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Fiscal and monetary rules for a currency union ☆

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ABSTRACT

This paper addresses the optimal joint conduct of fiscal and monetary policy in a two-country model of a currency union with staggered price setting and distortionary taxes. A tractable linear-quadratic approximation permits a representation of the optimal policy plan in terms of targeting rules. In the optimal equilibrium, monetary policy should achieve aggregate price stability following a flexible inflation targeting rule. Fiscal policy should stabilize idiosyncratic shocks allowing for permanent variations of government debt but should abstain from creating inflationary expectations at the union level. Simple policy rules can approximate the optimal commitment benchmark through a mix of strict inflation targeting and flexible budget rules. Conversely, the welfare costs of balanced budget rules are at least one order of magnitude higher than conventional estimates of the costs of business cycle fluctuactions.

1. Introduction and related literature

Forty years after the formulation of the concept of Optimum Currency Area (OCA) (Mundell, 1961)[1], eleven European countries delegated their monetary policy to the European Central Bank (ECB), creating the first example of monetary union among sovereign industrialized economies.

In terms of stabilization policies, the relinquishment of monetary independence to a supra-national institution means that each member of the European Monetary Union (EMU) can no longer resort to variations of the nominal exchange rate in response to idiosyncratic shocks. The centralized monetary authority only retains the ability to cope with aggregate disturbances. National fiscal policies then become the natural candidate to substitute for the nominal exchange rate in the stabilization process.

This paper studies the design of the appropriate rules that a benevolent centralized policymaker would assign to the national fiscal authorities and to the common central bank in order to deal with the coexistence of idiosyncratic and aggregate shocks in a currency area. While the centralized perspective adopted in this work delivers the best mix of stabilization policies that can be implemented in a currency union, it admittedly foregoes potentially important considerations of strategic interaction among policy authorities.[2] However, the objective of this paper is not to provide a positive description of the current fiscal and monetary policy process in the EMU. Rather, the aim is to put forward an optimal policy benchmark that highlights the key stabilization tasks to be pursued by the monetary and fiscal authorities of a currency union. This benchmark is then used to evaluate the welfare properties of alternative simple rules.

Given the peculiar institutional features of a monetary union and the prominent role of the EMU in the global economic arena, the design of the appropriate stabilization framework for a currency area represents a problem of primary importance. This paper contributes to the debate along two dimensions. First, it derives the targeting rules that implement the optimal fiscal and monetary policy plan. Second, it shows that the welfare costs of balanced budget requirements are potentially very high but can be substantially mitigated by allowing for a feedback on real activity.

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[1] See also McKinnon (1963). Kenen (1969) represents the first contribution that highlights some of the fiscal policy issues relevant for a currency union.

[2] Chari and Kehoe (2007) show that the strategic behavior of national fiscal authorities in a currency union generates high inflation equilibria if the monetary authority operates under discretion.

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In general, optimal targeting rules formalize the balance between the different stabilization objectives that policymakers seek to achieve in order to fulfill their mandate. In the context of a monetary union, the main advantage of targeting rules is the possibility of assigning transparent and verifiable stabilization prescriptions to the fiscal and monetary authorities. In the optimal equilibrium, (i) monetary policy should achieve price stability at the union level following a flexible inflation targeting rule; (ii) fiscal authorities should abstain from actions that create inflationary expectations at the union level; (iii) fiscal policy should stabilize idiosyncratic shocks allowing for permanent variations of government debt. The first two findings confirm the results of Benigno and Woodford (2003) in a closed economy, which is indeed isomorphic to the aggregate dimension of a currency area. The third result represents the distinctive feature of the stabilization problem in a monetary union. The optimal relative fiscal policy combines the intertemporal smoothing of tax distortions with the contemporaneous response to inflation differentials across countries. Absent the nominal exchange rate, a country hit by an adverse idiosyncratic disturbance must adjust its relative tax rate to dampen the negative impact of the shock on its competitiveness.

The model presented in this paper is similar to Benigno (2004) but moves one step beyond by introducing a fiscal dimension to the policy problem. This extension is critical. The possibility of responding to idiosyncratic disturbances by issuing debt and varying the tax rate moves the burden of stabilization onto the national fiscal authorities. The optimal policy problem is cast in terms of a standard linear–quadratic (LQ) representation. One advantage of this approach is the aforementioned possibility of representing the optimal policy plan in terms of targeting rules for fiscal and monetary authorities. Moreover, the resulting LQ framework can also be used to rank alternative policies correctly up to the second order.

With the optimal policy outcome as a benchmark, this paper computes the welfare costs associated with policies involving strict price stability and balanced budget. Depending on the exact specification of the steady state distortions, agents would be willing to sacrifice between 1% and 12% of their per-period consumption not to abandon the optimal policy regime. These welfare costs of suboptimal policies are large, ranging from one to two orders of magnitude larger than the highest cost of business cycle fluctuations reported in Lucas (2003). The source of the welfare costs is the constraint imposed on fiscal policy by the balanced budget requirement. A simple fiscal rule that allows for a persistent countercyclical feedback of real activity on the level of government debt cuts the welfare costs by roughly 60%.

The quantitative results carry two main implications. First, flexible debt rules might represent a feasible direction to reform the Stability and Growth Pact (SGP) within an accountability framework required by moral hazard considerations.[3] Second, should the ECB decide to adopt an explicit inflation targeting regime, a narrow formulation of the target would appropriately serve the medium run objective of price stability stipulated by the Maastricht Treaty and subsequently reinforced by the Governing Council of the ECB.

Closest in spirit to this work are the recent papers by Beetsma and Jensen (2005) and Galí and Monacelli (2008).[4] In terms of modelling strategy, the contribution of this paper is to focus on the role of distortionary taxation and government debt, rather than public spending, for fiscal stabilizations. The fundamental consequence of this assumption is that the optimal response to a stationary exogenous disturbance requires a permanent variation in the level of government debt. This result is reminiscent of the optimal taxation literature (Barro, 1979) and underlines the importance of minimizing the distortions associated with variations in the tax rates along the cycle. With respect to the main findings, this paper points towards a more active role for fiscal policy also in stabilizing the aggregate economy. In Beetsma and Jensen (2005) and in Galí and Monacelli (2008), the optimal policy requires the fiscal authority to provide, on average, the efficient level of public spending. In this paper, the optimal targeting rule for aggregate fiscal policy implies that national governments do not contribute to create, on average, expectations of future inflation. This mandate, however, does not coincide with using the average tax rate to simply offset any realization of cost–push shocks because the fiscal authorities need to consider how their actions influence intertemporal solvency.

The rest of the paper is organized as follows. The next section outlines the building blocks of the model. Section 3 presents the approximated LQ framework and derives the optimal targeting rules for fiscal and monetary policy that a benevolent policymaker would implement to maximize welfare for the average household of the currency union. Finally, Section 4 evaluates the welfare properties of strict and flexible simple targeting rules and their ability to approximate the equilibrium outcome under the optimal plan. Additional details and derivations are deferred to a separate appendix.[5]

2. A model of a currency union

The world consists of two countries, Home and Foreign (also denoted by $i=\{H,F\}$ hereafter), that form a currency union. A unit mass of households (indexed by j) and firms (indexed by k) populates the whole economy. The size (i.e. the measure of households and firms) of country i is $n_i \in (0, 1)$, with $n_H+n_F=1$. Each country has a separate fiscal authority. A common central bank decides upon monetary policy for the entire currency area. Financial markets are assumed to be complete both at the national and international level. Goods markets are characterized by monopolistic competition and nominal price rigidities. Labor markets are segmented in the sense that households offer a specialized labor input for the production of a specific final good. The remainder of this section discusses the optimization problem of households and firms and the role of the policy authorities.

2.1. Households

All households have identical preferences defined over consumption C_t^j and labor ℓ_t^j and discount future utility at rate $\beta\in(0,1)$. Individual lifetime utility is

$$u_0^j \equiv E_0\left\{\sum_{t=0}^{\infty}\beta^t\left[\frac{\left(C_t^j\right)^{1-\rho}}{1-\rho}-\frac{\left(\ell_t^j\right)^{1+\eta}}{1+\eta}\right]\right\}, \tag{1}$$

where $E_t\{\cdot\}$ is the expectation operator conditional upon the information set available at time t.

The single currency constitutes the common numeraire for all prices. The random variable D_{t+1}^j denotes the payoff of a portfolio of state-contingent securities, purchased by household j at time t. The random variable $Q_{t,t+1}$ represents the price of D_{t+1}^j. The nominal wage w_t^j is household-specific as a consequence of labor market segmentation. The flow budget constraint for household j is

$$\int_0^1 p_t(k)c_t^j(k)dk + E_t\left\{Q_{t,t+1}D_{t+1}^j\right\} = \left(1-\tau_{i,t}^w\right)w_t^j\ell_t^j + \Gamma_t^j + D_t^j, \tag{2}$$

[3] Several member countries have already violated the 3% deficit-GDP limit included in the SGP. Belgium, Italy and Greece have debt to GDP ratios around 100% and few other countries are above the 60% threshold. Despite the issuance of a number of early warnings, none of these countries actually incurred in the economic sanctions prescribed by the Pact. The fiscal rules in the SGP are currently under revision although no reform proposal has been formally put forward so far.

[4] See also Canzoneri et al. (2004), Kirsanova et al. (2007) and Leith and Wren-Lewis (2007). Relative to this study, the first two papers focus on simple policy rules in models of a currency union enriched by additional variables and frictions. The third paper addresses the performance of various fiscal policy instruments under either flexible exchange rates or a currency union.

[5] This appendix is available online at http://nyfedeconomists.org/ferrero/papers.html.

where Γ_t^j stands for after-tax nominal profits from ownership of the firms and $\tau_{i,t}^w$ is a country-specific labor income tax rate. The variable $p_t(k)$ corresponds to the price of variety k consumed in quantity $c_t^j(k)$ by household j. Since the law of one price is assumed to hold, the price of each variety is the same across countries.

The consumption index C_t^j is a Dixit–Stiglitz aggregator over two bundles of goods produced in country H and F respectively

$$C_t^j \equiv \left[n_H^{\frac{1}{\theta}} \left(C_{H,t}^j \right)^{\frac{\theta-1}{\theta}} + n_F^{\frac{1}{\theta}} \left(C_{F,t}^j \right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \tag{3}$$

where $\theta \geq 0$ is the elasticity of substitution between the Home and Foreign bundles. The index $C_{i,t}^j$ is in turn a Dixit–Stiglitz aggregator defined over the continuum of differentiated varieties of goods produced in country i

$$C_{i,t}^j \equiv \left[\left(\frac{1}{n_i} \right)^{\frac{1}{\sigma}} \int_0^{n_i} c_t^j(k)^{\frac{\sigma-1}{\sigma}} dk \right]^{\frac{\sigma}{\sigma-1}}, \tag{4}$$

where $\sigma > 1$ is the elasticity of substitution across goods produced within each country.

In what follows, P_t denotes the consumption price index (CPI) associated with Eq. (3) while $P_{i,t}$ corresponds to the price index implied by Eq. (4).

2.2. Firms

Firms sell their products in monopolistic competitive goods markets. The output of firm k is the differentiated consumption good $y_t(k)$, which can be traded internationally without frictions.

Technology is linear in labor

$$y_t(k) = a_{i,t} \ell_t(k), \tag{5}$$

where $a_{i,t}$ is a country-specific technology shock common to all sectors k in i. Labor is immobile across countries. Each firm acts as a wage-taker in segmented labor markets.[6]

Production plans may differ across firms because prices are assumed to be set on a staggered basis (Calvo, 1983). Every period, independently of previous adjustments, each firm faces a probability $(1-\alpha_i)$ of adjusting its price. In the event of a price change at time t, firms maximize the present discounted value of profits net of sales taxes $\tau_{i,t}^s$, given by

$$\Upsilon_t(k) = E_t \left\{ \sum_{T=t}^{\infty} \alpha_i^{T-t} Q_{t,T} \left[\left(1 - \tau_{i,T}^s \right) p_t(k) y_{t,T}(k) - w_T(k) \ell_T(k) \right] \right\}, \tag{6}$$

subject to Eq. (5) and the demand for their own good conditional on no further price change after period t

$$y_{t,T}(k) = \left[\frac{p_t(k)}{P_{i,T}} \right]^{-\sigma} Y_{i,T}.$$

2.3. Policy Authorities

The monetary policy instrument is the nominal interest rate $R_t > 0$. Following Woodford (2003), the model abstracts from monetary frictions and considers the limit of a "cashless economy". Hence, seigniorage does not represent a source of revenues for national governments. Nonetheless, monetary policy bears important implications for fiscal decisions, as the level of the interest rate contributes to the debt burden and the inflation rate alters the real value of debt.

In each period, fiscal authorities choose the mix of taxes and one period nominal risk-free debt to finance an exogenous process of public spending and interest rate expenditure on outstanding liabilities. The per-capita flow government budget constraint for country i is

$$B_{i,t} = R_{t-1} B_{i,t-1} - P_t s_{i,t}, \tag{7}$$

where $B_{i,t} \geq 0$ represents the nominal issues of country i risk-free bonds and $s_{i,t}$ is the per-capita real surplus.[7] This paper focuses on the case in which the fiscal authority in each country has access to only one tax rate for stabilization purposes.[8] Depending on whether such instrument is the sales or the labor income tax rate, the definition of the per-capita real surplus is

$$s_{i,t} \equiv \frac{1}{n_i} \int_0^{n_i} \frac{p_t(k)}{Pt} \left[\tau_{i,t}^s y_t(k) - g_t(k) \right] dk + \varsigma_{i,t}$$

or

$$s_{i,t} \equiv \frac{1}{n_i} \left[\int_0^{n_i} \tau_{i,t}^w \frac{w_t^j \ell_t^j}{P_t} dj - \int_0^{n_i} \frac{p_t(k) g_t(k)}{P_t} dk \right] + \varsigma_{i,t},$$

where $g_t(k)$ is the amount of government spending on the generic variety k produced in country i and $\varsigma_{i,t}$ is a lump-sum tax (or transfer).[9] The fiscal authority generally takes $\varsigma_{i,t}$ as exogenous except when the steady state is efficient.[10] In this circumstance, $\varsigma > 0$ is required to satisfy the steady state government budget constraint.

The two alternative formulations of the distortionary tax instrument deliver the same analytic representation of the optimal policy plan discussed in the next section. Nevertheless, the interaction between fiscal instruments and steady state distortions generate quantitative implications that differ across formulations by one order of magnitude. Section 4 illustrates these results.

3. The LQ approximate problem

This paper considers rational expectation equilibria in which the nominal interest rate is strictly positive and government debt is non-negative. This section derives an optimal fiscal and monetary policy benchmark from the perspective of a single benevolent policymaker that maximizes welfare for the currency union as a whole.[11] The union-wide objective for the policymaker is assumed to be per-capita welfare $u_{W,0} \equiv \int_0^1 u_0^j dj = n_H u_{H,0} + n_F u_{F,0}$, where $u_{i,0} \equiv n_i^{-1} \int_0^{n_i} u_0^j dj$. The non-linear optimal policy problem cannot be solved in closed form. The approach of this paper is to study the associated approximate LQ

[6] While immaterial for individual consumption levels under complete financial markets, labor market segmentation introduces a source of real rigidities that influences the slope of the linearized Phillips curve. See Woodford (2003) for more details on both points.

[7] In open economy, without further assumptions, the private sector transversality condition in each country implies a correspondent restriction only on the consolidated value of government liabilities. The non-negativity constraint imposed on government debt, while innocuous for the purposes of this paper, is sufficient to ensure that each fiscal authority respects intertemporal solvency (for details, see Canzoneri et al., 2001).

[8] Adao et al. (2006) show that, if endowed with the appropriate tax instruments, a benevolent policymaker can replicate in a currency union the equilibrium under flexible exchange rates. While the result depends crucially on the number of frictions in the economy (see Leith and Wren-Lewis, 2007), the presence of debt is irrelevant for the equivalence to hold. This paper, instead, follows the tradition of the dynamic optimal taxation literature (e.g. Chari et al., 1994) investigating the relevance of taxes and debt in the stabilization process. The restriction on the set of instruments available to the fiscal authorities is meant to capture the idea that in practice governments pursue goals other than macroeconomic stabilization (e.g. redistribution) or are constrained by factors (such as political cycles) that prevent the appropriate policies to be implemented.

[9] The government of country i chooses optimally how to allocate its expenditure among varieties produced in its own country (complete home bias) given an exogenous amount of total public spending $G_{i,t}$. The aggregators for government spending correspond to (4).

[10] An efficient steady state can be obtained if the government issues two subsidies, $\tau_s < 0$ to firms and $\tau^w < 0$ to workers, that eliminate the monopolistic distortions in goods and labor markets respectively.

[11] The benevolent policymaker is assigned a single welfare objective but is subject to two independent national budget constraints (i.e., debt and taxes are chosen separately for each country). This regime differs from a fiscal federation in which a common fiscal authority would have access to multiple tax rates but only one debt instrument.

problem under commitment.[12] The LQ framework is useful for two main reasons. First, the optimal commitment plan can be characterized in terms of targeting rules, whose nature is clarified in the remainder of this section. Second, the welfare implications of alternative policy rules can be easily evaluated against the optimal policy benchmark, an exercise undertaken in the next section.

3.1. The welfare objective

Independently of the exact specification of fiscal policy, the second order approximation of the welfare objective can be written as

$$u_{W,0} = -\left(\frac{\overline{C}^{1-\rho}}{2}\right)E_0\left\{\sum_{t=0}^{\infty}\beta^t L_{W,t}\right\} + t.i.p. + \mathcal{O}\left(||\xi_t||^3\right), \tag{8}$$

where *t.i.p.* collects the "terms independent of policy" and $\mathcal{O}\left(||\xi_t||^3\right)$ stands for terms of order three or higher. The per-period loss function is defined as

$$L_{W,t} \equiv \lambda_y y_t^2 + n_H n_F \lambda_q q_t^2 + n_H \lambda_{\pi H}\pi_{H,t}^2 + n_F \lambda_{\pi F}\pi_{F,t}^2, \tag{9}$$

where $y_t \equiv \hat{Y}_{W,t} - \tilde{Y}_{W,t}$, $q_t \equiv \hat{T}_t - \tilde{T}_t$ and $\pi_{i,t} \equiv \log(P_{i,t}/P_{i,t-1})$.[13] The λ-weights are combinations of the structural parameters (which change depending on the fiscal policy specification) defined in the appendix, together with the parameters of the linear approximation of the model and the target levels of the endogenous variables.

3.2. The equilibrium conditions

The first order approximation of the equilibrium relations is also invariant to the specification of fiscal policy, although the structural coefficients differ across formulations. A parsimonious representation of the model includes two Phillips curves, two government budget constraints, the link between CPI and GDP inflation rates and the law of motion of the terms of trade.

The country-specific Phillips curves feature the typical open economy expenditure-switching effect associated with the terms of trade (see Svensson, 2000)

$$\pi_{i,t} = \kappa_i\left[\delta_y y_t + \omega_\tau\left(\hat{\tau}_{i,t} - \tilde{\tau}_{i,t}\right) + \delta_{i,q} q_t\right] + \beta E_t \pi_{i,t+1}, \tag{10}$$

where $\hat{\tau}_{i,t}$ is the log-linear approximation of the tax rate for country *i*. The variable $\tilde{\tau}_{i,t}$ is the tax rate for country *i* compatible with full stabilization of inflation, output gap and terms of trade gap.[14]

The second pair of constraints are the government intertemporal solvency conditions

$$\hat{B}_{i,t} = (1-\beta)\left[b_y y_t + b_{i,q} q_t + \left(1+\omega_g\right)\left(\hat{\tau}_{i,t} - \tilde{\tau}_{i,t}\right)\right] + \beta E_t \hat{B}_{i,t+1}. \tag{11}$$

The left-hand side of the government budget constraint represents the real value of debt at maturity $\hat{b}_{i,t}$, deflated by the CPI inflation π_t and expressed in units of marginal utility

$$\hat{B}_{i,t} \equiv \hat{b}_{i,t-1} - \rho s_c^{-1} y_t - \pi_t + \psi_{i,t}.$$

The presence of the "fiscal stress" $\psi_{i,t}$, a composite of exogenous disturbances, depends on the representation of variables as deviations from their welfare-relevant targets. CPI inflation is a weighted average of the two GDP inflation rates

$$\pi_t = n_H \pi_{H,t} + n_F \pi_{F,t}. \tag{12}$$

The current component of the right-hand side of the government budget constraint is the adjusted expression for the time *t* level of surplus, also in units of marginal utility. In the absence of terms of trade shocks, the presence of the tax rate gives in principle the possibility of achieving complete stabilization of inflation and the output gap without violating the Phillips curves (10), even in case of cost–push disturbances. The fiscal stress summarizes the information about the exogenous shocks that instead require fluctuations of the output gap and inflation to occur.

Finally, the terms of trade evolves according to

$$q_t = q_{t-1} + \pi_{F,t} - \pi_{H,t} - \Delta\tilde{T}_t, \tag{13}$$

where $\Delta\tilde{T}_t \equiv \tilde{T}_t - \tilde{T}_{t-1}$ is the one-period change in the target level of the terms of trade.

Differently from the closed economy model of Benigno and Woodford (2003), the presence of structural (the different degree of price rigidities) and exogenous (the country-specific nature of the shocks) asymmetries across countries introduces one additional dimension to be taken into account by the optimal policy plan. The cooperative solution needs to seek an optimal balance between stabilization objectives in the two areas and the optimal solution of the traditional output–inflation tradeoff.

Moreover, differently from a model with flexible exchange rates (see, for instance, Benigno and Benigno, 2006), the policymaker needs to directly internalize the distortions due to the terms of trade. Differentials in GDP inflation rates cannot be absorbed by variations of the nominal exchange rate. For this reason, the dynamics of the terms of trade become an explicit constraint for the optimal policy problem.

In a closed economy, only the fiscal stress prevents contemporaneous stabilization of output gap and inflation in presence of sticky prices. In a currency union, even in the absence of any fiscal stress, full stabilization cannot be achieved because the nominal exchange rate does not adjust in response to terms of trade shocks.

The next section presents an example which highlights the characteristics of the stabilization problem for fiscal and monetary policy in a currency union and it is tractable enough to be solved analytically. Section 4 will illustrate the optimal plan in the general case by contrasting its welfare and stabilization properties with the equilibrium induced by simple rules.

3.3. Optimal targeting rules

This section derives the optimal targeting rules for fiscal and monetary policy that a benevolent policymaker would commit to follow in order to maximize welfare for the currency union.

A representation of the optimal policy via targeting rules directly maps into a subset of endogenous variables only, hence facilitating the interpretation of the policy mandate. As stressed by Giannoni and Woodford (2002), optimal targeting rules exhibit two additional desirable features. First, under mild assumptions, optimal targeting

[12] The approximation is taken around a non-stochastic symmetric steady state with no inflation and constant debt. The exact specification of fiscal policy influences the steady state real allocation and, consequently, some of the coefficients of the approximation. It does not, however, affect the general properties of the steady state and the representation of the approximate model.

[13] Given a variable X_t, $\hat{X}_t \equiv \log(X_t/X)$ represents the log-linear deviation from its steady state value, while $\tilde{X}_t$ corresponds to the welfare-relevant target level for $\hat{X}_t$. The targets coincide with the "efficient" level of the respective variable only if τ^w and τ^s eliminate the steady state monopolistic distortions in labor and goods markets respectively.

[14] One can also interpret $-\omega_\tau\tilde{\tau}_{i,t}$ as a "cost-push" shock that precludes simultaneous stabilization of inflation, the output gap and the terms of trade gap. If the steady state pricing condition is inefficient, in principle, all the underlying fundamental disturbances might have a cost-push effect.

rules generally lead to a unique locally determinate rational expectation equilibrium. Second, optimal targeting rules are robust to alternative stochastic processes assumed for the underlying fundamental disturbances.

This section assumes that the degree of price rigidity is the same across countries ($\alpha_i=\alpha$). This assumption allows for a separate determination of average and relative variables.[15] The loss function (9) becomes

$$L_{W,t}\equiv\lambda_y y_t^2+\lambda_\pi\pi_t^2+n_H n_F\left(\lambda_q q_t^2+\lambda_\pi\pi_{R,t}^2\right), \tag{14}$$

where $\pi_{R,t}\equiv\pi_{H,t}-\pi_{F,t}$ and $\lambda_\pi=\lambda_{\pi_i}$ given the assumption about the degree of price rigidity in the two countries.

3.3.1. The average block

The optimal policy plan for the average block consists of maximizing the present discounted value of (14) with respect to the union-wide output gap y_t, CPI inflation π_t, the average tax rate $\hat{\tau}_{W,t}$ and the average government debt $\hat{b}_{W,t}$, subject to the sequence of constraints given by the average Phillips curve

$$\pi_t=\kappa\left[\delta_y y_t+\omega_\tau\left(\hat{\tau}_{W,t}-\tilde{\tau}_{W,t}\right)\right]+\beta E_t\pi_{t+1} \tag{15}$$

and the average government budget constraint

$$\hat{B}_{W,t}=(1-\beta)\left[b_y y_t+(1+\omega_g)\left(\hat{\tau}_{W,t}-\tilde{\tau}_{W,t}\right)\right]+\beta E_t\hat{B}_{W,t+1}, \tag{16}$$

where

$$\hat{B}_{W,t}=\hat{b}_{W,t-1}-\rho s_c^{-1}y_t-\pi_t+\psi_{W,t}.$$

Given the same degree of price rigidity across countries, it is fairly intuitive to see that the average block of the currency union (the policy objective and the equilibrium relations) corresponds to a one sector closed economy. Therefore, the solution of the optimal policy problem is isomorphic to that of a closed economy (Benigno and Woodford, 2003). The optimal targeting rules for the average block are

$$\pi_t+\frac{n_\varphi}{m_\varphi}\pi_{t-1}+\frac{w_\varphi}{m_\varphi}(y_t-y_{t-1})=0 \tag{17}$$

and

$$E_t\pi_{t+1}=0. \tag{18}$$

Expression (17) represents a flexible inflation targeting rule for the monetary authority of the currency union. The presence of the rate of change of the output gap in expression (17), rather than its absolute level, is the typical feature of optimal monetary policy under commitment. Unlike Beetsma and Jensen (2005) and Galí and Monacelli (2008), here the government solvency condition imposes an additional constraint on the equilibrium allocation and requires that also past inflation enters the targeting rule.

Expression (18) prescribes an active role for fiscal policy in stabilizing the aggregate economy. Aggregate fiscal policy optimally shares the burden of CPI inflation stabilization with monetary policy by preventing expectations of future inflation to arise. Importantly, the fiscal adjustment occurs through permanent variations in the level of government debt.[16]

The optimal monetary policy can also be expressed as an interest rate rule. A log-linear approximation to the Euler equation yields

$$r_t=\tilde{r}_t+E_t\pi_{t+1}+\rho s_c^{-1}(E_t y_{t+1}-y_t), \tag{19}$$

where $\tilde{r}_t$ is the target level of the nominal interest rate. Using the optimal targeting rules into Eq. (19) to substitute for expected inflation and the expected growth rate of the output gap yields an interest rate feedback rule of the form

$$r_t=\tilde{r}_t+\omega_\pi\pi_t. \tag{20}$$

Under the baseline calibration (see below), independently of steady state distortions, ω_π is of the order of 10^2, de facto implying a strict inflation targeting rule.

The optimal fiscal policy for the average block can also be rewritten as the instrument rule

$$\left(\hat{\tau}_{W,t}-\tilde{\tau}_{W,t}\right)+m_\tau y_t+n_\tau\pi_t=0. \tag{21}$$

By explicitly featuring the tax instrument, expression (21) perhaps provides a more intuitive representation of the appropriate targeting rule for fiscal policy and allows for a direct comparison with some of the recent related literature. In Beetsma and Jensen (2005) and in Galí and Monacelli (2008), the optimal aggregate fiscal policy consists of setting the average fiscal stance at its efficient level. Here, fiscal policy prevents expectations of future inflation by actively responding with the tax instruments to contemporaneous movements of the output gap and the inflation rate. This mandate, however, does not correspond to simply choosing the average tax rate that offsets any realization of the cost–push shock. As mentioned above, the reason is that the presence of the fiscal stress precludes the complete and contemporaneous stabilization of inflation and the output gap, even in the absence of terms of trade shocks.

Expression (21) represents a tax rule that implements the optimal targeting criterion (18). Alternatively, the same targeting criterion can be implemented following a debt rule of the form

$$E_t\hat{B}_{W,t+1}+\omega_b\mathcal{Y}_t=0, \tag{22}$$

where $\mathcal{Y}_t$ is the present discounted value of future output gaps

$$\mathcal{Y}_t=E_t y_{t+1}+\beta E_t\mathcal{Y}_{t+1}.$$

Rule (22) carries a standard stabilization message. Holding constant the fiscal stress, good news about future economic activity leads to a reduction of real debt evaluated in units of marginal utility (and vice versa).

3.3.2. The relative block

The optimal policy plan for the relative block can be derived by maximizing the present discounted value of Eq. (14) with respect to the terms of trade gap q_t, the inflation rate differential $\pi_{R,t}$, the relative tax rate $\hat{\tau}_{R,t}$ and the relative government debt $\hat{b}_{R,t}$, subject to the sequence of constraints given by the relative Phillips curve

$$\pi_{R,t}=\kappa\left[\delta_q q_t+\omega_\tau\left(\hat{\tau}_{R,t}-\tilde{\tau}_{R,t}\right)\right]+\beta E_t\pi_{R,t+1}, \tag{23}$$

the relative government budget constraint

$$\hat{b}_{R,t-1}+\psi_{R,t}=(1-\beta)\left[b_q q_t+(1+\omega_g)\left(\hat{\tau}_{R,t}-\tilde{\tau}_{R,t}\right)\right]+\beta E_t\left(\hat{b}_{R,t}+\psi_{R,t+1}\right) \tag{24}$$

and the evolution of the terms of trade

$$q_t=q_{t-1}-\pi_{R,t}-\Delta\tilde{T}_t. \tag{25}$$

[15] See Benigno (2004) and Beetsma and Jensen (2005).

[16] The Lagrange multiplier on the average government budget constraint follows a random walk. If the fundamental shocks are *i.i.d.*, debt is a linear function of that multiplier and hence follows a pure random walk too. More generally, debt inherits the unit root from the Lagrange multiplier but follows an ARIMA process.

The optimal policy for the relative block can be represented by a flexible tax targeting rule adjusted for the terms of trade

$$E_t\mathcal{T}_{t+1}-\mathcal{T}_t = -\rho_\varphi(\mathcal{T}_t-E_{t-1}\mathcal{T}_t), \tag{26}$$

where the target $\mathcal{T}_t$ is a linear combination of the relative tax and terms of trade gaps

$$\mathcal{T}_t \equiv l_\tau(\hat{\tau}_{R,t}-\tilde{\tau}_{R,t})-l_q q_t. \tag{27}$$

From (26), if today's target is aligned with yesterday's expectations, the optimal fiscal policy for the relative block commands complete smoothing of the target variable. In this case, the target follows a random walk. On the other hand, any departure of today's target from expectations requires an aggressive response of relative taxes to bring the target back towards its long run equilibrium value. Fiscal policy partly substitutes the nominal exchange rate in absorbing regional inflation differentials but also needs to smooth intertemporally the inefficiencies arising from distortionary taxation. Operationally, this task is accomplished by moving the relative tax rate in response to movements of the terms of trade. Again, the aggressive response of policy to temporary shocks is the typical commitment outcome that aims at controlling future expectations and their effects on current variables. In this respect, the crucial difference with Beetsma and Jensen (2005) is that also the relative adjustment requires permanent variations of government debt rather than persistent but stationary changes in the level of government spending.[17]

In order to build further intuition about Eq. (26), it is instructive to contrast the result above with the case of flexible prices. In this circumstance, $\kappa^{-1}=0$ and relative inflation does not induce welfare costs ($\lambda_\pi=0$). Therefore, the evolution of the terms of trade (25) ceases to be a constraint for the optimal policy problem. Under flexible prices, Eq. (23) provides a simple mapping between the relative tax rate and the terms of trade. It follows that the optimal policy simply results from maximizing Eq. (14) with respect to debt and the terms of trade, subject to the constraint imposed by the government solvency condition. As a result, both the terms of trade and the relative tax rate follow a random walk and so does $\mathcal{T}_t$, which is just a linear combination of those two variables. Finally, government debt is a function of the fiscal stress only and its path features a unit root. This analysis highlights the general lesson that the permanent nature of the optimal fiscal policy response holds independently of nominal rigidities, in line with the taxation smoothing result of Barro (1979). Nominal rigidities enrich the dynamics by bringing in some degree of inertia associated with the costs of inflation. In particular, the optimal targeting rule (26) involves a more complicated process for $\mathcal{T}_t$ than a random walk because the relative inflation rate (and hence variations of the terms of trade) exhibits a forward looking element associated with nominal price stickiness.

4. Simple rules

When the degree of price rigidity differs across countries, the optimal stabilization policy can still be determined following a Lagrangian method. In this case, however, the average and relative block are not independent of each other and the representation of the optimal policy is more complicated. Relatively to the benchmark case of the previous section, the policymaker assigns more weight to the macroeconomic stabilization of the country with the higher degree of nominal rigidities. Nonetheless, the key properties of the optimal plan are unchanged. The real variables still display a unit root. The terms of trade retain the inertia associated with the sluggish adjustment of relative prices and the absence of the nominal exchange rate acting as an automatic stabilizer.

In the remainder of the paper, the optimal policy plan will serve as a benchmark for the evaluation of alternative (suboptimal) fiscal and monetary rules. If simple rules can approximate the stabilization properties of the optimal plan, this alternative policy framework should facilitate the communication of the institutional mandate and improve the accountability of fiscal and monetary authorities.

The rule for the single central bank takes the form of a flexible inflation targeting

$$\Pi_t\left(\frac{Y_t^{\text{gap}}}{Y_{t-1}^{\text{gap}}}\right)^\gamma = C_m, \tag{28}$$

where $\gamma \geq 0$ captures the intensity of the countercyclical monetary feedback to variations in economic activity.[18]

The fiscal authority of country i is subject to a constraint on the real value of debt that can be cast in terms of a flexible debt targeting rule

$$\frac{B_{i,t}}{P_t}\left(Y_{i,t}^{\text{gap}}\right)^\phi = C_f, \tag{29}$$

where $\phi \geq 0$ captures the intensity of the countercyclical fiscal feedback to the level of economic activity.[19]

Both Eqs. (28) and (29) privilege parsimony by explicitly targeting only one key policy variable and by requiring only one parameter to be determined. Nevertheless, both rules introduce a degree of flexibility, by admitting in principle a feedback from some indicator of real activity.

The quantitative analysis below first illustrates the stabilization and welfare properties of strict inflation targeting and constant real debt (γ and ϕ equal to 0). The baseline specification of a “rigid” regime aims at emphasizing the stabilization constraints of the current EMU policy framework. Despite being an abstract (and perhaps extreme) formulation of actual policymaking, it gives a flavor of the potential costs of excessively tight policy rules in a currency union.[20] The experiments that follow then consider a regime characterized by the optimal choice of the coefficients γ and ϕ and discuss the welfare properties of the optimal simple rules.

4.1. Steady state and calibration

The alternative formulations of fiscal policy discussed in Section 2.3 have different implications for the steady state. In the baseline case (sales taxes only), the steady state goods and labor market conditions are both distorted by the presence of a non-zero markup. In the first alternative specification of fiscal policy, labor income taxes are the source of government revenues while a constant subsidy (financed by lump-sum taxes) eliminates the monopolistic distortions in the goods market. In this case, the equilibrium in the labor market is still inefficient. In the second alternative specification, the government issues two separate steady state subsidies that eliminate the monopolistic distortions both in the goods and labor markets. Labor income

[17] As for the average block, the Lagrange multiplier on the (relative) government budget constraint follows a random walk.

[18] The variable Y_t^{gap} is implicitly defined as the non-linear version of the output gap y_t and C_m is a constant chosen so that the rule (28) is compatible with the optimal steady state relevant for the approximation. If $\gamma=0$, the rule requires “strict” CPI inflation targeting. Svensson (2003) discusses the advantages of targeting rules for monetary policy as compared to instrument rules. Benigno (2004) studies optimal strict inflation targeting rules in a model of a currency union without fiscal policy.

[19] Again, C_f is a constant chosen so that the rule [29] is compatible with the steady state of the model. If $\phi=0$, the rule requires that the fiscal authority of each country maintains real debt constant over time. Benhabib and Eusepi (2005) and Schmitt-Grohé and Uribe (2007) investigate constant debt rules in closed economy models with nominal rigidities.

[20] The Maastricht Treaty and recent statements of the Governing Council (ECB Monthly Bulletin, 1999, 2003) seem to suggest that the institutional mandate of the ECB is indeed compatible with a narrow inflation targeting regime for monetary policy, at least over the medium term. A constant debt rule (i.e., balanced budget in every period), while in principle more restrictive than the prescriptions in the SGP, conforms with the long run budget requirements embedded in the Maastricht Treaty.

Table 1
Baseline calibration and implied steady state values

n	=0.6	Size of country H
β	=0.99	Discount factor
η	=0.47	Inverse Frisch elasticity
α_H	=4/5	Degree of price rigidity in country H
α_F	=3/4	Degree of price rigidity in country F
$\overline{\tau}$	=30%	S.S. tax rate
$\overline{b}/(4\overline{Y})$	=60%	S.S. debt–output ratio
ρ	=3	Coefficient of risk aversion
θ	=4.5	Elasticity of intratemporal substitution
σ	=11	Elasticity of substitution among goods
$\overline{\mu}^w$	=1.05	S.S. gross wage markup
ρ_a	=0.815	Persistence of productivity shock
ρ_G	=0.945	Persistence of government spending shock
σ_a^2	=0.00624	Variance of productivity shock
σ_G^2	=0.00333	Variance of government spending shock
$\sigma_{\mu^w}^2$	=0.00295	Variance of wage markup shock
σ_ς^2	=0.001	Variance of fiscal transfer shock
$(1-\alpha_H)^{-1}$	=5 qrt.s	Avg. duration of price contracts in country H
$(1-\alpha_F)^{-1}$	=4 qrt.s	Avg. duration of price contracts in country F
$\overline{G}/\overline{Y}$	=27.6%	S.S. public spending-output ratio
$\overline{s}/\overline{Y}$	=2.4%	S.S. primary surplus–output ratio
$\overline{C}/\overline{Y}$	=72.4%	S.S. consumption–output ratio
$\overline{\mu}$	=1.65	S.S. gross total markup

taxes are still the source of government revenues outside the steady state while the steady state government budget constraint is satisfied by lump-sum taxes.

Across different specifications, the annualized steady state ratio of debt to GDP is held constant at 60%, in line with the long run objectives of the Maastricht Treaty, although lower than the average Euro area debt to GDP ratio (roughly 70%). In the baseline case (distorted steady state), the steady state tax level is assumed to be 30%, which approximately corresponds to the average total tax revenues as a percentage of GDP among the EMU members. Given a standard assumption about the discount factor (β=0.99) and zero lump-sum taxes/transfers, the steady state government budget constraint pins down the public spending to GDP ratio to 27.6%. When the government makes the steady state pricing condition efficient, the steady state public spending to GDP ratio is held constant and so is the consumption to GDP ratio via the resource constraint. The steady state labor tax rate that satisfies the government budget constraint is equal to 22.2%. Finally, when both the goods and labor market equilibrium conditions are efficient, the lump-sum taxes required to clear the steady state government budget constraint are equal to 35% of GDP, once again holding constant the public spending to GDP ratio.

Consistently with the estimates in Benigno and López-Salido (2005), the probability of holding the price fixed in a certain period α_i is calibrated so that the average duration of price contracts is 5 quarters in country H and 4 quarters in country F respectively.[21] Table 1 reports the calibrated values for the remaining parameters of the model, which are quite standard in the literature.

The productivity and government spending shocks follow an AR(1) process, while the wage markup and the fiscal transfer shocks are assumed to be white noise. Their processes are identical across countries, only their realizations differ. Except for the variance of fiscal transfers, all the parameters of the exogenous disturbances are fixed at the posterior median estimates reported in Smets and Wouters (2003).

4.2. Optimal simple rules

One advantage of the LQ framework described in Section 3 is that the welfare implications of any combination of suboptimal policies can be evaluated by replacing the first order conditions of the optimal plan with the rules that characterize the alternative regime. Provided that the suboptimal rules are consistent with the steady state of the model, the objective function is invariant to the specification of policy.

The welfare analysis relies on a transformation of the objective $u_{W,0}$ that ranks suboptimal policies (indexed by p) relative to the benchmark optimal plan (indexed by opt)

$$d_p \equiv -\left(\frac{1-\beta}{2\overline{C}^{1-\rho}}\right)\left[E\left(u_{W,0}^{p}\right)-E\left(u_{W,0}^{\text{opt}}\right)\right], \tag{30}$$

where $u_{W,0}^{opt}$ is welfare under the optimal policy plan and $u_{W,0}^{p}$ is welfare under any alternative policy plan. The operator $E(\cdot)$ defines the expectation over the distribution of shocks at time zero. The welfare measure d_p is conditional on the system being in a steady state before time 0 and corresponds to a correct second order approximation of the consumption equivalent of the two policies (Lucas, 2003). In other words, d_p measures the fraction of consumption under the optimal policy that the average household in the currency union would be willing to give up in each period to avoid switching to regime p. Based on Eq. (30), one can also compute the percentage welfare gain of adopting policy p_2 when the status quo is policy p_1

$$g(p_1,p_2) \equiv \frac{d_{p1}-d_{p2}}{d_{p1}} = \frac{E\left(u_{W,0}^{p1}\right)-E\left(u_{W,0}^{p2}\right)}{E\left(u_{W,0}^{p1}\right)-E\left(u_{W,0}^{\text{opt}}\right)}. \tag{31}$$

Table 2 summarizes the main results of the quantitative analysis, depending on the alternative specification of fiscal policy.[22] The first column describes the policy adopted in the suboptimal regime. The second column reports the optimal choice of the coefficients for the simple rules. The third and fourth columns present the welfare costs of the suboptimal policies relative to the optimal benchmark as a fraction of the optimal policy consumption stream and in € respectively.[23] Finally, the fifth column reports the gains of moving from a strict rule to an optimal flexible rule, where flexibility is granted to either monetary or fiscal policy.

In the context of the LQ framework developed above, the flexible policy rules Eqs. (28) and (29) read as

$$\pi_t + \gamma(y_t - y_{t-1}) = 0 \tag{32}$$

and

$$\hat{b}_{i,t} - r_t + \phi y_{i,t} = 0, \tag{33}$$

where $y_{i,t}$ is the output gap for country i.[24]

The first result that follows from Table 2 is that the absolute costs of strict policy rules are significantly high, between one and two orders of magnitude larger than the costs of business cycles found in Lucas (2003). In the baseline case, the average inhabitant of the currency union would be willing to give up more than 12% of her per-period consumption (almost € 1800 annualized) to remain under the optimal policy regime rather than adopting strict policy rules.[25] The alternative

[21] Country H corresponds to France, Italy, Netherlands and Spain. Country F corresponds to Germany. As a consequence, the relative size of country H is n=0.6. These five countries together account for almost 90% of the total Euro area GDP.

[22] A direct comparison among different specifications of fiscal policy is inappropriate to the extent that the steady states differ across formulations. Nevertheless, repeating the calculations of the welfare costs in each instance is still an informative exercise to assess the robustness of the quantitative findings.

[23] The monetary measure of the welfare costs is obtained by multiplying the factor d_p by the coefficient $c_{2005}^{€}$=€14,600, which is defined as the nominal private consumption expenditure per-capita in 2005.

[24] The flexible budget rule that corresponds to Eq. (33) is $(1-\beta)\,\hat{s}_{i,t} = \hat{b}_{i,t-1} - \pi_t + \beta\phi y_{i,t}$, where $\hat{s}_{i,t}$ is the first order approximation of the real primary surplus. Under the baseline calibration, determinacy requirements bound from above the search for the optimal ϕ>0 to 10.5.

[25] In this economy the optimal policy can neither eliminate completely the business cycle fluctuations nor achieve the efficient flexible price outcome. Therefore, the numbers reported in Table 2 indeed represent a lower bound when interpreted from the perspective of the costs of business cycles.

Table 2
Gains from flexible policy rules

Policy rules	Optimal coefficient	Consumption equivalent	Monetary loss	Relative gain
Baseline (Sales tax-distorted steady state)				
Strict (s)	–	d_s=12.13%	$d_s c^{€}_{2005}$=€1770.2	–
Monetary (m)	γ=0.05	d_m=12.06%	$d_m c^{€}_{2005}$=€1760.8	$g(s,m)$=0.53%
Fiscal (f)	ϕ=8.50	d_f=4.95%	$d_f c^{€}_{2005}$=€723.0	$g(s,f)$=59.16%
Alternative 1 (Labor income tax-efficient goods market equilibrium)				
Strict(s)	–	d_s=6.62%	$d_s c^{€}_{2005}$=€966.0	–
Monetary (m)	γ=0.05	d_m=6.55%	$d_m c^{€}_{2005}$=€956.8	$g(s,m)$=0.95%
Fiscal (f)	ϕ=3.00	d_f=2.18%	$d_f c^{€}_{2005}$=€318.4	$g(s,f)$=67.04%
Alternative 2 (Labor income tax-efficient steady state)				
Strict (s)	–	d_s=1.16%	$d_s c^{€}_{2005}$=€169.4	–
Monetary (m)	γ=0.05	d_m=1.15%	$d_m c^{€}_{2005}$=€167.7	$g(s,m)$=1.00%
Fiscal (f)	ϕ=1.5	d_f=0.53%	$d_f c^{€}_{2005}$=€77.9	$g(s,f)$=54.03%

fiscal policy specifications highlight the importance of the steady state distortions for the absolute welfare costs. If the policymaker eliminates the distortions in the goods market, the welfare costs are roughly cut in half. When the steady state is fully efficient, the welfare costs are one order of magnitude smaller than in the baseline case.

The optimal degree of monetary policy flexibility with strict debt rules is small (γ=0.05), independently of the specification of fiscal policy. The absolute welfare costs associated with an optimal inflation targeting are very similar to the case of strict policy rules. The relative gain of moving to an optimal inflation targeting, when the status quo is a strict inflation targeting, is between half and one percent. Hence, the second lesson of the quantitative exercise is that the gains from monetary flexibility are likely to be negligible. The monetary authority of a currency union should commit to achieve and maintain price stability. Galí and Monacelli (2008) stress the result of strict inflation targeting being optimal only if fiscal policy is also conducted optimally, that is, only if the fiscal stance does not pose threats on aggregate inflation. This paper finds that, even if fiscal policy is suboptimal, the gains from monetary flexibility might be quantitatively small.

Optimal flexible fiscal rules generally require a strong countercyclical feedback of the output gap on the real value of debt. The actual value of this coefficient, however, varies substantially depending on the characteristics of the steady state. Nevertheless, the relative gains of moving to an optimal flexible fiscal regime when the status quo is a strict policy regime are substantial (between 55% and 70%), independently of the specification of fiscal policy. The third message of the numerical analysis is that fiscal flexibility is highly desirable in the context of a currency union. While this result revisits one of the classical arguments of the Optimum Currency Area literature (see Kenen, 1969) and is shared by other recent studies (see, for instance, Beetsma and Jensen, 2005), the welfare analysis of this paper provides a precise quantitative assessment of the costs associated with the lack of stabilization in response to idiosyncratic shocks.

4.3. The sources of the welfare costs

Interestingly, the joint optimal choice of fiscal and monetary flexibility yields the same results as in the case of optimal flexible debt targeting rules, which is suggestive of the dominant role of fiscal stabilizations in this economy.[26] Indeed, if the government could resort to lump-sum taxes also outside the steady state, the absolute welfare costs of strict inflation target would be about 0.04% of per-period consumption, very much in line with standard estimates.

In comparing strict and flexible debt targeting rules, output and terms of trade volatility do not differ much across regimes whereas GDP inflation rates are almost twice as volatile under strict rules. Combined with the fact that the weights on GDP inflation rates are two order of magnitudes higher than those on output and the terms of trade in the welfare objective, this finding explains the high welfare costs of suboptimal fiscal policies discussed above. It is also important to remember that the loss associated with the variability of inflation stems from the disutility of working. In particular, it captures the distortions associated with price dispersion. Therefore, in this model, the sources of welfare costs are quite different in nature from those identified by Lucas (2003).

Turning to the exogenous shocks, relative disturbances are almost exclusively responsible for the costs of business cycle fluctuations. Independently of the fiscal policy specification, the welfare costs of aggregate shocks account for about 2% of the total. The remainder is attributable to relative disturbances.[27] The question, then, is which relative disturbance accounts for the bulk of the welfare costs. The answer is that the relative government spending shock and the relative productivity shock are respectively responsible for roughly 80% and 20% of the total welfare costs, with the *i.i.d.* shocks (wage markup and government transfers) playing virtually no role.[28] For the baseline case (distorted steady state), Figs. 1 and 2 compare the impulse response functions to a 1% innovation in relative government spending (an increase in $\hat{G}_{R,t}$) under strict and optimal simple rules (continuous red line). In both figures, the optimal policy plan (dashed blue line) constitutes the benchmark reference.

The differences are evident. Under strict rules (Fig. 1), the fiscal authorities must respect the balanced budget requirement. As a consequence, the variations in tax rates are far from optimal and monetary policy bears the burden of the adjustment. The persistent departure from zero of GDP inflation rates determines large movements in the terms of trade which translates into suboptimal fluctuations of the output gap. With flexible fiscal rules (Fig. 2), fiscal policy mimics much more closely the optimal adjustment in government debt. Given that with optimal simple rules government debt is stationary, tax rates vary less on impact than under the fully optimal plan. The ability to respond with the fiscal instrument to cyclical movements eases the burden of adjustment on monetary policy. GDP inflation rates return quickly to their long run value, reducing the amplitude of terms of trade variations which, in turn, move the response of the national output gap closer to the optimum.

[26] The absence of institutional factors that prevent taxes and debt to react on a quarterly basis to exogenous disturbances might introduce an upward bias in the absolute gains of fiscal stabilizations. Leith and Wren-Lewis (2007) relax this assumption by introducing implementation lags in fiscal policy in the context of a currency union. The relative ranking of alternative policies should remain unaffected, though, since all the regimes considered in this paper feature a contemporaneous response of debt and taxes to exogenous shocks.

[27] Since the exogenous shocks are orthogonal to each other, the total welfare costs are simply the sum of the welfare costs induced by each single shock alone.

[28] The appendix reports a table with the exact values depending on the fiscal policy specification.

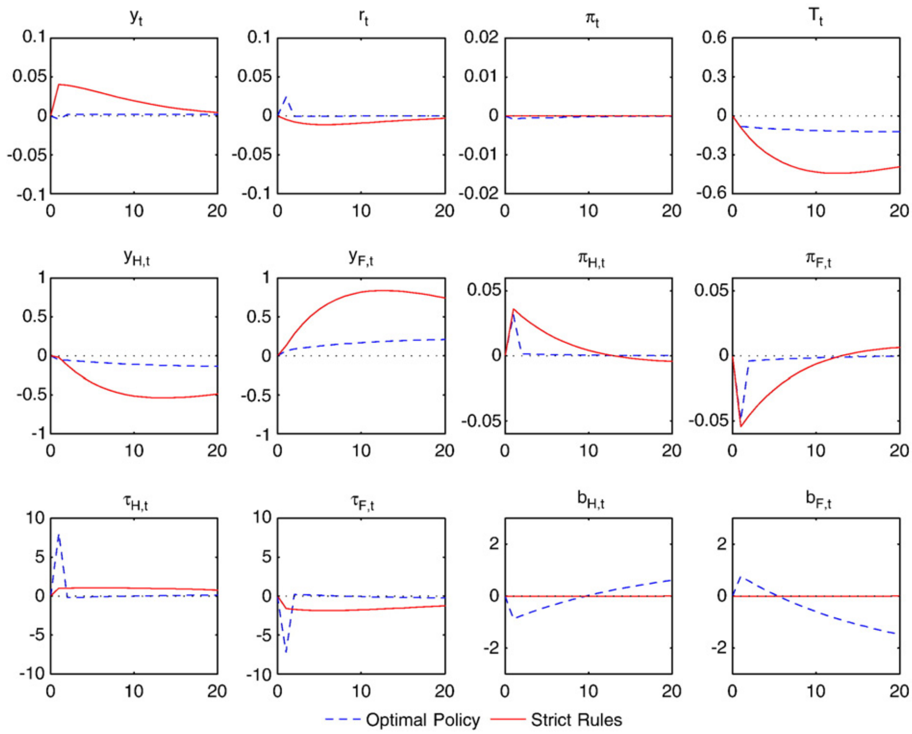

Fig. 1. Percentage response to a 1% innovation in $\hat{G}_{R,t}$ (optimal policy vs. strict rules).

The irrelevance of markup and fiscal transfer shocks for business cycle fluctuations depends crucially on the absence of persistence in the calibration of their stochastic processes. Similarly, the relative government spending shock accounts for the majority of the welfare costs of business cycle simply because the unit root built in the optimal plan implicitly attaches the highest weight to the shock with the highest persistence. If, for instance, the persistence of the relative productivity and government spending shocks were both 0.9 (keeping the other parameters fixed at the benchmark calibration), productivity would generally account for more than 60% of the costs of business cycle. However, the implications for the optimal degree of flexibility in monetary and fiscal policy would be basically unchanged. The relative gains of moving to an optimal flexible fiscal rule from a status quo of strict rules would now be even more substantial, in the neighborhood

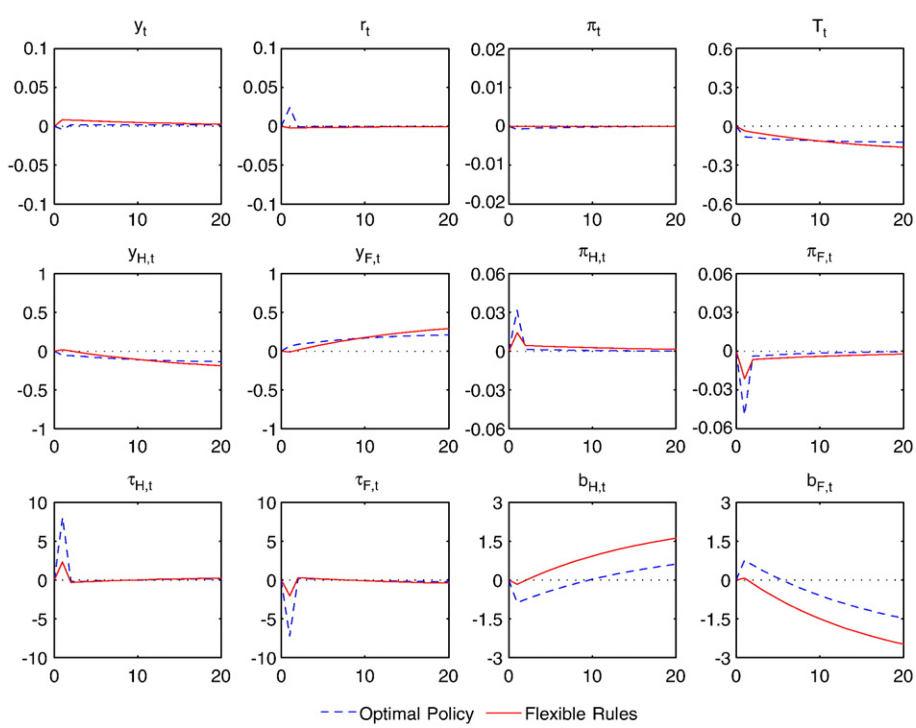

Fig. 2. Percentage response to a 1% innovation $\hat{G}_{R,t}$ (optimal policy vs. flexible rules).

of 80%. Relaxing the assumption of no persistence in the wage markup process would similarly change the relative importance of the exogenous shocks in accounting for business cycle fluctuations, but neither the pre-dominant role of fiscal stabilizations nor the welfare gains associated with flexible fiscal rules would be affected.

5. Conclusions

This paper has investigated the design of fiscal and monetary stabilization policies in a monetary union.

If the heterogeneity in the currency area is only due to exogenous shocks, the economy can be represented in terms of an average and a relative block and the optimal plan can be described in terms of optimal targeting rules. The average block resembles a closed economy. The optimal monetary rule takes the form of a flexible inflation targeting while the optimal fiscal rule prevents national governments from creating inflationary expectations at the union level. The relative block is characterized by cross-country adjustments. The optimal fiscal rule requires variations in relative tax rates that track the evolution of the terms of trade.

The basic properties of the optimal plan carry through to the case of structural heterogeneity (different degrees of nominal rigidities across countries). The equilibrium outcome under the optimal policy serves as a benchmark to evaluate a set of simple rules for monetary and fiscal policy. While suboptimal, this alternative formulation of policy facilitates the communication of the objectives and the verification of the outcomes. The main finding of the quantitative analysis is that the welfare costs of departing from the optimal policy are large, mainly as a consequence of the lack of permanent variations in the level of government debt under the suboptimal arrangements. A strict inflation targeting represents an appropriate simple rule for the monetary authority of a currency union. The benefits of fiscal flexibility are instead substantial. Moving from balanced budget rules to optimal flexible debt targeting improves welfare by more than 50%.

The focus of this paper has been on the stabilization properties of alternative monetary and fiscal rules in a currency union. However, strategic interaction elements that have been ignored in this analysis might indeed play a significant role in actual policymaking. The next step of this research agenda is to characterize the policy game between the fiscal authorities of each country and the monetary authority of the currency union.[29] The centralized optimal plan described in this paper would remain an appropriate benchmark to evaluate the costs of strategic interaction. This enriched framework can also shed some light on the potential benefits of alternative fiscal arrangements in a currency union, such as the possibility of creating a fiscal federation among member states.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jinteco.2008.09.004.

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[29] Baxter and King (2005) address the fiscal side of this game in a *N*-country real model.