assume that the premium is a function of the country's net foreign debt ratio, $\widetilde{f} \equiv \frac{(1-\lambda)TT^{1-\nu}d - TT^{\nu^*}f^h}{y^H}$. The latter is another obvious candidate for the emergence of country interest rate premia. In particular, equation (15) changes to (assuming a zero threshold parameter in this case)[31]

$$Q_t - Q^* = \psi\left(e^{\frac{(1-\lambda)dTT^{1-\nu} - TT^{\nu^*}f^h}{y^H}} - 1\right). \tag{26}$$

The new results are summarized in tables 10 and 11. As can be seen by comparing tables 10 and 11 with tables 4 and 6, respectively, the main messages remain the same.

7. What Would Have Happened under Flexible Exchange Rates?

This section resolves the baseline model developed in section 2 under the fiction of flexible exchange rates, other things being equal. Again,

[31]The value of ψ is recalibrated in the same way as explained in subsections 3.1 and 6.1 above (namely, to hit the net foreign debt position in the data).

Table 11. Welfare over Different Time Horizons with, and without, Debt Consolidation and when the Premium Depends on Foreign Debt

	Two Periods	Four Periods	Ten Periods	Twenty Periods	Thirty Periods
With Consolidation	1.3667	2.8256	7.4659	15.1503	22.1528
Without Consolidation[a]	(1.6251)	(3.1793)	(7.4468)	(13.4065)	(18.1785)
Welfare Gain/Loss	−0.0834	−0.0698	0.0018	0.0974	0.1635

[a]In the reference case without debt consolidation, the optimal feedbacks are $\gamma_l^g = 0.3303$, $\gamma_l^c = 0.0033$, $\gamma_l^k = 0.7693$, $\gamma_l^n = 0.2089$, $\gamma_y^g = 0.3042$, $\gamma_y^c = 0.4519$, $\gamma_y^k = 0.0041$, $\gamma_y^n = 0.0045$.
Notes: See notes in table 10.

the initial conditions for the state variables will be those of the steady-state solution of the status quo model. In terms of modeling, the only difference from the model in section 2 is that now the exchange rate becomes an endogenous variable. Thus, R_t and S_t exchange places. The former was endogenous in section 2, while now it is the latter that becomes endogenous, with the former being free to follow a national Taylor-type rule for the nominal interest rate. In particular, we postulate

$$\log\left(\frac{R_t}{R}\right) = \phi_\pi \log\left(\frac{\Pi_t}{\Pi}\right) + \phi_y \log\left(\frac{y_t^H}{y^H}\right) + \phi_\epsilon \log\left(\frac{\epsilon_t}{\epsilon}\right), \tag{27}$$

where ϕ_π, ϕ_y, $\phi_\epsilon \geq 0$ are feedback monetary policy coefficients on price inflation, output, and exchange rate depreciation, respectively, as deviations from their steady-state values. This is like the fiscal policy rules above. All feedback (monetary and fiscal) policy coefficients are again computed optimally, as described in section 4.

Since money is neutral in the long run (and $\Pi^{H*} \equiv 1$), a switch to flexible exchange rates does not affect the solution of real variables in the steady state. Any differences will thus arise in the transition only, during which money is not neutral because of Calvo-type nominal fixities. Results are reported in tables 12 and 13, which need to be compared with tables 4 and 6, respectively (appendix 10 also presents impulse response functions). The computed values of ϕ_π and ϕ_y are as typically found in the related literature (see, e.g.,

Table 12. Optimal Reaction to Inflation, Depreciation, Debt, and Output with Debt Consolidation (Optimal Monetary and Fiscal Policy Mix) under Flexible Exchange Rates

Monetary Policy		Fiscal Policy		
Monetary Instrument	**Optimal Reaction to Inflation, Output, and Depreciation**	**Fiscal Instruments**	**Optimal Reaction to Debt**	**Optimal Reaction to Output**
R_t	$\phi_\pi = 1.36$	s_t^g	$\gamma_l^g = 0.5268$	$\gamma_y^g = 0.0001$
	$\phi_y = 0$	τ_t^c	$\gamma_l^c = 0$	$\gamma_y^c = 0$
	$\phi_\epsilon = 100$	τ_t^k	$\gamma_l^k = 0.0012$	$\gamma_y^k = 2.782$
		τ_t^n	$\gamma_l^n = 0.0744$	$\gamma_y^n = 2.1876$

Notes: See notes (i)–(iii) in table 4. (iv) $V_0 = 79.9954$.

Table 13. Welfare over Different Time Horizons with, and without, Debt Consolidation under Flexible Exchange Rates

	Two Periods	Four Periods	Ten Periods	Twenty Periods	Thirty Periods
With Consolidation	1.3482	2.7976	7.4448	15.1411	22.1486
Without Consolidation[a]	(1.6247)	(3.1786)	(7.4451)	(13.4043)	(18.1768)
Welfare Gain/Loss	−0.0890	−0.0750	−0.00005	0.0969	0.1634

[a]In the case without debt consolidation, the optimal feedbacks are $\phi_\pi = 1.3972$, $\phi_y = 0$, $\phi_\epsilon = 0.0002$, $\gamma_l^g = 0.2515$, $\gamma_l^c = 0.0011$, $\gamma_l^k = 0.6417$, $\gamma_l^n = 0.3298$, $\gamma_y^g = 0.3572$, $\gamma_y^c = 0.3132$, $\gamma_y^k = 0.0169$, $\gamma_y^n = 0.0001$.
Notes: See notes in table 12.

Schmitt-Grohé and Uribe 2007), while the high value of ϕ_ϵ implies that exchange rate stabilization is desirable. But, in the context of our paper, the key result is that the optimal fiscal policy mix remains as above. Notice also that the associated welfare is only slightly higher than that without monetary policy independence in table 4. In other words, to the extent that feedback policy coefficients are selected optimally, the loss of monetary policy independence is not a big loss, at least in this class of New Keynesian models with Calvo- or Rotemberg-type nominal fixities. This is in line with the related literature (see Schmitt-Grohé and Uribe 2016).[32]

[32]Schmitt-Grohé and Uribe (2016) give the following explanation for the small differences in macro performance under fixed and flexible exchange rates in this class of models: increases in unemployment during recessions are roughly offset by rises in work hours during expansions, so that the average level of employment, and hence welfare, is affected relatively little by the exchange rate regime (we report that, in our model, impulse response functions for hours of work and real wages are very similar under flexible and fixed exchange rates). It therefore seems that one has to add extra forms of nominal fixities to make flexible exchange rates, and hence the use of independent monetary policy, more desirable. For instance, Schmitt-Grohé and Uribe (2016) add downward nominal wage rigidity in a small open-economy model and also assume a labor contract according to which employment is demand determined during recessions but demand-supply determined during booms. This implies that aggregate fluctuations cause higher unemployment on average, so that having an extra instrument for stabilization, such as independent monetary policy, becomes useful.

8. Concluding Remarks and Possible Extensions

This paper has studied fiscal policy action in a New Keynesian model of a small open economy facing debt-elastic interest rate premia and not being able to use monetary policy. Our analysis was based on optimized, simple, and implementable feedback policy rules for various categories of tax rates and public spending.

Since the main results have been listed in the introduction already, we close with some possible extensions. Here, we have focused on the macroeconomic, or aggregate, implications of alternative debt consolidation policies, leaving out the issue of distributional implications. It would be interesting to add heterogeneity both in terms of economic agents within the country and in terms of countries. For instance, within each country, we could distinguish between those who have access to financial markets and those who just work and consume (the so-called rule-of-thumb consumers) or between those working in the private sector and those working in the public sector (public employees). It would be also interesting to use a two-country model, where countries can differ in, say, fiscal imbalances and/or time preferences, and so study the asymmetric cross-border effects of national stabilization and debt consolidation policies. We leave these extensions for future work.

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