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Abstract

Using a DSGE model with nominal wage rigidity, we investigate two scenarios for the Italian economy. The first considers sustained policy commitment to reform. The results indicate the possibility of `growing out of bad initial conditions', if fiscal consolidation is combined with a program for bank recovery and for competitiveness and growth. The second scenario involves a strong asymmetric recession. It is likely to be very severe under the restrictions of the currency union. A benign exit from the Eurozone with stable investor expectations could substantially dampen the short-run impact. Stabilization is achieved by monetary expansion, combined with exchange rate depreciation. However, investor panic may lead to escalation. Capital market reactions would offset the benefits of monetary autonomy and much delay the recovery.

Keywords

Italy, competitiveness, sovereign debt, bad loans, bank recapitalization, Eurozone crisis

JEL Classification

E42, E44, E60, F30, F36, F45, G15, G21

1 Introduction

The global financial crisis revealed large imbalances in the Eurozone. Banks were highly leveraged and unable to absorb large shocks, requiring government support. With the increase in public debt, doubts emerged about the solvency of several member states. Investors thus charged higher risk premia leading to rising borrowing costs for those governments. In addition, some countries in the Eurozone periphery had gradually lost competitiveness in the pre-crisis boom during the early 2000s and have experienced stagnant growth thereafter. The latter significantly constrains the borrowing capacity of governments and hampers the role of the fiscal budget in stabilizing the economy during a recession. Instead of providing fiscal relief, governments may be forced to pursue a policy of fiscal consolidation. This reinforces the downturn and ultimately magnifies the share of non-performing loans, thereby further weakening banks.

Italy arguably comes close to the Eurozone trilemma of fiscal solvency issues, problems in the banking sector and stagnant growth. On all three fronts, the country starts from unfavorable initial conditions and is especially vulnerable to shocks. First, public debt is excessively high and accounts for 130 percent of GDP. The chronically high debt level is mainly a result of the 1980s and early 1990s. Between the late 1990s and 2008, it remained stable around 100 percent of GDP. However, the financial crisis led to an increase in the public debt ratio by roughly 30 percentage points.[1] Second, Italian banks suffer from many non-performing loans. Their share increased from six to 16 percent of total loans between 2006 and 2013 (Schivardi et al., 2017). Another source of financial instability is that banks have held large amounts of domestic sovereign bonds, more than 11 percent of bank assets in 2017 according to ECB data. Third, the Italian economy has long suffered from sluggish growth. In 2017, real GDP per capita was virtually the same as in 2000. An important reason for this pattern is stagnant or declining labor productivity since the 1990s, which contributed to rising unit labor costs and deteriorating competitiveness.

[1] Public debt is likely to further increase by the same amount due to costs of the current Covid epidemic. Our paper, however, is not about the Covid shock which affects all Eurozone member countries.

The present paper formulates a dynamic stochastic general equilibrium (DSGE) model to analyze the Eurozone trilemma and to evaluate policy options for Italy. We first simulate how sustained policy commitment to fiscal and banking reforms within the monetary union can help Italy overcome bad initial conditions and converge to a new steady state. Subsequently, we simulate three counterfactual scenarios in case of a severe, asymmetric recession in Italy: (i) continued membership in the Eurozone, (ii) a 'benign' exit from the Eurozone, and (iii) an 'escalating' exit. An exit replaces fixed by flexible exchange rates and allows for an autonomous monetary policy tailored to the Italian economy. These scenarios and our focus on events following a recession reflect the view that money and exchange rates affect real activity in the short and medium run due to nominal rigidities but are largely neutral in the long run. Given the uncertainty about how an exit from the Eurozone could be organized, we consider two distinct cases. The 'benign' scenario pictures the best case without severe short-run disruptions such as a widespread loss of confidence. In contrast, the 'escalating' scenario introduces investor panic with runs on banks and a flight to safety with a large sell-off of sovereign bonds.

The paper sets out a three-region DSGE model that features Italy, the rest of the Eurozone and the rest of the world. The Italian economy includes a banking sector, a government, and a real sector and thereby captures three reinforcing driving forces of a crisis within the Eurozone. The other two regions are intentionally kept stylized. The regions are connected with trade in goods and capital flows. The key rigidity in the model is nominal wage stickiness, which allows monetary policy to have real effects. Importantly, we introduce a regime change from monetary union to a new currency with flexible exchange rates and renationalization of monetary policy. The model is empirically implemented: The initial steady state is calibrated to match Italian data in the early 2000s. Adding structural shocks to the model and using Bayesian estimation procedures allows us to track past performance and approximately replicate time series until 2017.

The quantitative analysis yields three main results: First, a 'reform package' consisting of tax- and expenditure-based fiscal consolidation, a shift to productivity-enhancing fiscal spending, tax incentives for investment, as well as labor market and banking reform could help Italy overcome unfavorable initial conditions and gradually reach a new equilibrium with lower public debt, a more robust banking sector, and higher income and consumption.

Second, the short- and medium-term response to an asymmetric recession markedly differs depending on whether the country continues to be part of the Eurozone or exits. An exit would allow Italy to conduct an independent monetary policy more tailored to the specific needs of its economy and to depreciate its new currency. Nominal rigidities are critical for this result as monetary expansion may immediately depreciate real wages, thereby increasing employment. Compared to continued membership, the recession generally reduces real variables like domestic output, employment and capital stock less strongly in the short but more strongly in the medium run if Italy exits.

Third, an escalating exit accompanied with investor panic would eliminate any such short-term gains from a more flexible monetary policy and would magnify the recession. An important driver are strongly rising risk premia for banks and governments, which translate into higher borrowing costs and significantly lower investment.

The existing literature on the Eurozone is large and predominantly relates to specific aspects of the crisis. The aim of the present paper is to capture vicious spirals and reinforcing feedback loops in a DSGE model and evaluate alternative policy scenarios. Specifically, it compares the recovery following a recession under continued membership in the monetary union with two exit scenarios. Closest to our endeavor is the research by Gourinchas et al. (2016) and Chodorow-Reich et al. (2019) who suggest an open economy New Keynesian DSGE model to explain the evolution of the Greek economy during the crisis. Martin and Philippon (2017) develop a stylized two-country model to analyze the contrasting behavior of the periphery and core countries and to investigate macroprudential policies. They also include amplifying feedback mechanisms in reduced form. Gilchrist et al. (2017) introduce a DSGE model with two financially heterogeneous regions where financial frictions prevent price adjustments. None of these papers considers an exit scenario with a complete regime shift, that is, moving from fixed to flexible exchange rates and from common to national monetary policy.

Kriwoluzky et al. (2020), in turn, explicitly analyze a potential exit from a monetary union using a New Keynesian model. They focus on exit expectations during a sovereign debt crisis, which contribute to rising interest rates for public and private borrowers prior to an exit thereby reinforcing the debt crisis and depressing economic activity. The importance of such expectations is one reason why we model shocks to risk premia in our 'escalating exit' scenario. Furthermore, an exit scenario resembles the break-up of currency pegs. Schmitt-Grohe and Uribe (2016), for example, show how downward wage rigidity combined with free capital mobility causes overborrowing in booms and unemployment during recessions, resembling key aspects of the Eurozone crisis.

The present paper emphasizes a trilemma of high public debt, weak banks, and deteriorating competitiveness (Shambaugh, 2012). Empirical research documents the importance of these three reinforcing drivers of the Eurozone crisis: First, a systemic banking crisis entails severe macroeconomic and fiscal costs. Laeven and Valencia (2012), for example, estimate a 32 percent median cumulative output loss in advanced economies. A weakened banking sector tends to prolong the crisis as under-capitalized banks continue to finance distressed firms and engage in 'Zombie' lending (e.g., Schivardi et al., 2017; Acharya et al., 2019). In addition, a banking crisis typically leads to a massive increase in public debt, and it can rapidly transform into a public debt crisis as the Irish experience has shown (e.g., Acharya et al., 2014).

Second, a sovereign debt crisis undermines financial stability. European banks typically hold large amounts of domestic sovereign bonds (e.g., Acharya and Steffen, 2015; Altavilla et al., 2016; Ongena et al., 2019). Given this exposure, a public debt crisis causes a contraction of private credit especially if banks' sovereign bond holdings are large and they are highly leveraged (Gennaioli et al., 2014). Bofondi et al. (2018) show that domestic Italian banks reduced credit significantly more during the sovereign debt crisis than foreign banks that operate in Italy.

Third, a lack of competitiveness can become an obstacle for economic growth and lead to persistent unemployment. Declining tax revenues magnify budget deficits and render fiscal consolidation more painful and less effective in stabilizing public debt. Furthermore, non-performing loans tend to rise as private defaults become more frequent. The empirical literature emphasizes the role of growth and unemployment (e.g., Louzis et al., 2012; Salas and Saurina, 2002) or the specific impact of recessions (Quagliariello, 2007). A large stock of non-performing loans, in turn, hurts banks, weakens growth by constraining reallocation, and is a source of financial instability.

The remainder of the paper sets out the DSGE model in Section 2. Section 3 reports on calibration and illustrates how the model tracks the performance of Italy since the introduction of the Euro. After investigating a scenario of sustained reform, it then turns to three recession scenarios, with and without Eurozone exit. Section 4 concludes.

2 The Model

The monetary DSGE model includes three regions. The focus is on Italy. The rest of the Eurozone is modeled in much less detail but is sufficient to explain trade and capital flows. The rest of the world (RoW) is represented by export demand functions. Goods are differentiated by geographic origin, with the RoW good serving as numeraire.[2]

2.1 Production Sector

Investment firms accumulate capital. *Monopolistic input firms* rent capital and hire labor to produce components. Competitive *final goods producers* assemble inputs y_{vt} to produce a final good subject to $Y_t^g = \left[\int_0^1 y_{vt}^{(\sigma_v-1)/\sigma_v} dv\right]^{\sigma_v/(\sigma_v-1)}$. Given aggregate demand Y_t^g, expenditure minimization results in input demand and a price index P_t,

$$y_{v,t} = (P_t/p_{vt})^{\sigma_v} Y_t^g, \quad P_t = \left[\int_0^1 p_{vt}^{1-\sigma_v} dv\right]^{1/(1-\sigma_v)}, \quad P_t Y_t^g = \int_0^1 p_{vt} y_{vt} dv. \tag{1}$$

[2] The presentation is meant to provide an overview. For a complete documentation, we refer to the Technical Appendix in Keuschnigg (2020).

Aggregate spending is $P_t Y_t^g$, and the price elasticity of demand for components is $\sigma_v > 1$.

Input suppliers are specialized in a single variety v and use technology $y_{vt} = z_t k_{vt}^{\alpha} l_{vt}^{1-\alpha}$. They rent capital k_{vt} at a price w_t^K from investment firms, and employ labor l_{vt} at a uniform price w_t^L . Labor is a bundle of specialized services with unit cost w_t^L, see below. In a first stage, firms minimize cost per unit of output, giving $m_t^c = \min_{l_{vt},k_{vt}} w_t^L l_{vt} + w_t^K k_{vt}$ s.t. $y_{vt} = 1$. Since components y_{vt} are close substitutes, firms enjoy local monopoly power and earn $\chi_{vt}^m = \max_{p_{vt}} (p_{vt} - m_t^c)\, y_{vt}$. In a second stage, they set a profit maximizing price p_{vt} subject to the perceived demand elasticity in (1). Since all firms face identical factor prices, production is symmetric. The price is a mark-up over marginal costs,

$$p_t = \frac{\sigma_v}{\sigma_v - 1} \cdot m_t^c, \quad \chi_t^m = (p_t - m_t^c)\, Y_t^g. \tag{2}$$

Due to symmetry, $p_t = P_t$ and $y_t = Y_t^g$. Aggregate monopoly profit is χ_t^m.

By linear homogeneity, factor use is linear in output and must exhaust factor supply, $K_{t-1} = k_t^u Y_t^g$ and $L_t = l_t^u Y_t^g$. The unit isoquant $1 = z_t\, (k_t^u)^{\alpha}\, (l_t^u)^{1-\alpha}$ implies final output

$$Y_t^g = z_t K_{t-1}^{\alpha} L_t^{1-\alpha}, \quad z_t = (1 - \rho^z)\, \bar{z}_t + \rho^z z_{t-1} + \varepsilon_t^z, \tag{3}$$

where z_t is a standard productivity shock and $\bar{z}_t$ is specified in (24) below.

Total costs are $m_t^c Y_t^g = w_t^L L_t + w_t^K K_{t-1}$. Noting (2), the value of final output is equal to competitive returns on labor and capital, augmented by monopoly profits,

$$P_t Y_t^g = w_t^L L_t + w_t^K K_{t-1} + \chi_t^m. \tag{4}$$

Finally, employment is a CES composite $L_t = \left[\int_0^1 L_{j,t}^{(\sigma_l - 1)/\sigma_l} dj\right]^{\sigma_l/(\sigma_l - 1)}$ of differentiated services $L_{j,t}$ supplied by specialized individuals. Firms face wages $w_{j,t}$ set by households and, to minimize labor costs, adjust the use of labor services according to

$$L_{j,t} = \left(w_t^L / w_{j,t}\right)^{\sigma_l} L_t, \quad w_t^L = \left[\int_0^1 w_{j,t}^{1-\sigma_l} dj\right]^{1/(1-\sigma_l)}. \tag{5}$$

Total costs are $w_t^L L_t = \int_0^1 w_{j,t} L_{j,t} dj$ and w_t^L is a nominal wage index.

2.2 Household Sector

Households supply labor, consume goods, and demand real money balances. Final goods consumption in region i is C_t^{ij} where $j \in \{i, e, o\}$ refers to the origin country. We think of Italy i (home), the rest of the Eurozone e, and other countries o (RoW). In most cases, we suppress the index i so that $C_t = C_t^{ii}$ is demand for home goods, and C_t^{ie} and C_t^{io} are imports. Assuming that final goods are differentiated by origin, households consume a basket $\bar{C}_t = \left[\sum_j \left(s^j\right)^{1/\sigma_r} \left(C_t^{ij}\right)^{(\sigma_r-1)/\sigma_r}\right]^{\sigma_r/(\sigma_r-1)}$, and optimally demand

$$C_t^{ij} = s^j \left(\bar{P}_t / P_t^{ij}\right)^{\sigma_r} \bar{C}_t, \quad \bar{P}_t = \left[\sum_j s^j \left(P_t^{ij}\right)^{1-\sigma_r}\right]^{1/(1-\sigma_r)}, \tag{6}$$

The price index is $\bar{P}_t$ and minimum spending $\sum_j P_t^{ij} C_t^{ij} = \bar{P}_t \bar{C}_t$. Exchange rates relate import prices in domestic currency to foreign producer prices in foreign currency,

$$P_t^{ie} = e_t^{ie} \cdot P_t^e, \quad P_t^{io} = e_t^{io} \cdot P^o. \tag{7}$$

Suppose i (Italy) uses Lire, e uses Euros and o Dollars. Exchange rates convert one Euro and one Dollar into e_t^{ie} and e_t^{io} Lire. Lira prices for imports are P_t^{ie} and P_t^{io} where foreign prices P_t^e and $P^o = 1$ (numeraire) are in foreign currency. The inverse rate converts one Lira into $1/e_t^{ie}$ Euros and $1/e_t^{io}$ Dollars. By transitivity, the Euro Dollar exchange rate is $e_t^{eo} \equiv e_t^{io}/e_t^{ie}$. When Italy is part of the Euro Area, the exchange rate $e_t^{ie} = 1$ is fixed.

Households are extended families with individuals $j \in [0, 1]$, each offering labor services $N_{j,t}$. Household size is H, and $N_{j,t}$ is labor supply per capita. Preferences for consumption, labor supply and *real* money balances $\bar{M}_t$ are

$$V_t^h = E_t \sum_{s=0}^{\infty} \beta^s u\left(\bar{C}_{t+s}, \bar{M}_{t+s}, \{N_{j,t+s}\} H\right). \tag{8}$$

Preferences are homothetic and separable with instantaneous utility

$$u_t = \frac{X_t^{1-\sigma_c}}{1-\sigma_c} - \phi_t \cdot \frac{\int_0^1 N_{j,t}^{1+\eta} H dj}{1+\eta}, \quad X_t = \left[s_c \bar{C}_t^{1-\sigma_m} + (1-s_c) \bar{M}_t^{1-\sigma_m}\right]^{1/(1-\sigma_m)}. \tag{9}$$

The process $\phi_t = \left(1-\rho^\phi\right)\bar{\phi} + \rho^\phi \phi_{t-1} + \varepsilon_t^\phi$ introduces fluctuations in labor supply and converges to $\bar{\phi}$ in the absence of shocks. Changing the taste parameter $\bar{\phi}$ captures, in reduced form, 'institutional' changes affecting the willingness to work.

Labor earnings derive from differentiated services $N_{j,t}$. Type j is a monopolist over her specialized services and sets a wage $w_{j,t}$. Pooling within the family perfectly smooths income differences. Households pay a wage income tax at rate τ_t and a consumption tax at rate τ_t^c, and are able to reduce tax liability by T_t^l (see the fiscal budget). They collect dividends χ_t and χ_t^b from firms and banks, respectively, and receive social transfers E_t and seignorage T_t^M. Net income from bank deposits S_t^d includes interest plus repayment of deposits, net of any new savings. Net earnings on government debt holdings are $\left(1-\tilde{s}^b\right) S_t^G$. We assume that households directly hold a share $1-\tilde{s}^b$ of fiscal debt, and banks hold the rest. Residual savings in bonds is subject to the nominal budget constraint

$$\begin{aligned} A_t/\left(1+i_t\right) &= A_{t-1}+\int_0^1\left(1-\tau_t\right) w_{j,t} N_{j,t} H dj+E_t+T_t^l+\chi_t+\chi_t^b \\ &+ S_t^d+\left(1-\tilde{s}^b\right) S_t^G+\left(M_{t-1}-M_t\right)+T_t^M-\left(1+\tau_t^c\right) \bar{P}_t \bar{C}_t . \end{aligned} \tag{10}$$

All variables are measured at the beginning of the period, except for stocks M_t and A_t which are dated at the end. Nominal money holdings are M_{t-1} at the beginning of the period t, giving real money balances $M_{t-1}/\bar{P}_t \equiv \bar{M}_{t-1}$. Finally, the inflation rate π_t must also account for changes in commodity tax rates. Real and nominal interest rates, r_t and i_t, are related by the Fisher equation

$$1+i_t=\left(1+r_t\right)\left(1+\pi_t\right), \quad 1+\pi_t=\frac{\left(1+\tau_{t+1}^c\right) \bar{P}_{t+1}}{\left(1+\tau_t^c\right) \bar{P}_t}. \tag{11}$$

In period t, the family maximizes expected utility in (8-9) by choosing consumption, real money balances, and a wage w_t^* for the fraction of individuals receiving a new wage setting opportunity. With details set out in the separate Technical Appendix, optimal consumption growth follows a standard Euler equation

$$u_{C,t}=\beta E_t\left(1+r_t\right) \cdot u_{C,t+1}, \quad \frac{u_{M,t}}{u_{C,t}}=\frac{i_t}{\left(1+\tau_{t+1}^c\right)\left(1+r_t\right)}. \tag{12}$$

Marginal utilities are defined as $u_{C,t} \equiv du_t/d\bar{C}_t$ and $u_{M,t} \equiv du_t/d\bar{M}_t$.[3] A higher real interest tilts consumption to the future, implying larger savings today. The tangency

[3] Given functional forms, $u_{C,t}=s_c x_t^{\sigma_m-\sigma_c}/\bar{C}_t^{\sigma_c}$ and $u_{M,t}=\left(1-s_c\right) x_t^{\sigma_m-\sigma_c}/\left(m_t^{\sigma_m} \bar{C}_t^{\sigma_c}\right)$ where x_t is given by $x_t=\left[s_c+\left(1-s_c\right) m_t^{1-\sigma_m}\right]^{1/\left(1-\sigma_m\right)}$.

condition for money implies that money demand is a fraction of consumption, $\bar{M}_t = m_t \bar{C}_t$,[4] where the desired money consumption ratio m_t is declining in nominal interest. Money demand depends on the opportunity cost, the return that could have been obtained if it were invested in the market at a rate i_t, or $i_t / (1 + r_t)$ in present value.

Turning to wage setting and labor supply, individual j faces demand $L_{j,t}$ for her labor type as in (5). Being a monopolist, $N_{j,t} H = L_{j,t}$, she sets a wage to exploit market power. Being one among many close substitutes, she takes the wage index w_t^L and aggregate demand L_t as given which implies a perceived demand elasticity σ_l. To account for wage rigidity, we assume that, in any period t, only a *random selection* of workers, a fraction $1 - \omega$, can optimally set wages (see, e.g., Gali 2015), $w_{t,t} = w_t^*$. The remaining fraction ω is stuck with a wage set in the past, $w_{t-i,t} = w_{t-i}^*$. Consequently, wages are heterogeneous, and agents serve labor demand at the relevant wage.

In general, compensation for labor effort is equal to the marginal rate of substitution $MRS_{j,t} = -u_{N_{j,t}} / u_{C,t}$.[5] Being endowed with unique skills in performing specialized tasks, individuals enjoy limited market power and set a wage that makes the real wage equal to a mark-up over $MRS_{j,t}$, an individual's valuation of marginal effort, if wages were flexible. In a steady state, new and old wages as well as the marginal valuations are all the same, so that wage setting collapses to the static solution,

$$\frac{(1 - \tau) w^*}{(1 + \tau^c) \bar{P}} = \frac{\sigma_l}{\sigma_l - 1} \cdot MRS. \tag{13}$$

Households are locked into the currently set wage until the next wage setting opportunity arrives. The new wage determines not only current, but also future earnings resulting from labor demand at that wage. Wage setting thus becomes forward looking, replacing the right hand side of (13) by a present value of marginal valuations. Wage setting today equates the current real wage with an average of present and future valuations $MRS_{t,t+i}$,

[4] Given the specification of utility, the ratio is $m_t = \left(\frac{1-s_c}{s_c} \frac{(1+\tau_{t+1}^c)(1+r_t)}{i_t} \right)^{1/\sigma_m}$.

[5] Given functional forms, $MRS_{j,t} = -u_{N_{j,t}} / u_{C,t} = \phi \cdot N_{j,t}^{\eta} \bar{C}_t^{\sigma_c} / \left(s_c x_t^{\sigma_m - \sigma_c} \right)$. Again, a detailed derivation of wage setting is offered in the Technical Appendix.

discounted with the real interest and weighed by the probabilities that the wage in period $t+i$ is still unchanged. Wage stickiness implies that the real wage does not move one to one with variations in marginal rates of substitution. In the aggregate, the wage index determining labor demand of firms and unit costs changes only with delay,

$$w_t^L = \left[(1-\omega)\cdot w_{t,t}^{1-\sigma_l} + \omega\cdot\left(w_{t-1}^L\right)^{1-\sigma_l}\right]^{1/(1-\sigma_l)}. \tag{14}$$

2.3 Investment and Private Debt

Investment firms own intermediate goods producers, accumulate capital, and rent back services on an 'internal capital market', charging a price w_t^K. Noting (4), revenues are $w_t^K K_{t-1} + \chi_t^m = P_t Y_t^g - w_t^L L_t$. Investment I_t augments the capital stock by $K_t = I_t + (1-\delta) K_{t-1}$, where δ is the depreciation rate. Investment including installation costs creates demand $\bar{Z}_t = I_t + \frac{\psi}{2} K_{t-1}\left(I_t/K_{t-1} - \delta\right)^2$ for domestic and imported final goods as in (6), with total cost $\bar{P}_t\bar{Z}_t$. Finally, the required return on equity is $i_t^k = \theta_t^k i_t$. Households demand an equity premium $\theta_t^k = \left(1-\rho^\theta\right)\bar{\theta}^k + \rho^\theta\theta_{t-1}^k + \varepsilon_t^k$ relative to the safe benchmark interest i_t, which fluctuates around $\bar{\theta}^k \geq 1$ and is subject to shocks ε_t^k.

Firms finance investment with retained earnings and bank credit. At the beginning of the period, they repay loans S_t^l, giving outstanding debt of $B_{t-1}^l - S_t^l$. Noting interest payments $i_t^l\left(B_{t-1}^l - S_t^l\right)$, external debt amounts to $B_t^l = B_{t-1}^l - S_t^l + i_t^l\left(B_{t-1}^l - S_t^l\right)$ at the end of the period, or $B_t^l/\left(1+i_t^l\right) = B_{t-1}^l - S_t^l$. Subtracting wages, investment, debt service and taxes from total earnings leaves dividends of

$$\chi_t = P_t Y_t^g - w_t^L L_t - \bar{P}_t\bar{Z}_t - S_t^l - \tau_t T_t^k. \tag{15}$$

The tax base is $T_t^k = P_t Y_t^g - w_t^L L_t - t^z\bar{P}_t\bar{Z}_t - i_t^l\left(B_{t-1}^l - S_t^l\right)/\left(1+i_t^k\right)$. Firms may deduct an investment tax credit at rate t^z and interest on debt (discounted to the beginning of the period, using the firm's discount rate i_t^k). For simplicity, we lump together corporate and personal taxes on capital income which gets taxed with the overall income tax rate τ_t. Note finally that the cash-flow $P_t Y_t^g - w_t^L L_t = w_t^K K_{t-1} + \chi_t^m$ stems from a competitive return to capital plus monopoly profits, see (4).

A firm's debt capacity is limited and constrains the use of debt. We assume that debt is restricted to a fixed fraction b^l of the replacement cost of preexisting capital,

$$B_t^l / \left(1 + i_t^l\right) = b^l \cdot \left(1 + i_t^k\right) \left(1 - t^z \tau_t\right) \bar{P}_t K_{t-1}. \tag{16}$$

Private investment cost is reduced by a factor $1 - t^z \tau_t$ due to the tax subsidy.

Using $V_t = V\left(K_{t-1}, B_{t-1}^l\right)$, value maximization $V_t = \max_{I_t} \chi_t + V_{t+1} / \left(1 + i_t^k\right)$ gives optimal investment and new debt. The *net* investment rate $x_t^I \equiv I_t / K_{t-1} - \delta$ is

$$x_t^I = \left(Q_t - 1\right) / \psi, \quad Q_t \equiv \frac{\lambda_{t+1}^K / \left(1 + i_t^k\right)}{\left(1 - t^z \tau_t\right) \bar{P}_t}. \tag{17}$$

Tobin's Q_t is the shadow price or market value $E_t \lambda_{t+1}^K / \left(1 + i_t^k\right)$ per unit of capital, divided by the tax-adjusted acquisition cost of capital $\left(1 - t^z \tau_t\right) \bar{P}_t$. End of period debt follows from (16) and determines repayment S_t^l to banks.

In a steady state, $I = \delta K$ and $Q = 1$. The user cost of capital is then a weighted average of the cost of equity and debt, using the debt ratio b^l as a weight,

$$w^K = \left[\frac{\delta}{1 - \tau} + \frac{i^k}{1 - \tau} \cdot \left(1 - b^l\right) + i^l \cdot b^l\right] \left(1 - t^z \tau\right) \bar{P}. \tag{18}$$

A unit of capital effectively costs $\left(1 - \tau^z \tau\right) \bar{P}$, to be financed with debt and equity. The tax inflates the cost of equity $i^k / (1 - \tau)$, but not the cost of debt i^l, since interest on debt is tax deductible. Replacement investment is fully equity financed, and hence bears a tax-adjusted cost of depreciation equal to $\delta^K / (1 - \tau)$.

2.4 Fiscal Policy

The government inherits debt B_{t-1}^G, raises tax revenue T_t, spends on productive services $P_t G_t$ and on social transfers E_t, and potentially pays subsidies T_t^b to stabilize banks (see below). The fiscal constraint restricts issuing new gross debt B_t^G at a price $1 / \left(1 + i_t^g\right)$,

$$B_t^G / \left(1 + i_t^g\right) = B_{t-1}^G - S_t^G, \quad S_t^G = T_t - P_t G_t - E_t - T_t^b. \tag{19}$$

Sovereign risk is reflected in an interest premium on sovereign bonds, $i_t^g = \theta_t^g \cdot i_t$. The premium is assumed to follow an autoregressive process $\theta_t^g = 1 - \rho^g + \rho^g \theta_{t-1}^g + \varepsilon_t^g$ that converges to $\theta^g = 1$ in the long run. Shocks reflect investor panic (or a safe haven effect if $\theta_t^g < 1$). As a result, the interest rate must rise to induce investors to hold on to stocks, leading to increasing costs of government debt service.

Taxing wages and profits at rate τ_t and consumption at rate τ_t^c yields revenue

$$T_t = \tau_t \cdot w_t^L L_t + \tau_t \cdot T_t^k + \tau_t^c \cdot \bar{P}_t \bar{C}_t - T_t^l, \quad T_t^l = \left(1 - \rho^T\right) \bar{t}^l P_t Y_t + \rho^T T_{t-1}^l + \varepsilon_t^T. \tag{20}$$

Reflecting the efficiency of tax collection, we allow revenues to shrink due to base erosion, leading to revenue losses T_t^l. The tax yield is reduced by $\bar{t}^l$ percent of GDP in the long run. The larger such tax losses, the higher tax rates must be. This magnifies distortions and slows down growth. To satisfy the fiscal constraint, we scale tax rates $\tau_t = t_t^s \tau_0$ and $\tau_t^c = t_t^s \tau_0^c$ by a common factor t_t^s starting from initial values.

To prevent unstable debt, the government must pursue a consolidation policy. We specify a policy rule for the 'structural' part $\tilde{S}_t^G$ of the primary surplus which excludes any surprise expenditures or windfall gains. Indeed, the Maastricht rules impose restrictions on the structural rather than the actual deficit, and also specify a long-run debt-to-GDP ratio $\bar{b}^g = B^G/(PY)$. The parameter γ^g determines how fast debt is reduced (or increased) to reach the long-run target. The consolidation rule thus specifies a structural surplus

$$\tilde{S}_t^G = \left(1 - \frac{\gamma^g}{1 + i_t^g}\right) B_{t-1}^G - \frac{1 - \gamma^g}{1 + i_t^g} \bar{b}^g P_t Y_t. \tag{21}$$

In the absence of fiscal shocks, debt $B_t^G/(1 + i_t^g) = B_{t-1}^G - \tilde{S}_t^G$ is exclusively driven by the target surplus. With $\gamma^g < 1$, debt follows a stable path

$$B_t^G = \gamma^g \cdot B_{t-1}^G + (1 - \gamma^g) \cdot \bar{b}^g P_t Y_t. \tag{22}$$

The stabilization rule makes debt converge to $B^G = \bar{b}^g PY$, equal to $\bar{b}^g$ percent of GDP. Actual and structural surplus may differ due to unexpected shocks. Spending policies and required tax revenues T_t are

$$
\begin{aligned}
P_t G_t &= \bar{g} \cdot P_t Y_t - \xi^g \cdot \tilde{S}_t^G + \varepsilon_t^G, \\
E_t &= \bar{e} \cdot w_t^L L_t - \xi^e \cdot \tilde{S}_t^G + \varepsilon_t^E, \\
T_t &= \bar{g} \cdot P_t Y_t + \bar{e} \cdot w_t^L L_t + (1 - \xi^g - \xi^e) \cdot \tilde{S}_t^G.
\end{aligned} \tag{23}
$$

Productive spending consists of a normal level $\bar{g} P_t Y_t$, reduced by spending cuts to finance a share ξ^g of the required surplus. Social spending reflects a replacement rate $\bar{e}$ of wage earnings, and spending cuts must contribute a share ξ^e to fiscal consolidation. The required tax revenue T_t covers the structural part of public spending, $\bar{g} P_t Y_t + \bar{e} w_t^L L_t$, plus tax increases equal to $(1 - \xi^g - \xi^e)\, \tilde{S}_t^G$, needed to reduce public debt. Tax rates are set such that revenue (20) matches this target level. Spending shocks ε_t^G and ε_t^E as well as unexpected subsidies to banks T_t^b are not immediately financed with taxes but raise next period's debt and are consolidated only later on. To see how unconsolidated shocks affect fiscal debt dynamics, substitute the policy rules (23) into the primary surplus (19) and get $S_t^G = \tilde{S}_t^G - \varepsilon_t^G - \varepsilon_t^E - T_t^b$. Unexpected spending reduces the actual primary surplus and raises debt before it gets consolidated in future periods.

The policy parameters ξ^e and ξ^g determine whether consolidation is tax or expenditure based. If ξ^e and ξ^g are low, budget consolidation is mostly tax based. High values indicate budget consolidation with spending cuts. These parameters thus connect to research on the effectiveness of tax- versus spending-based consolidation (e.g., Alesina et al., 2015). Higher tax rates discourage labor supply and investment and slow down growth. Spending cuts involve their own costs. For example, cuts in social spending might be good for growth but involve unfavorable distributional effects. Cutting productive spending tends to impair private sector productivity. In the spirit of Barro (1990), we assume that a higher stock of infrastructure K_t^G shifts factor productivity by $\bar{z}_t$ in (3),

$$
K_t^G = G_t + (1 - \delta^g)\, K_{t-1}^G, \quad \bar{z}_t = z_0 \left(K_t^G / \bar{K}^G \right)^{\sigma^z}. \tag{24}
$$

2.5 Banking Sector

Banks provide credit B_t^l to (investment) firms and B_t^g to the government. The government issues debt B_t^G in total, of which $B_t^g = \tilde{s}^b B_t^G$ is acquired by banks, and the rest by investors (private households). In holding a fixed share $\tilde{s}^b$ of bonds, banks receive interest and repayment S_t^G in proportion. The remainder is paid to households, see (10). Outstanding business loans and sovereign bond holdings thus evolve as

$$B_t^l / \left(1 + i_t^l\right) = B_{t-1}^l - S_t^l, \quad B_t^g / \left(1 + i_t^g\right) = B_{t-1}^g - \tilde{s}^b S_t^G. \tag{25}$$

We introduce a share s_t^l of non-performing loans to capture loan risks by default of private borrowers. When a default occurs, banks extract a liquidation value $1-\ell$ which is available for new lending.[6] The relationship in (25) lists the liabilities of (surviving) firms, while credit losses $d_t^l B_{t-1}^l$ reflect real costs that diminish bank earnings. Losses are proportional to the share of non-performing loans,

$$d_t^l = \ell \cdot s_t^l, \quad T_t^b = t_t^b d_t^l B_{t-1}. \tag{26}$$

To keep up lending in a crisis and to mitigate the bank's losses, the government may provide some support T_t^b. The latter is equal to a fraction t_t^b of total losses.[7]

Banks are funded with deposits and equity. Given repayment S_t^d and interest, the stock of deposits D_t follows

$$D_t / \left(1 + i_t^d\right) = D_{t-1} - S_t^d. \tag{27}$$

Depositors and equity holders require a risk premium compared to the safe benchmark rate such that deposit rate and return on equity satisfy

$$\begin{aligned} i_t^d &= \theta_t^d \cdot i_t, \quad \theta_t^d = 1 - \rho^\theta + \rho^\theta \theta_{t-1}^d + \varepsilon_t^d, \\ i_t^b &= \theta_t^b \cdot i_t, \quad \theta_t^b = \left(1 - \rho^\theta\right) \bar{\theta}^b + \rho^\theta \theta_{t-1}^b + \varepsilon_t^b. \end{aligned} \tag{28}$$

[6] Keuschnigg and Kogler (2020) provide microfoundations for the process of credit reallocation.

[7] More specifically, public support stems from asset purchases similar to the troubled asset relief program (TARP) of the U.S. during the financial crisis. The government buys a fraction t_t^b of the loan portfolio and pays the face value of one, giving a volume $t_t^b B_{t-1}^l$. After absorbing losses $T_t^b = t_t^b d_t^l B_{t-1}$, it sells back 'cleaned' assets at a depreciated value $\left(1 - d_t^l\right) t_t^b B_{t-1}^l$. The net transfer to banks is T_t^b.

Bank equity requires a permanent premium $\bar{\theta}^b \geq 1$. The deposit rate is normally equal to the safe benchmark rate. In a crisis, a loss of confidence may lead to prohibitive interest, causing a sudden stop in deposit funding. To capture panic-driven shocks, we include a deposit risk premium, which is absent in normal times ($\theta_t^d \to 1$ without shocks).

Relating *net* inflows and outflows, the bank's budget constraint gives dividends[8]

$$\chi_t^b = S_t^l + \tilde{s}^b S_t^G - S_t^d - \left(1 - t_t^b\right) d_t^l B_{t-1}^l. \tag{29}$$

The balance sheet constraint dictates that total assets are equal to deposits and equity,

$$\frac{B_t^l}{1+i_t^l} + \frac{B_t^g}{1+i_t^g} = \frac{D_t}{1+i_t^d} + \frac{E_t^b}{1+i_t^b}. \tag{30}$$

Banks are subject to capital requirements, which define minimum regulatory capital as a fraction of risk-weighted assets. They must thus raise total equity equal to κ^B percent of business loans plus κ^G percent of sovereign bonds. In line with the preferential treatment of government debt, which is deemed to be safe in the Basel accords, we assume $\kappa^G < \kappa^B$. Given that equity is much more expensive than deposits, banks tend to economize on the use of equity and raise no more than $\frac{E_t^b}{1+i_t^b} = \kappa^B \frac{B_t^l}{1+i_t^l} + \kappa^G \frac{B_t^g}{1+i_t^g}$. Substituting into the balance sheet determines the volume of deposits

$$\frac{D_t}{1+i_t^d} = \left(1-\kappa^B\right) \frac{B_t^l}{1+i_t^l} + \left(1-\kappa^G\right) \frac{B_t^g}{1+i_t^g}. \tag{31}$$

In addition to holding a share of total government debt, banks choose net deposit funding S_t^d and net business lending S_t^l. Referring to the Technical Appendix for details, value maximization subject to financing constraints results in loan pricing

$$1 + i_t^l = \frac{\kappa^B \cdot \left(1+i_t^b\right) + \left(1-\kappa^B\right) \cdot \left(1+i_t^d\right)}{1 - \left(1 - t_{t+1}^b\right) d_{t+1}^l}. \tag{32}$$

The loan rate i_t^l is a mark-up over the cost of capital which is a weighted average of deposit interest and the cost of equity. The mark-up factor reflects default risk and

[8] For example, the gross inflow from deposit funding is $D_t / \left(1+i_t^d\right)$, while the gross outflow is the repayment of the stock D_{t-1}. The *net* outflow is $S_t^d = D_{t-1} - D_t / \left(1+i_t^d\right)$ and reduces dividends.

expected depreciation of bad loans. Government support with a subsidy t_t^b reduces the markup, leading to lower loan rates. After all, the program aims at preventing a surge in loan rates that would block investment of firms.

To close the feedback loop between banks and the real economy, we relate the share of bad loans to macroeconomic fundamentals and assume an autoregressive process

$$s_t^l = \left(1-\rho^{sl}\right) s_0^l \cdot \left(\bar{Y}_t/Y_t\right)^{\sigma^{sl}} + \rho^{sl} s_{t-1}^l + \varepsilon_t^{sl}, \quad t_t^b = \rho^{sl} t_{t-1}^b + \varepsilon_t^{tb}. \tag{33}$$

When output Y_t falls short of potential output $\bar{Y}_t$, the share of bad loans shifts up with elasticity σ^{sl}. The subsidy rate on bad loans follows a policy process as specified in the second equation. The program is activated only if the share of non-performing loans s_t^l is very high. When the program is terminated, the subsidy rate vanishes at a rate ρ^{sl}.

2.6 General Equilibrium

We analyze fluctuations around a steady state with constant money supply and zero inflation. To introduce monetary policy, we specify a policy rule as in Ascari and Ropele (2013) and Sargent and Surico (2011),

$$M_t^s = (1-\rho^m)\,\phi^m \bar{Y}_{t-1} \cdot \frac{\left(\bar{Y}_{t-1}/Y_t\right)^{\psi_y}}{\left(1+\pi_t\right)^{\psi_\pi}} + \rho^m M_{t-1}^s + \varepsilon_t^m, \quad T_t^M = M_t^s - M_{t-1}^s. \tag{34}$$

Trend output is smoothed over the business cycle according to $\bar{Y}_t = \delta^m Y_t + (1-\delta^m)\,\bar{Y}_{t-1}$, and depends less heavily on current output realizations when the rate δ^m is small. Money supply consists of a trend and a cyclical component. The trend component $\phi^m \bar{Y}_{t-1}$ accommodates a permanent increase in output. The cyclical part dampens short-run fluctuations, depending on parameters ψ_y and ψ_π. If current output is below trend, $Y_t < \bar{Y}_{t-1}$, money supply scales up by a factor $\left(\bar{Y}_{t-1}/Y_t\right)^{\psi_y} > 1$. If actual inflation exceeds the trend rate ($\pi_t > 0$), money supply is scaled down by $1/\left(1+\pi_t\right)^{\psi_\pi} < 0$.

An autonomous monetary policy regime creates exchange rate risk. If a Eurozone saver invests 1 Euro at home, she earns gross interest $1 + i_t^e$. If she invests 1 Euro in the

Italian bond, she gets e_t^{ie} Lire at the beginning of the period which grow by $1+i_t$ and are converted back at a rate $1/e_{t+1}^{ie}$, giving end-of-period wealth equal to $(1+i_t)\, e_t^{ie}/e_{t+1}^{ie}$. Standard interest rate parity prevents arbitrage. However, when there is country risk, investors request a premium θ_t. Modified interest rate parity then requires

$$(1+i_t)\, e_t^{ie}/e_{t+1}^{ie} = \left(1+i_t^e\right)\theta_t. \tag{35}$$

The return of the Italian bond in Euros must exceed the domestic return $1+i_t^e$ by a factor of θ_t. When the country's debt ratio rises, investors start to worry about solvency and ask for a higher premium. The reverse case may be associated with a safe haven effect. Following Schmitt-Grohé and Uribe (2003), we postulate

$$\theta\left(b_t^f\right) = 1+\gamma\left(e^{b_t^f-\bar{b}^f}-1\right), \quad b_t^f \equiv B_t^f/\left(P_tY_t\right). \tag{36}$$

In a steady state, exchange rates are constant and $i = i^e = 1/\beta$, to support stationary consumption. The country premium disappears, $\theta\left(b^f\right) = 1$ which requires $b_t^f = \bar{b}^f$. The model thus explains fluctuations around a stationary foreign debt-to-GDP ratio.

The trade balance TB_t is equal to the value of exports minus imports. In focusing on the interactions within the Euro Area, we assume that foreign debt is exclusively held by Eurozone investors. Foreign debt B_t^f, denominated in domestic currency, grows by

$$B_t^f/\left(1+i_t\right) = B_{t-1}^f - TB_t, \quad TB_t = P_tE_t^x - P_t^{ie}\left(C_t^{ie}+Z_t^{ie}\right) - P_t^{io}\left(C_t^{io}+Z_t^{io}\right). \tag{37}$$

Since loans B_t^l are in nominal terms, real credit losses are $d_t^lB_t^l/P_t$. Subtracting from gross output Y_t^g as listed in (3) gives net output or real GDP, $Y_t = Y_t^g - d_t^lB_{t-1}^l/P_t$. Market clearing conditions for output, asset and money markets are,[9]

$$Y_t = C_t + G_t + Z_t + E_t^x, \quad A_t = -B_t^f, \quad \bar{M}_t = M_t^s/\bar{P}_{t+1}. \tag{38}$$

Demand for home goods stems from consumption, public spending, investment and exports. Households own firms and banks and, accordingly, receive dividends as in (10).

[9] There is no separate condition for labor market clearing since each household type j is a 'local' monopolist and serves the entire market.

They also hold deposits, leading to a net income flow S_t^d. Therefore, A_t is the residual stock of savings which must be equal to net foreign assets if B_t^f is negative. Finally, the private sector chooses real money balances which must be equal to money supply, $\bar{M}_t = M_t^s / \bar{P}_{t+1}$. One of the conditions is redundant by Walras' Law.

2.7 Eurozone and Rest of the World

Given our focus on Italy, we propose a minimal model of the rest of the Eurozone but rich enough to analyze Italy's policy alternatives in the Euro Area. We therefore entirely abstract from fiscal policy, banking and supply side details, and replace production of final goods by an autoregressive process for Eurozone GDP,

$$Y_t^e = \left(1 - \rho^{Y,e}\right) Y_0^e + \rho^{Y,e} Y_{t-1}^e + \varepsilon_t^{Y,e}. \tag{39}$$

Preferences are similar to (8-9), except for fixed labor supply. Being endowed with an income stream $P_t^e Y_t^e$, households choose intertemporal consumption and money demand. The real interest rate determines consumption growth and savings as in the Euler equation (12), and demand for real money balances is $\bar{M}_t^e = m_t^e \bar{C}_t^e$. By the same principles as in (6), households allocate spending on home goods and imports,

$$\bar{P}_t^e \bar{C}_t^e = P_t^e C_t^e + P_t^{ei} C_t^{ei} + P_t^{eo} C_t^{eo}, \tag{40}$$

where $P_t^{ei} = P_t^i / e_t^{ie}$ and $P_t^{eo} = P^o e_t^{eo}$ are local demand prices of final goods from Italy and rest of the world, denominated in Euros. Goods demand is parallel to (6). Given the trade balance $TB_t^e = P_t^e E_t^{x,e} - P_t^{ei} C_t^{ei} - P_t^{eo} C_t^{eo}$, the current account is the mirror image of (37). Net foreign debt of Italy corresponds to net foreign assets of the Eurozone. In parallel to (38), market clearing in the EZ economy requires $Y_t^e = C_t^e + E_t^{x,e}$, $A_t^e = -B_t^e$, and $\bar{M}_t^e = M_t^{s,e} / \bar{P}_{t+1}^e$. Supply stems from the output process above. Demand consists of consumption demand and exports only. In an autonomous regime, the money supply rule is parallel to (34). One of the three conditions is redundant by Walras' Law.

The Rest of the World consists of other countries (indexed by o) and is even simpler. The final good serves as the *numeraire*, i.e., we abstract from monetary policy in RoW and normalize the local price to $P^o = 1$. RoW is represented only by import demand functions for Italian and EZ exports to RoW,

$$C_t^{oi} = s^{oi} \cdot \left(e_t^{io}/P_t\right)^{\sigma_r}, \quad C_t^{oe} = s^{oe} \cdot \left(e_t^{eo}/P_t^e\right)^{\sigma_r}. \tag{41}$$

Now all export demands are specified. Italian exports $E_t^x = C_t^{ei} + C_t^{oi}$ reflect import demand from the Eurozone and RoW. Exports of the Eurozone and of RoW to Italy serve Italian imports for both consumption and investment needs, giving $E_t^{x,e} = C_t^{ie} + Z_t^{ie} + C_t^{oe}$ and $E_t^{x,o} = C_t^{io} + Z_t^{io} + C_t^{eo}$. Since we abstract from capital flows relating to RoW, trade of that region must be balanced, $TB_t^o = P^o E_t^{x,o} - P_t^{oe} C_t^{oe} - P_t^{oi} C_t^{oi} = 0$. Finally, by Walras' Law, $TB_t + e_t^{ie} TB_t^e + e_t^{io} TB_t^o = 0$. In the world economy, the sum of trade balances, after converting them into the same currency (e.g. Lire), must add up to zero.

2.8 Currency Union

In a *currency union*, there is only one monetary policy subject to one money market clearing, and the internal exchange rate is fixed at $e^{ie} = 1$. Money supply is based on the state of the whole union which is a weighted average of the two regions. We use weights $s^Y = PY/\left(PY + P^e Y^e\right)$ and $1 - s^Y$ equal to the calibrated shares in total Eurozone GDP of Italy and the rest. We define a 'price index' $\bar{P}_t^u$ and get

$$Y_t^u \equiv \left(P_t Y_t + P_t^e Y_t^e\right)/\bar{P}_t^u, \quad \bar{P}_t^u \equiv s^Y \bar{P}_t + \left(1 - s^Y\right) \bar{P}_t^e. \tag{42}$$

Accordingly, the Euro Area wide inflation is $1 + \pi_t^u \equiv \bar{P}_{t+1}^u/\bar{P}_t^u$, while local inflation reflects changes in local price indices. In money market equilibrium, central money supply must accommodate the sum of money demands in both regions, $M^{s,u} = \bar{P}\bar{M} + \bar{P}^e \bar{M}^e$. The common monetary policy rule includes trend and countercyclical components as before,

$$M_t^{s,u} = \left(1 - \rho^m\right) \phi^{m,u} \bar{Y}_{t-1}^u \cdot \frac{\left(\bar{Y}_{t-1}^u / Y_t^u\right)^{\psi_y}}{\left(1 + \pi_t^u\right)^{\psi_\pi}} + \rho^m M_{t-1}^{s,u} + \varepsilon_t^{m,u}. \tag{43}$$

We allocate total money supply to each region to accommodate local money demand.

In a monetary union, the internal exchange rate is fixed ($e^{ie} = 1$), and monetary policy is centralized. Total money supply is governed by the policy rule (43) and must accommodate the sum of regional money demands. For a very small member state with little weight in Euro Area wide GDP and inflation, monetary policy is effectively exogenous. Common monetary policy serves as our base case. Alternatively, in the autonomous regime, money markets are separate. Monetary policy is decentralized to target local conditions, and the internal exchange rate e_t^{ie} becomes fully flexible. Exit from the Eurozone reflects a regime change from common to separate policies.

3 Quantitative Analysis

3.1 Model Calibration and Estimation

We calibrate a stationary state and estimate selected parameters and shock processes to track past economic performance. To reflect conditions in the early phase of the Eurozone, we use an average of the period 2001:1-2006:4 of detrended quarterly data. After detrending, growth and inflation rates are zero. Model solutions thus reflect deviations from long-run rates. We normalize Italian GDP to 100 so that all macro data are interpreted in percent of GDP. We infer relative country size from Eurostat and Worldbank data. Italy produced 18% of EA's GDP, while EA's GDP was 17% of world GDP.

Table 1 reports key parameters and data. By OECD data, EA sovereign bonds paid an annual rate of roughly 4%, largely the same in all member states. The prototype safe asset is long-term US Treasury bills which paid on average of 2% per annum. We assume that all assets yield the same risk adjusted return of 0.75% quarterly, corresponding to 3% per annum. The discount factor β is set to support stationary consumption. A typical equity premium from Eurostat data yields a return of 3% (12% p.a.). The loan interest on private credit relates to bank funding costs and is 1.45%, or 5.8% p.a.

Table 1: Key Parameters and Data

Quarterly interest rates:		
i	0.75%	safe, benchmark interest rate
i^k, i^b	3%	required return on equity
i^l	1.45%	loan rate of interest
Household sector:		
$1/\eta$	0.5	Frisch labor supply elasticity
$1/\sigma^c$	2/3	intertemporal SE
σ^m	3	SE consumption / money
σ^r	5	SE goods by region
σ^v	6	SE differentiated products
σ^l	4.5	SE labor varieties
ω	0.8	rate of wage adjustment
Production and banking sector:		
α	0.25	capital income share
δ	0.03	capital depreciation rate
b^l	0.6	debt/asset ratio firms
κ^B	0.11	equity ratio business credits
κ^G	0.03	equity ratio sovereign bonds
s^l	0.06	non performing loan share
$1-\ell$	0.075	liquidation loss rate loans (quarterly)
σ^{sl}	13.2	output elasticity of bad loan share
Dynamics:		
b^f	0.88	net foreign debt/GDP ratio (quarterly)
γ	0.0124	interest sensitivity w.r.t. foreign debt
ψ	5	adjustment cost to investment
ρ	0.924	persistence of cyclical shocks

Remark: SE substitution elasticity.

Based on evidence in Keane and Rogerson (2012) and Chetty et al. (2011), we set the Frisch labor supply elasticity to 1/2, corresponding $\eta = 2$. The intertemporal substitution elasticity is 2/3, implying $\sigma^c = 1.5$, which is a typical value as in Smets and Wouters (2003, 2005), for example. The interest sensitivity of money demand depends on the substitution elasticity between consumption and real money balances which is 3 as in Walsh (2010, p.49-52 and 72). The price sensitivity of trade flows depends on the Armington elasticity of substitution between goods of different country origin. Evidence in Adolfson et al. (2007)

and Obstfeld and Rogoff (2000) gives $\sigma^r = 5$. To match mark-up data, we fix the elasticity of variety substitution at $\sigma^v = 6$, implying a mark-up factor of 1.2 (Schmitt-Grohé and Uribe, 2005). Finally, we follow Gali (2015, p.177) and set the substitution elasticity for labor varieties equal to $\sigma_l = 4.5$ and the degree of wage stickiness to $\omega = 0.8$. This is broadly consistent with Schmitt-Grohé and Uribe (2005) who rely on wage stickiness between 0.64 and 0.87 and with Erceg et al. (2000) who use a value of 0.75.

Regarding transitional dynamics, a widely used parameter value for adjustment costs to investment is $\psi = 5$, in line with Smets and Wouters (2003) who estimate a confidence interval between 5.1 and 8.9. We set the prior of the autoregressive coefficients of business cycle shocks equal to $\rho = 0.95$, with the estimated values ranging from 0.9 to 0.94 (see Appendix). Estimations for the Euro Area suggest values between 0.85 and 0.95 (Smets and Wouters, 2003, Gerali et al., 2010).

Turning to production, we set the capital share in value added to $\alpha = 0.25$. Adding monopolistic profits then comes close to OECD data on the income share of capital. The depreciation rate is $\delta = 0.03$, or 12% annually. Demand for bank credit follows from a fixed debt-to-asset ratio $b^l = 0.6$, based on Eurostat data of a debt-to-asset ratio of 63% for EA non-financial firms. Italian banks had an equity ratio κ^B of 11%, leaving a buffer of 3% in excess of the regulatory capital ratio of 8% for corporate credit. In line with Basel II accords, the regulatory weight for sovereign bonds is zero so that κ^G is equal to the voluntary buffer. Already in the early 2000's, Italy's non-performing loan (NPL) share amounted to 6.6%, substantially above the share of 2.5% in the EA, and multiplied by roughly 2.7 since then. The loss rate on non-performing loans amounts to 30% annually, or $l = 7.5\%$ per quarter, reflecting estimates for total recovery rates between 50 and 85%.[10] The NPL share is sensitive to output fluctuations. By (33), the semi-elasticity in a steady state is $ds^l = -s^l \sigma^{sl} \cdot dY/Y$. We postulate that a recession with an output loss of 5% ($dY/Y = -.05$) changes the NPL share by four percentage points ($ds^l = .04$)

[10] Acharya et al. (2007) report a mean loan recovery rate of 81% from a sample of non-financial US corporations over 1982-1999. Grunert and Weber (2009) find a 73% retrieval rate for German firms while Caselli et al. (2008) estimate a rate of only 48% for Italian SMEs.

which requires $\sigma^{sl} = (.04/.05)/s^l \approx 13.3$.[11]

Finally, net foreign debt amounts to 22% of annual GDP, or 88% of quarterly GDP. An increase in net foreign indebtedness translates into a higher country premium and raises domestic interest rates. We normalize the country premium to zero in the steady state, so that $\theta = 1$ in (36). We then calibrate γ such that an increase in the debt-to-GDP ratio by 20 percentage points raises the interest rate by 25 basis points (1 percentage point annually).[12] Turning to trade flows, Italy imported 23% of GDP and exported 21%, according to Eurostat data. Of all imports, 47% were sourced from the EA and 53% from RoW. On the export side, 47% of all exports went to the EA and 53% to RoW. Using export data from RoW to all individual EA countries (except Italy), one can determine EA's import share as 19% of GDP, of which 12% stemmed from Italy and 88% from RoW.

Table 2: Policy Parameters

Fiscal policy:		
$\bar{b}^g$	420%	fiscal debt-to-GDP target (quarterly)
γ^g	0.97	fiscal consolidation speed
$\bar{g}$	15%	public consumption spending to GDP
σ^z	0.25	productivity effect public infrastructure
ξ^g	0.2	consolidation share productive spending
ξ^e	0.1	consolidation share social spending
Monetary policy:		
m	1.3	money-consumption ratio
ψ_π	2	sensitivity of money supply to inflation
ψ_y	1	sensitivity of money supply to output gap

Table 2 reports parameter values that govern fiscal and monetary policy as well as transitional dynamics. By OECD data, the Italian debt was 105% of annual GDP in 2006

[11] Nkusu (2011) finds that a 2.7 percent shock to GDP growth causes NPLs to increase by 1.7 percentage points within four years in an advanced economy. His analysis also shows that this relationship is highly non-linear. Larger shocks to GDP growth will lead to substantially larger responses in NPL rates.

[12] Specifically, we define $(1+i_t)\, e^e_t/e^e_{t+1} \equiv 1 + \tilde{\imath}_t$ in (35) and use (36) to calculate the slope $d\tilde{\imath}_t/db^f_t = (1+i^e)\,\gamma$ where $e^{b^f - \bar{b}^f} = 1$ in a steady state. Replicating the quantitative response thus requires $d\tilde{\imath}_t/db^f_t = (1+i^e)\,\gamma = .0025/.2$. Noting $i^e = i = .0075$, we find the parameter $\gamma = .0124$.

(420% of quarterly GDP, $\bar{b}^g = 4.2$). This compares to a much lower ratio of 61% in EA without Italy in 2006, and has grown since then to about 130% of annual GDP. Banks (and other financial institutions) hold around 35% of national public debt in Italy, giving $\tilde{s}^b = 0.35$. The parameter γ^g determines the speed of fiscal consolidation. The value $\gamma^g = 0.97$ implies a half-life of debt adjustment of 23 quarters, or less than six years. We assume that 70% of consolidation results from tax increases and 30% from spending cuts. One third of cuts affect social spending ($\xi^e = 0.1$), and two thirds productive spending ($\xi^g = 0.2$). Social spending absorbs 18.5% of GDP which is 30% of gross wage income ($\bar{e} = 0.295$). Public consumption in Italy amounts to 14.6% of GDP ($\bar{g} = .15$). Adding debt service gives a total expenditure share of 44.3% of GDP.

Following Barro (1990), we allow for a positive productivity effect of productive public spending where $\sigma^z = 0.25$ is consistent with typical estimates of the output effect.[13] In calibrating money demand, we set the money-consumption ratio to $m = 1.3$. Regarding monetary policy, we postulate a money supply rule, but allow for discretionary intervention in times of crisis. Ascari and Ropele (2013) have estimated the sensitivities of money supply to changes in the price level and the output gap and report values between 1 and 3 for ψ_π and a range of 0 to 1 for ψ_y.

3.2 Tracking Past Performance

Calibration results in a deterministic steady state reflecting the conditions at the start of the monetary union in early 2000. We now use the model to track the evolution of the Italian economy since then, and Euro Area GDP. Since the model requires stationary

[13] Colombier (2009) finds that an increase in spending on transport, water systems and education by one percentage point raises the per capita growth rate of real GDP by 0.5 percentage points. The estimate of Bleaney et al. (2001) is lower at 0.3 percentage points. In (24), the long-run productivity effect is $\hat{z} = \sigma^z \hat{G}$, where $z = \bar{z}$ and $G = \delta^g K^G$. Assuming constant user cost and employment, technology $Y^g = zK^\alpha L^{1-\alpha}$ implies $\hat{Y}^g = \hat{z} + \alpha\hat{K}$ while Y^g_K constant yields $\hat{Y}^g_K = \hat{z} - (1-\alpha)\hat{K} = 0$. Combining, the long-run output effect is $\hat{Y}^g = \frac{1}{1-\alpha}\hat{z} = \frac{\sigma^z}{1-\alpha}\hat{G}$. With $\alpha = .25$ and $\sigma^z = .25$, the output elasticity of productive spending is $.25/.75 = 0.33$, well within the range of typical estimates.

data, we use a Kalman implementation of the one-sided HP filter for detrending output data. The Kalman filter includes a zero constant which allows us to scale the series to fluctuate around a normalized output value. We also remove seasonal trends in wages. Prior to 2014, the share of non-performing loans is reported with annual frequency only. We obtain quarterly data by linear interpolation of annual values.

The most commonly used estimation method adds structural shocks (see Smets and Wouters 2003, 2007, and Rabanal and Rubio-Ramírez, 2005) to estimate the parameters influencing model dynamics and to calibrate those affecting the steady state. Using Bayesian estimation procedures, we let the model determine the shock processes to replicate key time series from 2000 to 2018. Specifically, we estimate shocks to factor productivity ϕ_t^Y, bad loan share s_t^l, risk premia on sovereign bonds θ_t^g and deposits θ_t^d, as well as government consumption G_t and social spending E_t in Italy. Furthermore, we include a shock process to the Eurozone GDP Y_t^e into our estimation. With seven endogenously determined shocks, the model replicates exactly, without error, seven selected time series as part of the stochastic general equilibrium solution. Motivated by the earlier discussion of past economic performance in Italy, we track the wage index w_t, the GDP share of fiscal debt $B_t^G/(P_tY_t)$ and government consumption $G_t/(P_tY_t)$, the bad loan share s_t^l, interest rates i_t^d and i_t^g on deposits and fiscal debt in Italy, as well as output in the Eurozone Y_t^e.

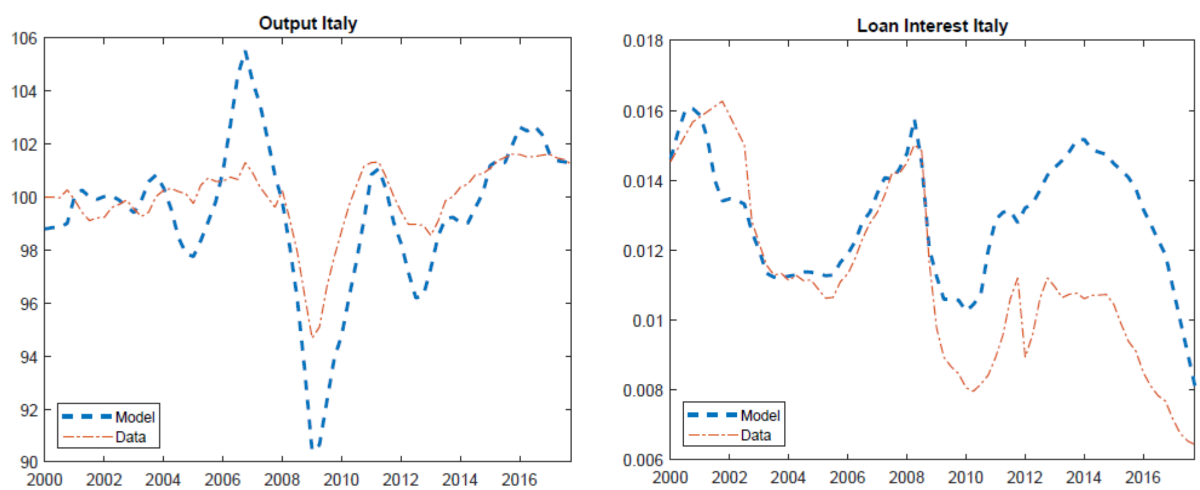

Figure 1: Simulated and Actual Time Series

Given a relatively small selection of 'targeted' variables, the model cannot exactly replicate but only approximate more or less closely the remaining data. Figure 1 compares actual and simulated gross output and the loan rate of interest in Italy since the start of the currency union. As a result of detrending, the Figure shows fluctuations around a trend. The approximation appears reasonable. The relatively favorable performance prior to the crisis led to output substantially moving above trend. The sharp recession starting in 2008 resulted in a large drop in output. The subsequent periods have seen a moderate recovery over the past ten years. By and large, the loan rate of interest followed a downward trend, although with a period of rising rates prior to the start of the crisis.

In addition to the shocks, we have also estimated a number of structural parameters. Appendix B describes the estimation procedure in more detail, including our assumptions on priors and the resulting posterior distributions of estimated parameters in Table A1.

3.3 Sustained Reform

Our rich structural model of Italy as part of the Eurozone allows for an analysis of many policy options. Although the model is quite detailed, we can only paint a broad picture. Starting from unfavorable initial conditions, we explore the potential consequences of (i) sustained reform within the Eurozone with a long-term policy commitment; and (ii) exit from the Eurozone, triggered by a severe asymmetric recession. The starting point of the analysis is an unfavorable stationary equilibrium as portrayed in Table 3.

The model is calibrated to reflect the situation at the start of the Eurozone and some key model parameters are estimated to track the development since then. Today, Italy appears to be stuck in a bad equilibrium and confronts a 'trilemma' of excessive government debt, a vulnerable banking sector and stagnant growth. The last column of Table 3 illustrates a constructed steady state that can rationalize the state of the Italian economy today in several key variables (FSS). The numbers partly reflect a cumulative negative causation of the three drivers of the Eurozone crisis that were discussed, for example, by Shambaugh (2012). Public debt is about 130% of GDP, compared to 105% twenty years earlier, with no clear tendency for reversal. Given the growth in government spending resulting from a larger debt burden and an assumed increase in social spending of about 3% of GDP,[14] the effective income tax rate is 3.5 points higher,[15] thereby discouraging employment and investment. To stabilize debt, the government must initiate fiscal consolidation which, by assumption, is based 70% on tax increases, 20% on cuts in productive spending and 10% in social spending (which partly offsets the initial increase). Importantly, the cuts in productive spending imply deteriorating public services and infrastructure which endogenously transmits into stagnant factor productivity.

Table 3: A Bad Stationary Equilibrium

Symbols	Names	ISS	FSS
B_G/PY	Fiscal Debt/GDP *)	4.2000	5.2000
s_l	Bad Loan Share Banks	0.0600	0.1500
Y	Real GDP	0.0000	-10%
K	Capital Stock	0.0000	-17%
L	Employment	0.0000	-3%
Cbar	Private Consumption	0.0000	-9%
w/Pbar	Real Wage	0.0000	-6%
z	Factor Productivity	1.0700	1.0389
tau	Income Tax Rate	0.3000	0.3362
i	Ann.Domestic Interest	0.0300	0.0300
B_f/PY	Net For. Debt/GDP *)	0.8800	0.8800

Remark: *) In pc of quarterly GDP. ISS steady state at start of Eurozone. FSS steady state in bad equilibrium.

On top of that, the banking sector remains vulnerable with a high share of bad loans which forces banks to raise the loan rate. A higher cost of credit, a higher tax burden and a deteriorating infrastructure all contribute to a slowdown of investment and growth.

[14] By Eurostat data, social spending increased from 19% in the early 2000s to more than 22% in 2018.

[15] The OECD tax database reports an all-in average personal income tax rate at the average wage for a single worker without children of 31.4%, up from 28.5% in 2001.

In this bad equilibrium, the model implies a capital stock 17% lower than at the start of Eurozone membership. Higher labor taxes and lower real wages on account of declining productivity discourage labor supply and employment as well which is 3% lower. The decline in real wages of about 6% comes close to observed trends (ILO, 2018). Reduced factor inputs and declining productivity imply a 10% reduction of the output level and a 9% loss in private consumption.[16]

These developments render Italy in a vulnerable position. As a member of the Eurozone, it lacks monetary policy instruments that could be targeted to the national economy to dampen the impact of asymmetric shocks. It also lacks important adjustment mechanisms such as exchange rate flexibility. The ability of fiscal policy, banks and the real sector to absorb shocks and dampen business cycle fluctuations is limited, leading to larger recessions and making it more vulnerable to a loss of confidence on financial markets. We first discuss key reforms that could potentially reverse the unfavorable trends and increase the gains from Eurozone membership. Although the proposed reform agenda is not unique, any comprehensive reform for sustained recovery should address all three parts of the economic trilemma as discussed above:

- Fiscal reform: We reduce the long-term debt target $\bar{b}^g$ to the level at the start of Eurozone membership equal to 105% of annual GDP which initiates tax- and expenditure-based consolidation as described in (22-23). Past experience shows that fiscal consolidation is predominantly tax based. To reconcile consolidation with growth, we instantaneously raise investment tax credits (increasing the expensing rate t^z from .1 to .5) to reduce the effective tax on investment.
- Reversing stagnant productivity growth: Specifically, we raise the share $\bar{g}$ of productive fiscal spending (e.g., basic research, schools, judicial system, hard infrastructure) by 2% of GDP. This endogenously transmits into slowly accumulating pro-

[16] The last two lines of Table 3 result from a model with international capital flows and infinitely lived agents. In the long run, domestic interest is tied to foreign interest rates, see (36). The net foreign asset position must thus be a constant fraction of GDP, with possibly large deviations in transitory periods.

ductivity gains, see (24) and (2). To boost competitiveness, we also mimic internal devaluation and reduce the taste parameter $\bar{\phi}$ by 5% which initiates a delayed reduction of ϕ_t as in (9), thereby stimulating employment and inducing households to accept somewhat lower wages.[17]

- Reducing non-performing loans: We analyze the consequences of banks reducing the share of bad loans to the level at the start of the Eurozone ($s_t^l \rightarrow \bar{s}^l$, from 15% to 6%, see 32-33). This decrease is supported by economic recovery initiated by sustained reform. To accelerate bank recovery and stimulate lending at lower interest rates, the government provides support and subsidizes the currently high credit losses at a rate t^b, starting with 50% and phasing out with the reduction in bad loans.

Comprehensive reform requires long-term commitment and involves a long time-horizon for the gains to become effective. Private and public capital accumulation and fiscal consolidation are slow processes. The figures below show the adjustment process over 400 quarters or 100 years. Table 4 reports key indicators, starting from a bad equilibrium (column ISS) as portrayed in Table 3 and reaching a new final steady state (column FSS). Column 'Q40', for example, lists the changes 40 quarters or 10 years after the start of the reform program. The dark shaded rows report absolute numbers, the light shaded rows give percent changes relative to the base case equilibrium.

The reform is designed for the country 'to grow out of high debt levels'. Adjustment is driven by several strong growth stimuli, consisting of a large, instantaneous increase in investment tax credits, a productivity-enhancing program of improving public infrastructure, 'internal devaluation' by inducing households to accept somewhat lower wages, and a bank recovery program to assure lower rates of interest. The total reform plan initiates

[17] A lower ϕ_t directly reduces the marginal rate of substitution between work and consumption which determines the required consumption and wage to compensate for extra work, see (13) and footnote 5. In a more refined labor market model, such reform could reduce the bargaining strength of unions, remove obstacles to labor market participation etc. An alternative would be fiscal devaluation by shifting the tax burden from wage to consumption taxes (which are already rather high in Italy).

strong and sustained accumulation of private and public capital stocks and boosts productivity and competitiveness. The early adjustment phase reflects intertemporal substitution in labor supply. Households are willing to work more in the beginning when income and consumption levels are low, while they work less in the future when consumption is expected to be high.[18] Furthermore, the instantaneous increase in employment by almost 5% in the first quarter also reflects the internal devaluation, making households willing to work more even though taxes are higher initially and wages increase only with delay. The initial rise in GDP rests on employment gains and is somewhat less, since the capital stock can rise only slowly. The increase in GDP mainly accommodates strong investment demand and leaves little room for private consumption and exports. Consumption is only 1% higher after five years or 20 quarters, and exports even decline by 3% in the short run before export growth sets in. Over time, the GDP expansion increasingly relies on capital accumulation while the initial employment gains fade out. Household incomes increasingly stem from growth in real wages rather than more employment. Private consumption recovers only with considerable delay.

Ultimately, GDP is 18% higher than in the bad equilibrium. The long-run income gains exclusively rest on capital accumulation and improved factor productivity as employment remains rather constant and even slightly declines in the long run. Consumption follows the increase in aggregate output only with substantial delay but finally exceeds low initial levels in the bad equilibrium by about 12%. Rising exports, although setting in only after more than two years, reflect improved international competitiveness.

Strong growth is achieved in spite of fiscal consolidation, which requires higher consumption and income taxes. In isolation, the latter would discourage labor supply but larger investment tax credits more than compensate for the higher tax rate, substantially reduces the cost of capital, and boosts investment. Tax rates almost instantaneously rise

[18] In other words, low consumption today implies a low marginal rate of substitution (MRS) between leisure and consumption so that households require little compensation for an extra unit of work and are willing to expand labor supply at low wages. As sustained growth increases the MRS in line with rising wages and consumption, households increasingly cut back on labor supply in the future.

by 3 percentage points to generate the revenue needed for sustained debt reduction but they roughly stay constant thereafter. Income and consumption growth swells the tax base and generates more revenue. Furthermore, the sustained reduction in the debt-to-GDP ratio on account of strong income growth partly reduces the need for further revenue increasing measures. Social entitlements are largely determined by a constant replacement rate of wage earnings as in (23) and contribute relatively little to budget consolidation. The simulation shows a reduction in social spending of less than half a percent of GDP. We conclude that a program of national recovery can be designed to be largely neutral in terms of intra-generational fairness but must involve substantial redistribution across present and future generations.[19]

Table 4: Reform Within the Eurozone

Symbols	Names	ISS	Q1	Q4	Q8	Q20	Q40	FSS
B_G/PY	Fiscal Debt/GDP *)	5.2000	4.9252	4.8845	4.8281	4.6411	4.3813	4.2000
s_l	Bad Loan Share Banks	0.1500	0.1452	0.1319	0.1168	0.0839	0.0549	0.0600
Y	Real GDP	0.0000	4%	4%	5%	7%	10%	18%
K	Capital Stock	0.0000	2%	5%	9%	16%	21%	40%
L	Employment	0.0000	5%	3%	2%	1%	1%	-1%
Cbar	Private Consumption	0.0000	0%	0%	0%	1%	4%	12%
Ex_e	Exports to Rest of EZ	0.0000	-3%	-2%	0%	3%	6%	10%
Ex_o	Exports to RoW	0.0000	-3%	-2%	0%	3%	5%	9%
K_G	Public Capital Stock	0.0000	0%	2%	3%	8%	14%	36%
w/Pbar	Real Wage	0.0000	1%	2%	3%	5%	7%	17%
z	Factor Productivity	1.0389	1.0390	1.0397	1.0415	1.0496	1.0651	1.1216
tau	Income Tax Rate	0.3362	0.3709	0.3709	0.3705	0.3697	0.3666	0.3613
i	Ann.Domestic Interest	0.0300	0.0305	0.0307	0.0315	0.0347	0.0367	0.0300
i_g	Ann.Gov.Debt Interest	0.0300	0.0305	0.0307	0.0315	0.0347	0.0367	0.0300
i_l	Ann.Loan Interest	0.0859	0.0629	0.0635	0.0643	0.0659	0.0639	0.0582
e_io	Euro/Dollar Exch.Rate	0.9938	1.0039	1.0021	1.0002	0.9963	0.9948	1.0062
B_F/PY	Net For. Debt/GDP *)	0.8800	0.8619	0.9284	0.9927	1.0569	1.0003	0.8800

Remarks: *) Quarterly GDP ratios. ISS steady state in bad equilibrium. FSS steady state in reform scenario.

Table 4 also illustrates a strong decline in interest rates for business loans, down from about 8.6% in the initial situation to about 5.8% annually in the long-term. A major part is due to the fiscal subsidy which temporarily subsidizes credit losses of banks and

[19] A model of infinitely lived families doesn't lend itself to discuss fairness across generations. Future research should use an overlapping generations model to explore intergenerational effects.

is priced into lower loan rates. The subsidy is phased out along with the reduction in the share of bad loans. The debt ratio of firms is about 60% of assets. The reduction in bank lending rates therefore substantially reduces the cost of capital and boosts investment, which is the main purpose of the measure in the first place. Finally, the investment-led recovery in the early adjustment phase is financed to a large extent with foreign debt. Net foreign debt is relatively low at the outset, equal to 22% of annual GDP (88% of quarterly GDP). Italy is thus in a relatively good position to resort to foreign funding of domestic investment. Within five years, the foreign debt-to-GDP ratio rises substantially before it reverts back to historical values. Within the same time span, the national interest rate rises by about half a percentage point as investors require a somewhat higher country premium due to the rising debt-to-GDP ratio. Funding costs of government, banks and firms increase in line and decline thereafter.

Figure 2 illustrates dynamic adjustment and separates the effects of the three pillars of the reform plan. The decomposition is cumulative, that is, the competitiveness program is added to the fiscal package, and bank recovery comes on top of the other parts. Fiscal reform stabilizes the debt-to-GDP ratio. Consolidation is mostly tax based and immediately raises tax rates across the board (income and consumption taxes) by more than three percentage points. To avoid distortions, a strategy of 'growing out of debt' must thus combine consolidation with powerful investment incentives. Model simulations draw an encouraging picture of growth-friendly fiscal consolidation. The direct effect is a sustained reduction of the debt-to-GDP ratio after a small decline in the first quarters. This is partly due to strong growth induced by tax incentives. The output gains correspond to about six percentage points of GDP,[20] and the index of real producer wages recovers to the level at the start of the Eurozone. As discussed above, labor supply responses shift employment from the future to the present and speed up current recovery.

The program that aims at enhancing competitiveness and growth includes internal

[20] The effect appears large but studies of fundamental tax reform yield even larger effects. Altig et al. (2001), for example, simulate output gains up to 9% from a comprehensive tax reform in the U.S. that among other measures includes full expensing of new investment.

devaluation to encourage employment and an increase in productive government spending. The growth effect is powerful, adding another 5 percentage points of GDP in the long run which substantially stems from employment gains. Engineering an internal devaluation realistically takes considerable time. We mimic this by slowly phasing in labor supply incentives with the autoregressive process stated in (9). The employment gains (relative to the fiscal scenario) thus materialize with some delay. The budget cost of productive spending increases tax rates by about 2 percentage points across the board (not shown). Apart from transitional dynamics, the consolidation policy in (22) allows the nominal debt level to increase in proportion to nominal income gains where the proportionality factor corresponds to the new target level of 105% of annual GDP. For this reason, the effect on the debt-to-GDP ratio is almost not visible in the early adjustment phase, while induced growth in later periods speeds up the debt reduction.

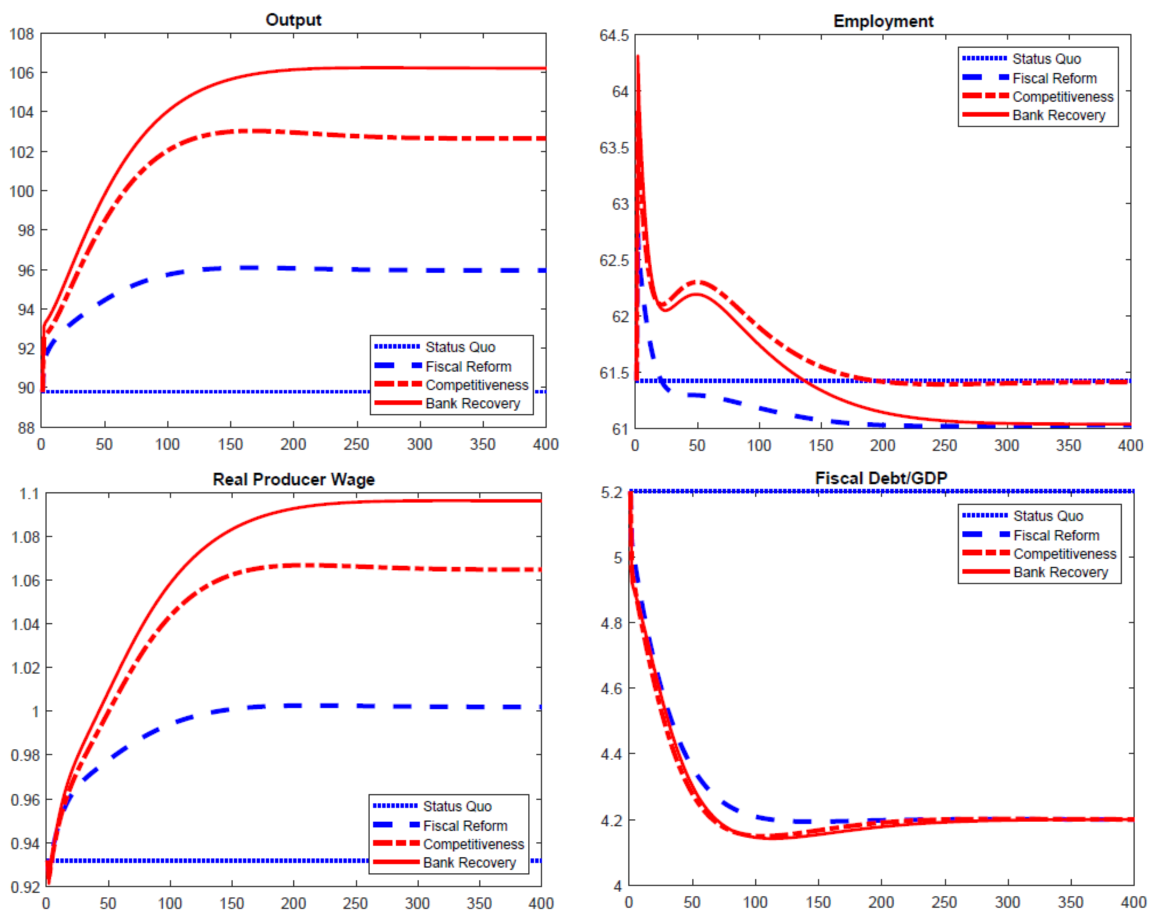

Figure 2: Reform Within the Eurozone

Finally, the bank recovery program, by reducing the cost of credit and stimulating demand driven bank lending, adds roughly three additional percentage points of GDP in the long run. The effects kick in with some delay, since induced investment takes time to build up productive capacity, and because the reduction in bad loans is a prolonged process as well. Since we treat temporary bank subsidies as not being part of the 'structural deficit' subject to consolidation, they fully go into debt before they are consolidated in later periods. The bank subsidies may thus slow down the reduction in fiscal debt-to-GDP ratios in the early adjustment phase, but the difference is hardly noticeable.

3.4 Recession and Exit

Scenarios: The preceding section paints an encouraging picture about how structural reform and fiscal consolidation could help to escape the current stagnation. An uncompromising policy commitment over more than a decade could yield substantial productivity gains, revive growth and achieve a remarkable reduction in the public debt-to-GDP ratio. However, is political commitment realistic? Could the reform process be interrupted by another severe crisis? Given the difficulties of securing lasting political support and the current economic vulnerabilities, we explore an alternative scenario. How can the country cope with a severe asymmetric recession when exchange rate adjustment is not possible and monetary policy cannot target the specific situation in a single member country? Whether intentional or forced, an exit from the Eurozone and the introduction of an own currency (Lira) might become a possibility. To which extent could the country reduce the costs of a severe recession by pursuing autonomous monetary policy and allowing for exchange rate flexibility? Given the complexity of the problem, our analysis can be no more than a crude approximation of possible developments. We focus on three scenarios.

- Asymmetric recession with continued Eurozone membership: Italy is hit by a combination of severe economic shocks, lasting for six quarters, while other regions are unaffected. Disutility of labor supply is exogenously increased by 10% over the period, implying that workers reduce labor supply and/or request higher wages. In addition, factor productivity is exogenously reduced by 2%, and the share of bad loans rises by 10% (from 15% to 16.5%). Apart from these exogenous changes, the emerging output gap endogenously adds to the share of bad loans as in (33), and factor productivity partly responds to changes in productive fiscal spending.

- Benign exit: Italy is hit by the same recession which instantaneously triggers exit from the Eurozone. The Euro/Lira exchange rate is flexible, and monetary policy is autonomously chosen. We assume that the national central bank aggressively responds to the output gap by expanding money supply, and thus raises the sensitivity to the output gap from one to five (see ψ_y in Table 1). The exit is benign in the sense that it does not lead to investor panic and speculative capital flight.

- Escalating exit: Mimicking investor panic, we raise the interest premium on government bonds and bank deposits as well as equity of firms and banks by a factor of 2. The sudden increase in 'risk premia' reflects funding shocks that require high interest to secure at least a reduced level of funding. These shocks last for two quarters and then phase out with the autoregressive process.

We emphasize two implications of the model to prepare intuition for the results. First, we treat the recession with and without Eurozone exit as a purely temporary event which may have quite dramatic short- and medium-run effects but is inconsequential for the long run. After the recession ends, the shock variables revert back to initial values in line with the estimated autoregressive processes. In the same vein, monetary policy may have substantial effects in the short but is neutral in the long run. Since we abstract from any permanent changes in structural parameters, the economy reverts to the same bad stationary equilibrium. Second, whenever the economy is in a steady state and no shock occurs, and whenever national monetary policy fully replicates centralized policy making, an unanticipated exit is completely neutral. Any effect on the exchange rate can only result from asymmetric shocks and from differences in monetary policy between Italy and the Eurozone. We thus expect in our scenarios rather modest changes in exchange rates even after an exit. Figures 3 and 4 decompose the cumulative effects of the three scenarios and illustrate transitional dynamics for key economic indicators. Table 5 reports more detailed information of the total effect (scenario 3, escalating exit).

Recession Within Eurozone: The dashed lines in Figures 3-4 refer to the impact of a deep asymmetric recession in Italy. Neither the internal exchange rate nor monetary policy can adjust. Our assumption is that monetary policy is conditional on average economic performance in the total Euro area and cannot separately address the recession in Italy. Given several large negative shocks, the recession is bound to be very severe and involves an instantaneous output loss of about six percentage points. This loss accumulates to a maximum of eight percentage points within eight quarters when shocks start to fade out and economic recovery sets in.

The recession feeds on several sources: The cost of capital is linked to interest rates, which tend to rise rather than fall in the absence of monetary intervention. The output price instantaneously rises due to a negative productivity shock and weakens competitiveness relative to trading partners, thereby eroding exports as well. Given nominal wage stickiness, the price increase somewhat reduces the real producer wage to stabilize employment. However, the negative labor supply shock counteracts this effect so that employment, all in all, drops by four percent relative to the bad stationary state. The large emerging output gap substantially raises the share of non-performing loans from already high 15% to 23% within four years. This forces banks to raise loan interest rates by about 2.4 percentage points annually, from 8.6 to more than 11% over the same period such that firm investment substantially falls.

By construction, centralized monetary policy cannot target the specific situation in Italy and remains rather passive. Fiscal policy is constrained by a high level of debt and cannot run into a substantial deficit, thereby preventing automatic fiscal stabilization to a large degree. The model does not allow for a deviation from the consolidation rule as described in Section 2.4, so that the government must slightly tighten the fiscal stance to prevent a substantial increase in public debt. Our model simulation thus emphasizes that a

Eurozone member state with excessive public debt, little competitiveness and a vulnerable banking sector is bound to experience more severe recessions than other member states if they were subject to the same shocks.

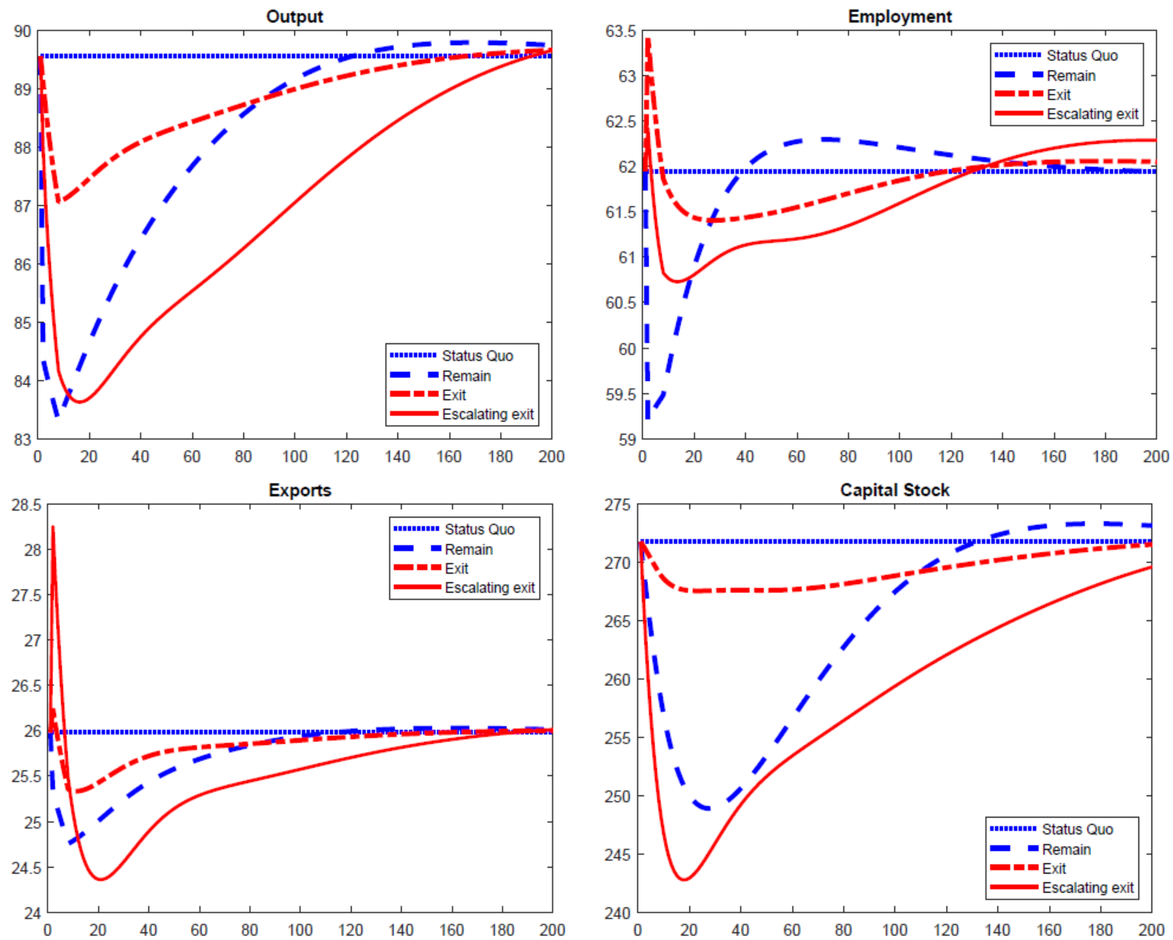

Figure 3: Recession and Exit from Eurozone

Benign Exit: A 'benign exit' is defined as one that occurs without panic-driven investor reactions. We consider the same shocks as before but now the internal exchange rate is flexible, and monetary policy is autonomous and can help cushion the recession. We assume that the national central bank aggressively expands money supply and liquidity to counter the deep recession. We thus raise the sensitivity of money supply to the output gap from one to five. The aggressive monetary expansion leads to a sudden and unanticipated increase in the price level. The real value of outstanding nominal debt is depreciated.

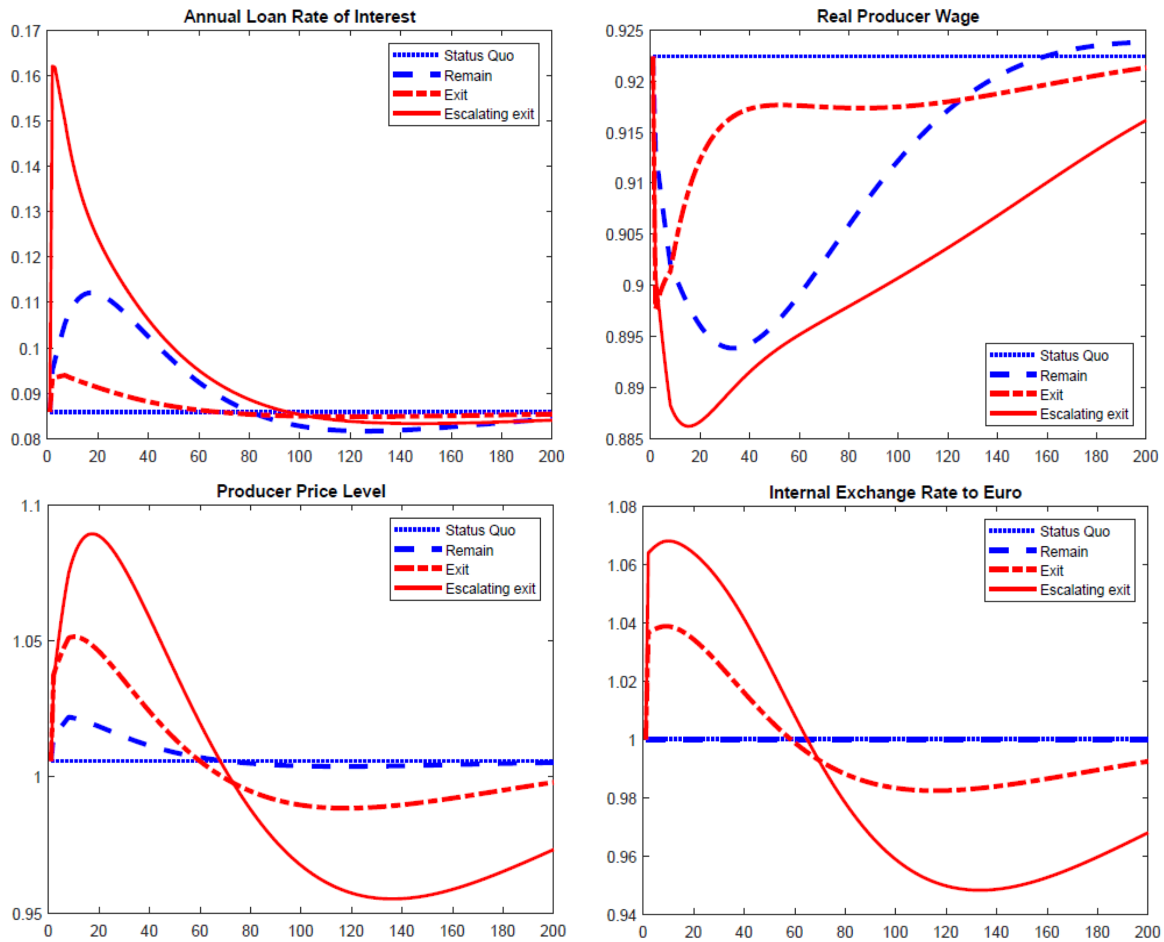

Figure 4: Recession and Exit from Eurozone

More importantly, given sticky nominal wages, monetary policy is able to engineer an immediate reduction in real wages, much faster than in the first scenario. Real wage cuts lead to substantial employment gains before the recession deepens. Given the immediate losses in real wages and consumption, households respond by expanding labor supply today when consumption is low, and reduce it later on when real wages and consumption recover again. The initial employment response prevents a massive reduction in output. The real wage reduction more than halves the output loss in the early adjustment period. On the demand side, the decline in investment and consumption is much less dramatic, and exports largely keep up as the sudden increase in domestic producer prices goes in line with an immediate depreciation of the Lire. This restores competitiveness in international markets, facilitates a moderate initial increase in exports and contributes to the reduction in output losses. Given the more benign nature of the recession in the exit scenario, the share of bad loans rises much less dramatically, so that banks can abstain from charging much higher loan rates and thereby squeezing credit demand.

Table 5: Recession and Exit from Eurozone

Symbols	Names	ISS	Q1	Q4	Q8	Q20	Q40	FSS
B_G/PY	Fiscal Debt/GDP *)	5.2000	5.1443	5.1751	5.1765	5.1627	5.2482	5.2000
s_l	Bad Loan Share Banks	0.1500	0.1666	0.1771	0.1978	0.2314	0.2145	0.1500
Y	Real GDP	0.0000	-2%	-4%	-6%	-6%	-5%	0%
K	Capital Stock	0.0000	-2%	-6%	-9%	-11%	-8%	0%
L	Employment	0.0000	1%	-1%	-2%	-2%	-1%	0%
Cbar	Private Consumption	0.0000	-1%	-2%	-3%	-3%	-4%	0%
Ex_e	Exports to Rest of EZ	0.0000	9%	3%	-3%	-7%	-4%	0%
Ex_o	Exports to RoW	0.0000	8%	2%	-3%	-6%	-4%	0%
K_G	Public Capital Stock	0.0000	0%	-2%	-3%	-5%	-6%	0%
w/P	Producer Real Wage	0.0000	0%	-1%	-3%	-4%	-4%	0%
w/Pbar	Consumer Real Wage	0.0000	-1%	-2%	-3%	-4%	-4%	0%
z	Factor Productivity	1.0198	0.9983	0.9976	0.9976	1.0037	1.0041	1.0198
tau	Income Tax Rate	0.2959	0.3401	0.3328	0.3202	0.3024	0.2990	0.2959
P	Producer Prices	1.0059	1.0351	1.0575	1.0784	1.0879	1.0565	1.0059
Pbar	Consumer Price Index	1.0016	1.0362	1.0547	1.0717	1.0785	1.0490	1.0016
gi	Ann.Inflation Rate	0.0000	0.0232	0.0128	0.0027	-0.0042	-0.0070	-
i	Ann.Domestic Interest	0.0300	0.0328	0.0311	0.0275	0.0217	0.0219	0.0300
i_d	Ann.Deposit Interest	0.0300	0.0984	0.0888	0.0717	0.0440	0.0327	0.0300
i_g	Ann.Gov.Debt Interest	0.0300	0.0984	0.0888	0.0717	0.0440	0.0327	0.0300
i_k	Ann.Return on Equity	0.1200	0.1968	0.1821	0.1543	0.1091	0.0985	0.1200
i_l	Ann.Loan Interest	0.0859	0.1621	0.1558	0.1437	0.1230	0.1055	0.0859
e_ie	Lire/Euro Exch.Rate	1.0000	1.0639	1.0663	1.0680	1.0631	1.0397	1.0000
e_eo	Euro/Dollar Exch.Rate	0.9937	1.0386	1.0496	1.0595	1.0616	1.0354	0.9937
B_f/PY	Net For. Debt/GDP *)	0.8800	0.8148	0.7031	0.6463	0.7408	0.9307	0.8800

Remarks: *) Quarterly GDP ratios. ISS steady state in bad equilibrium. FSS steady state in exit scenario.

The recession becomes worse as soon as employment gains disappear and investment cuts erode the capital stock. Although negative shocks fade out after eight quarters, their effects persist and make the recovery slower. A striking feature of the adjustment is that the same recession within the currency union is much more devastating in the early phase compared to a benign exit, but recovery is faster thereafter. The pattern is most dramatic in the time paths of real wages and employment. The monetary expansion shifts the real wage reduction forward in time so that real wages are lower today but higher thereafter. In consequence, employment first rises but is subsequently lower over a long time span which delays the recovery in employment, capital stock and output. The ability of monetary policy to stabilize the economy may thus reduce output and income losses over a prolonged early period but not uniformly so.

Escalating Exit: Since the economy starts from a vulnerable position, an exit could trigger a general loss of confidence and even panic-driven capital flight. An unanticipated inflation shock and a corresponding devaluation of the Lira implies a one-time reduction of wealth. We picture the loss of confidence by a sudden increase in risk premia on government bonds and bank deposits as well as equity of banks and firms. Interest rates on fiscal bonds and deposits essentially triple in the first two quarters of the recession and then revert back to normal levels with some delay. The solid lines in Figures 3-4 and Table 5 illustrate the dynamic adjustment.

Banks pass the increased cost of deposits as well as equity funding onto firms. The resulting increase in the loan rates of interest reflects a weighted average of deposit and equity funding costs and leads to a severe credit crunch. Compared to a benign exit, the funding stop caused by the sudden jump in capital costs severely impairs investment and leads to a much larger decline in the capital stock. The escalating scenario thus multiplies the recession in the early adjustment phase. The decline in economic activity endogenously swells the share of non-performing loans that reaches a maximum of almost 22% after 25 quarters, up from 15% in the bad initial equilibrium. The resulting credit losses endogenously force banks to raise loan rates even more which substantially delays the decline of credit costs and prolongs the recession.

The aggressive monetary policy response to the emerging output gap implies a substantially larger increase in the domestic price level and magnifies the depreciation of the Lira. With sticky nominal wages, the resulting real wage reduction is not only much larger but also persists over a long time span. The real wage cuts still result in a moderate employment gain in the very first quarters but smaller than before. Exports initially rise even more on account of a larger depreciation. However, export demand cannot make up for reduced investment and consumer demand. The sudden increase in sovereign funding costs constrains fiscal policy, which can thus not contribute to the stabilization of the economy. Overall, an escalating exit with a general loss of confidence and rising funding costs not only leads to a much sharper recession in the early adjustment period, but also substantially delays the economic recovery.

4 Conclusions

In a currency union, the internal exchange rate is fixed. Monetary policy is no longer available to stabilize the business cycle in a single member country but focuses on the average state of the entire union. Important adjustment mechanisms are missing. To compensate for the loss of monetary autonomy as a tool of macroeconomic stabilization, an individual member country must instead rely on fiscal policy and on automatic fiscal stabilizers. These instruments require low public debt, however. Banks can only help absorb shocks if endowed with sufficient equity and if lending activity rests on a low share of non-performing loans. Finally, a competitive and innovative economy is also more resilient and can better absorb macroeconomic fluctuations without creating large employment losses. In contrast, a recession can set off a vicious cycle if these conditions are not met, driven by mutual contagion between an overly indebted sovereign, a vulnerable banking sector, and an uncompetitive real economy.

Today, the Italian economy appears to be in a vulnerable position with respect to all three focal points. Using a New Keynesian DSGE model with nominal wage rigidity that pictures Italy and the rest of the Eurozone, this paper analyzed two broad alternatives for economic policy. The first scenario considered the possibility of sustained reform within the Eurozone, involving strong policy commitment over several decades. The results indicate the possibility of 'growing out of currently unfavorable initial conditions', provided that sustained fiscal consolidation is combined with bank recovery and a program for competitiveness and growth.

On the other hand, a strong asymmetric recession could interrupt any attempt at reform and move the economy ‘off track’. In a second scenario, we considered the possible developments in a severe asymmetric recession. We report three main insights. First, an asymmetric recession within the Eurozone is likely to be very severe, given the absence of typical shock absorbers. Second, a benign exit from the Eurozone with stable investor expectations could substantially dampen the negative short-run impact of a recession. On the negative side, the economy takes significantly longer to recover. Stabilization is achieved by an aggressive monetary expansion, combined with exchange rate depreciation to restore international competitiveness. However, ‘stable investor expectations’ after an exit might be rather unrealistic, given the large vulnerabilities. Third, investor panic may lead to an escalating exit with funding stops due to sudden jumps in risk premia, which magnify private and public borrowing costs, thereby further depressing investment and constraining fiscal policy. Unfavorable capital market reactions tend to offset the advantages of monetary autonomy. Such an exit scenario makes the recession as deep as under continued membership, while considerably delaying the full recovery.

5 Appendix: Estimation

Following standard procedures in DSGE research, we add shocks to the model and apply Bayesian estimation techniques. Table A1 provides an overview of estimated shocks together with some structural parameters and reports our prior assumptions together with the resulting posterior distributions.

We have harmonized the priors for the standard deviation of the shock processes by assuming an inverse-gamma distribution (e.g. Gerali et al. 2010) with mean 0.1 and standard deviation of 2. Since persistence of the AR(1) processes is restricted in the 0-1 range, the parameters are assumed to be beta distributed with mean 0.95 and standard deviation 0.01. For other parameters, we use calibrated values as the mean, see Table 2. We estimate σ^{sl} with a mean of 13.33, a value that associates an output loss of 5% with an increase in the NPL share by four percentage points. For the elasticity between productivity and government spending, σ^z, we consider a mean of 0.25. This implies a 2.5 percentage point increase in factor productivity after a 10% increase in government spending. The shares of fiscal consolidation attributed to productive government spending and social spending ξ_g and ξ_e, are set to a prior of 0.2 and 0.1, respectively. The prior for the parameter of investment adjustment costs, ψ is set to 5, while the prior for the fiscal adjustment speed γ_g is 0.97.

Table A1: Prior and Posterior Distributions

Parameter		Prior distribution			Posterior distribution		
		Density	Mean	St.dev	10%	Mean	90%
Autocor. risk premia	ρ^{th}	Beta	0.95	0.01	0.9552	0.9638	0.9720
Autocor. NPL shock	ρ^{sl}	Beta	0.95	0.01	0.9468	0.9572	0.9672
Autocor. revenue losses	ρ^{T}	Beta	0.95	0.01	0.9353	0.9492	0.9622
Autocor. business cycle	ρ	Beta	0.95	0.01	0.9085	0.9244	0.9401
Sensitivity NPL rate	σ^{sl}	Normal	13.33	1	11.8706	13.1838	14.4691
Sensitivity Productivity	σ^{z}	Normal	0.25	0.001	0.2487	0.2500	0.2513
Fiscal adjustment speed	γ^{g}	Beta	0.97	0.001	0.9699	0.9711	0.9723
Investment adj. costs	ψ	Normal	5	0.01	4.9878	5.0008	5.0138
Consolidation share G	ξ_g	Normal	0.2	0.001	0.1985	0.1997	0.2011
Consolidation share E	ξ_e	Normal	0.1	0.001	0.0987	0.1000	0.1013
SD productivity shock IT	$\tilde{\sigma}^{z}$	Inv.Gamma	0.1	2	0.0113	0.0126	0.0139
SD income shock EZ	$\tilde{\sigma}^{ye}$	Inv.Gamma	0.1	2	1.9746	2.2054	2.4501
SD deposit shock	$\tilde{\sigma}^{d}$	Inv.Gamma	0.1	2	0.0805	0.0898	0.0999
SD gov. interest shock	$\tilde{\sigma}^{g}$	Inv.Gamma	0.1	2	0.0739	0.0825	0.0916
SD gov. spending shock	$\tilde{\sigma}^{G}$	Inv.Gamma	0.1	2	0.5310	0.5898	0.6527
SD social spending shock	$\tilde{\sigma}^{E}$	Inv.Gamma	0.1	2	3.9114	4.3608	4.8363
SD NPL shock	$\tilde{\sigma}^{sl}$	Inv.Gamma	0.1	2	0.0095	0.0106	0.0118

The last three columns of Table A1 show the means and confidence intervals of the posterior distributions as obtained by the Metropolis Hastings algorithm. We used five chains, each with 25,000 draws which ensures convergence of the sampling algorithm. Shock persistence is estimated to be quite high. Autocorrelation coefficients range from 0.92 (for the business cycle) to 0.96 for the risk premia. All other parameters are estimated to a value close to our prior assumptions.

Figure A1 shows prior (gray, doted curves) and posterior distributions (black, solid curves) of the estimated parameters. The vertical dashed lines indicate the estimated posterior mode.[21] The smaller variance of the posterior indicates that the data appear to be informative of the persistence of shock processes.

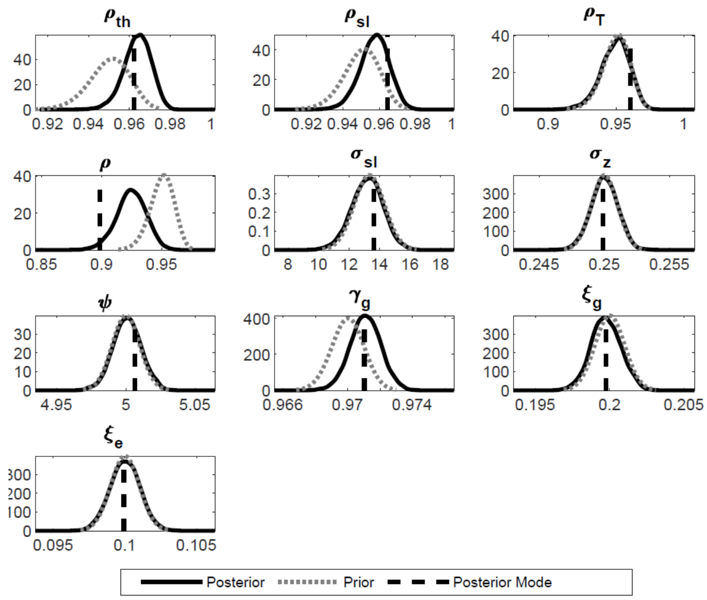

Figure A1: Prior and Posterior Distribution of Parameters

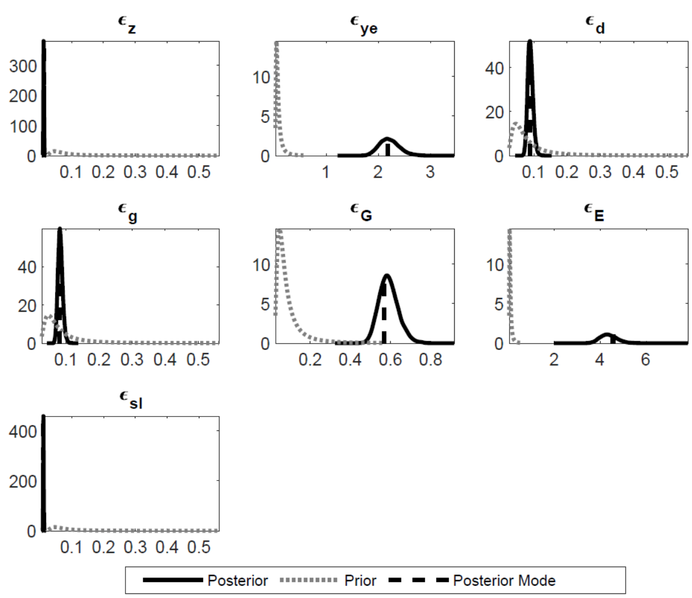

Figure A2: Prior and Posterior Distribution of Shock SDs

Figure A2 plots estimated standard deviations. They are relatively large for the shocks

[21] The mode is the most frequently computed value. It does not coincide with the mean for non-normal (non-symmetric) distributions and not necessarily with the peak of the posterior distribution.

to Eurozone income, deposits, government interest rate, and both types of government expenditures. By contrast, the estimated standard deviations of the productivity shock and the non-performing loans shock are rather small. The model seemingly does not rely much on these shocks to explain fluctuations.

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