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The Unbearable Tightness of Being in a Monetary Union: Fiscal Restrictions and Regional Stability

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Abstract

We study how constrained fiscal policy can affect regional inflation and output in a two-region model of a monetary union with sticky prices and distortionary taxation. Both government expenditure and taxes can be used to stabilize regional variables; however, the best welfare outcome is obtained under constant taxes and constant regional inflations. With cooperation debt and deficit constraints reduce regional inflation variability, but the path of output is suboptimal. Under non-cooperation the opposite occurs due to a trade-off between taxation and inflation variability. Decentralized rules, rather than constraints, stabilize regional inflation and output. They imply more fiscal action for smaller union members.

JEL classification: E63, F41, F42

Keywords: Inflation Differentials, Monetary Union, Budgetary Restrictions, Fiscal rules

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1 Introduction

The creation of a monetary union means that domestic monetary policy can not be used to respond to region-specific economic disturbances. Interest rates, in fact, can no longer serve to meet regional targets for inflation and output and, for a region wishing to exert influence over its domestic economic conditions, fiscal policy is the only instrument left for maneuver.

The use of fiscal policy as a stabilization tool in a monetary union poses several questions: Can regional fiscal policy affect inflation differentials and how? Are country-members bound by fiscal constraints (as the ones imposed by the Stability and Growth Pact in the EMU) able to offset the effects of shocks to regional variables? Can fiscal constraints be sustainable? What are their welfare consequences? Are there alternative arrangements to fiscal constraints that are welfare improving?

All these questions arise naturally in the European Monetary Union. The fiscal framework exemplified in the Stability and Growth Pact (henceforth SGP) attempts to combine flexibility for coping with cyclical downturns, with discipline for deterring negative externalities produced by individual members' irresponsible policies. However, the rigidity of the SGP had undermined its credibility. Today it is generally accepted that the restrictions designed in the Pact are too inflexible in light of a changing economic reality and that they represent an impediment to the evolution of the union-wide economy (See, e.g., Blanchard and Giavazzi (2003)). For that reason, a reform of the SGP has been planned. The proposed reform allows for more flexibility in budgetary rules and puts stronger emphasis on debt and regional idiosyncrasies. Given the ongoing political discussions on the reform of the SGP, it is only natural to question the usefulness of fiscal constraints and to study welfare improving alternatives.

This paper addresses exactly these questions. It investigates how regional fiscal policy can affect regional inflation and output in a two-region model of a monetary union where agents' preferences are characterized by home bias in consumption, prices are sticky and taxes are distortionary, analyzes the macroeconomic and welfare properties of fiscal constraints and proposes alternative welfare improving arrangements.

In particular, we construct a DSGE model of a monetary union where regional government spending is financed with distortionary (income) taxation and study the dynamics of the economy under debt and deficit rules when the central bank targets union-wide inflation and fiscal authorities cooperate respecting the constraints. We also consider an equilibrium where fiscal authorities respect the constraints but do not cooperate in their actions.

We show that welfare is maximized under constant regional inflation and constant tax rates and that both the cooperative and the non-cooperative equilibrium with fiscal constraints are suboptimal when taxes are distortionary. This occurs because of a trade-off between taxation variability and inflation stabilization. In the cooperative equilibrium regional inflation is stabilized, but this requires variable taxation. In the non-cooperative equilibrium local authorities smooth taxes at the cost of variable inflation. This is possible because policy makers can use the terms of trade strategically in this setting.

Fiscal policy has a direct effect on domestic inflation and can affect the terms of trade via aggregate demand movements (by means of government spending) and aggregate supply changes (by means of income taxes). Since, income taxes and government spending move domestic marginal costs in the same direction, local authorities can affect the terms of trade even under budgetary restrictions. This outcome is consistent with the analysis of Canova and Pappa (2003) who show that balanced budget shocks generate significant relative price movements and play an important role in explaining relative price differentials in US states and EMU nations. Thus, the non-cooperative equilibrium delivers output but not regional inflation stability.

The last part of the paper searches for decentralized fiscal rules that approximate the equilibrium with constant regional inflation and constant taxes, and can be implemented as a Nash equilibrium when regional fiscal authorities have preferences for domestic inflation and domestic output stability. A deficit rule with feedbacks from past deficits and from domestic inflation and a tax rule with feedbacks from past domestic real debt can guarantee regional inflation and output stability. These fiscal rules imply tighter limits on deficits for larger countries. The intuition for this result is simple. In an environment where the central bank targets the average inflation rate, the inflation of countries with higher consumption share receives more weight in the calculation of union-wide inflation and, as a result, local stabilization is achieved through the union-wide objective. On the other hand, small countries receive low weights in the union-wide objective. Therefore, the existence of active fiscal policy is crucial for achieving regional inflation and output stability.

Several studies have studied the interaction between fiscal and monetary policy in a monetary union. Most have highlighted that countercyclical fiscal policy may create coordination failures between regional fiscal authorities and the central bank. Dixit and Lambertini (2001, 2003) provide an excellent review of this literature. Others investigated the desirability of fiscal constraints in a monetary union. For example, Dixit (2001) shows that fiscal independence at regional level might undermine the central bank's objectives and provides arguments in favor of fiscal constraints; Beetsma and Bovenberg (1998) and Beetsma and Uhlig (1999) argue that fiscal constraints improve welfare because they correct the debt bias originating from government myopia; Uhlig (2002) shows that budgetary rules help to avoid the free-riding problems arising from the interaction between many fiscal and one monetary authority, while Chari and Kehoe (1998) and Adams and Billi (2004) claim that fiscal constraints are unnecessary when the monetary authorities can commit.

The work which is most closely related to ours is the one of Beetsma and Jensen (2002), who study the optimal coordinated monetary and fiscal policies in a currency area. Relative to these authors, we adopt a more general specification of preferences, allowing for home bias in consumption, we allow for distortionary taxation and we focus on the design of fiscal rules in monetary unions that deliver regional price and output stability. Duarte and Wolman (2002) also study the interaction between regional fiscal policy and inflation differentials in a monetary union with flexible prices, but emphasize the positive as

opposed to the normative side of the problem.

The rest of the paper is organized as follows: the next section describes the model. In section 3 we characterize our benchmark equilibrium with constant regional inflation and constant taxes and in section 4 the properties of the equilibrium obtained under balanced budget restrictions when regional authorities cooperate. Section 5 analyzes the Nash equilibria between independent fiscal authorities constrained by deficit rules, whereas section 6 studies how our benchmark of constant regional inflation - constant taxes equilibrium can be implemented by decentralized rules. Section 7 concludes.

2 The Model

2.1 The Economy

The economy consists of two regions, H (home) and F (foreign). Each region is populated by identical, infinitely lived agents. There is no migration. Each agent produces a single differentiated good and consumes the goods produced in both regions. Time is discrete. At each $t = 0, 1, \ldots$, demand and supply shocks occur. Firms and households make their decisions after observing the shocks. All agents have access to an international financial market, where they can trade a state-contingent nominal bond. Since the economic structure of the foreign region, F, is similar, except that the share of domestic goods in the consumption basket may differ from that in the home region, in what follows, we denote all foreign variables with an asterisk and assume that all other relationships and parameters are comparable with their counterparts in the home country.

2.1.1 Representative Households

Households derive utility from consuming a composite private good, C_t, and a composite public good, $\widehat{G}_t$, from holding real money balances, $\frac{M_t}{P_t}$, and disutility from working , l_t. At period 0 they maximize the expected value of utility flows:

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, l_t, \frac{M_t}{P_t}, \widehat{G}_t) \tag{1}$$

where $u(.)$ is assumed to be concave and twice continuously differentiable.

Consumption is an aggregate of home and foreign goods:

$$C_t = \left[(1-\alpha_H)^{\frac{1}{\eta}} C_{Ht}^{\frac{\eta-1}{\eta}} + \alpha_H{}^{\frac{1}{\eta}} C_{Ft}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{2}$$

The agents of region H consume a continuum of varieties of home goods indexed by $i \in [0, \beta_H]$ and imported goods indexed by $i \in [\beta_F, 1]$. The home and foreign goods in (2) are aggregates of these continua of varieties:

$$C_{Ht} = \left(\int_0^{\beta_H} C_{Ht}(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}}, \qquad C_{Ft} = \left(\int_{\beta_F}^{1} C_{Ft}(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}} \tag{3}$$

where $\theta > 1$, is the elasticity of substitution between varieties of goods; η is the elasticity of substitution between domestic and imported goods, while $(1-\alpha_H)$ $((1-\alpha_F))$ measures the degree of home bias in consumption in region H (F). Finally, $\beta_H = \frac{1}{2} + \alpha_F - \alpha_H$, $\beta_F = \frac{1}{2} + \alpha_H - \alpha_F$ measure the economic size of region H and F respectively. We allow for different degrees of home bias in consumption in order to characterize the equilibrium properties of our model when countries are of unequal size.

In what follows, we specialize the period utility function to be of the form:

$$u(C, l, \frac{M}{P}, \widehat{G}) = \frac{C^{1-\sigma}}{1-\sigma} - \psi \frac{l^{1+v}}{1+v} + \chi \frac{(M/P)^{1-\varepsilon}}{1-\varepsilon} + \epsilon \varkappa(\widehat{G})$$

We assume that the government has the same preferences as the consumers, thus $\widehat{G}_t$ is a composite of home and foreign goods and is determined similarly with the composite private consumption good:

$$\widehat{G}_t = \left[(1-\alpha_H)^{\frac{1}{\eta}} G_{Ht}^{\frac{\eta-1}{\eta}} + \alpha_H{}^{\frac{1}{\eta}} G_{Ft}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{4}$$

where

$$G_{Ht} = \left(\int_0^{\beta_H} G_{Ht}(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}}, \qquad G_{Ft} = \left(\int_{\beta_F}^{1} G_{Ft}(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}} \tag{5}$$

If P_{Ht}, P_{Ft} denote respectively the prices of the home and foreign bundle of goods, the CPI index in region H for the composite consumption good is:

$$P_t = \left[(1-\alpha_H) P_{Ht}^{1-\eta} + \alpha_H P_{Ft}^{1-\eta} \right]^{\frac{1}{1-\eta}} \tag{6}$$

Letting $S_t = \frac{P_{Ft}}{P_{Ht}}$ be the terms of trade, CPI in region H is:

$$P_t = \left[(1-\alpha_H) + \alpha_H S_t^{1-\eta} \right]^{\frac{1}{1-\eta}} P_{Ht} \tag{7}$$

and the CPI in region F is:

$$P_t^* = \left[(1-\alpha_F) + \alpha_F S_t^{\eta-1} \right]^{\frac{1}{1-\eta}} P_{Ht}^* \tag{8}$$

Given the structure of preferences of the domestic and foreign consumers, the demand function for domestic goods consumed at home, C_{Ht}, and abroad, C_{Ft}^*, is given by:

$$C_{Ht} = (1-\alpha_H) \left(\frac{P_t}{P_{Ht}} \right)^{\eta} C_t, \qquad C_{Ft}^* = \alpha_F \left(\frac{P_t^*}{P_{Ft}^*} \right)^{\eta} C_t^* \tag{9}$$

Similarly, the demand for foreign goods consumed by foreign consumers, C_{Ht}^* and domestic consumers, C_{Ft}, is given, respectively, by:

$$C_{Ht}^* = (1-\alpha_F) \left(\frac{P_t^*}{P_{Ht}^*} \right)^{\eta} C_t^* \qquad C_{Ft} = \alpha_H \left(\frac{P_t}{P_{Ft}} \right)^{\eta} C_t \tag{10}$$

The government demands for goods are given by similar expressions:

$$G_{Ht} = (1-\alpha_H)\left(\frac{P_t}{P_{Ht}}\right)^{\eta}\widehat{G}_t, \qquad G^*_{Ft} = \alpha_F\left(\frac{P^*_t}{P^*_{Ft}}\right)^{\eta}\widehat{G}^*_t \tag{11}$$

$$G^*_{Ht} = (1-\alpha_F)\left(\frac{P^*_t}{P^*_{Ht}}\right)^{\eta}\widehat{G}^*_t \qquad G_{Ft} = \alpha_H\left(\frac{P_t}{P_{Ft}}\right)^{\eta}\widehat{G}_t \tag{12}$$

Representative consumers in each region receive after tax income from working, from asset holdings, and from profits. Households then consume, accumulate real money balances, purchase new assets and split savings between money and other assets. The household has access to an international financial market, where state-contingent nominal bonds (denominated in Home currency) can be traded. The home consumer also holds a riskless nominal bond issued by the domestic government, B^H_t, paying $(1+R_t)$ currency units in period $t+1$.

The intertemporal budget constraint of the representative household of region H, expressed in domestic currency units, is:

$$P_tC_t + E_t\{Q_{t,t+1}D_{t+1}\} + B^H_{t+1} + M_{t+1} \leq (1-\tau^{lH}_t)P_tw_tl_t + M_t + D_t + (1+R_t)B^H_t + \tau^H_tP_t + \Xi_t \tag{13}$$

where Ξ_t represents profits of domestic firms (assumed to be owned by domestic consumers), $(1-\tau^{lH}_t)P_tw_tl_t$ the after tax nominal labor earnings, τ^H_t lump sum taxes, D_{t+1} is the holdings of state-contingent nominal bonds that pay one unit of home currency in period $t+1$ if a specified state is realized and $Q_{t,t+1}$ is the price of such bonds at t.

Finally, the problem of the representative household in the home (foreign) region is to choose sequences for consumption, C_t, labor, l_t, nominal state-contigent bonds, D_{t+1}, domestic government bonds[1], B^H_{t+1}, and money holdings, M_{t+1}, in order to maximize the expected discounted utility (1) subject to the sequence of intertemporal budget constraints in (13), taking prices and wages and government consumption and taxes as given.

The optimality condition for bond holdings in the two regions and the definition of the real exchange rate, q_t, obtains (after normalizing initial conditions):

$$C_t = \varrho C^*_t q_t^{1/\sigma}, \quad \text{for } \forall t \tag{14}$$

where ϱ is a constant that reflects initial conditions on relative consumption.

2.1.2 Firms and Market Structure

Production units are imperfectly competitive and the production function in each country is given by $z^s_t l^i_t$, where z^s_t (z^{s*}_t) is a domestic (foreign) productivity shock. Following Calvo (1983), at each t each domestic producer is allowed to reset her price with a constant probability, $(1-\gamma)$, independently of the time elapsed since the last adjustment. Producers face domestic and foreign demand for their product, but do not engage in international price discrimination. This assumption together with the fixity of

[1] Although. we do not allow for holdings of foreign government bonds for simplicity, our analysis is independent of this assumption.

the exchange rate implies that the real exchange rate is equal to the ratio of foreign to domestic prices: $q_t = P_t^*/P_t$. When a producer receives a signal to change her price, she chooses her new price, P_{Ht}^{new}, to maximize:

$$\max E_t \sum_{j=0}^{\infty} (\beta\gamma)^j Q_{t,t+j} Y_{t+j}^H (P_{Ht}^{new} - P_{Ht+j} MC_{t+j}) \tag{15}$$

Real marginal costs and the newly set price are then given by:

$$MC_t = \frac{w_t}{P_{Ht}} P_t \tag{16}$$

$$P_{Ht}^{new} = \frac{\theta}{(\theta - 1)} \frac{E_t \sum_{j=0}^{\infty} (\gamma\beta)^j Q_{t,t+j} P_{Ht+j} MC_{t+j}^H Y_{t+j}^H}{E_t \sum_{j=0}^{\infty} (\gamma\beta)^j Q_{t,t+j} Y_{t+j}^H} \tag{17}$$

2.1.3 Monetary Policy and Regional Fiscal Policy

We assume that monetary policy is characterized by the rule:

$$M_t^U = \mu_t M_{t-1}^U R_{t-1}^{\chi} \tag{18}$$

where μ_t is an aggregate monetary policy shock and R_t is the union-wide interest rate. Seigniorage is distributed according to the size of the two regions:

$$M_{t+1}^U - M_t^U = K_t^U = K_t^H + K_t^F \tag{19}$$

where $K_t^H = \beta_H K_t^U$, and $K_t^F = \beta_F K_t^U$.

Finally, the union-wide price level is:

$$\beta_H P_t + \beta_F P_t^* = P_t^U \tag{20}$$

The fiscal authority in the home region issues nominal debt, B_t^H, taxes nominal income at the rate τ_t^{lH}, has access to lump sum taxes, τ_t^H, and receives seigniorage revenues from the central monetary authority, K_t^H. These revenues finance domestic government spending, $\widehat{G}_t$, and interest payments on debt. The government budget constraint in region H is given by:

$$B_{t+1}^H + K_t^H \leq (1 + R_t) B_t^H + P_t \widehat{G}_t - P_t \tau_t^{lH} w_t l_t - \tau_t^H P_t \tag{21}$$

We assume that:

$$\widehat{G}_t = G_t z_t^d \tag{22}$$

where z_t^d is random and G_t depends on the state of the local economy.

As we shall see, the presence of the systematic expenditure and tax component are necessary to guarantee that both regional inflation is stabilized and government debt is not explosive in equilibrium.

2.1.4 Exogenous Processes

The law of motion for the productivity shocks $\xi_t^s = [z_t^s,\ z_t^{s*}]'$ is:

$$\xi_{t+1}^s = \Gamma \xi_t^s + \varepsilon_t^s \tag{23}$$

where $\xi_t^{s\prime} = [z_t^s, z_t^{s*}]$, $E_t \varepsilon_{t+1}^s = 0, E_t \varepsilon_{st} \varepsilon_{s^*t}' = D$. While the correlation between supply shocks is unrestricted, demand shocks are assumed to be uncorrelated.

$$\xi_{t+1}^d = \vartheta \xi_t^d + \varepsilon_t^d \tag{24}$$

where $\xi_t^{d\prime} = [z_t^d, z_t^{d*}]$, $E_t \varepsilon_{t+1}^d = 0, E_t \varepsilon_{dt} \varepsilon_{d^*t}' = ID$, where ID is a diagonal matrix.

Finally the monetary disturbance follows:

$$\mu_t = \rho_\mu \mu_{t-1} + \varepsilon_t^\mu \tag{25}$$

Equilibrium in the economy is defined by market clearing and efficiency conditions, given the policies of the central monetary and regional fiscal authorities and the evolution of prices. Market clearing implies among other things:

$$\begin{aligned} Y_t &= (1-\alpha_H)[C_{Ht} + G_{Ht}] + \alpha_F [C_{Ft}^* + G_{Ft}^*] \\ Y_t^* &= (1-\alpha_F)[C_{Ht}^* + G_{Ht}^*] + \alpha_H [C_{Ft} + G_{Ft}] \end{aligned} \tag{26}$$

In order to investigate the dynamics of the model, we log-linearize the equilibrium conditions around the steady state of zero regional inflation. We consider both a symmetric steady state in which the two countries have equal size and an asymmetric one. The steady state conditions are presented in the Appendix.

2.2 Equilibrium Dynamics

In this subsection we present the linearized equilibrium dynamics for the home region. Since the conditions for the foreign region are analogous they are omitted. All variables appear in log linear deviations from steady state values.

The regional aggregate demand depends on nominal interest rates as well as expectations of domestic CPI inflation:

$$c_t = E_t c_{t+1} - \frac{1}{\sigma}(\widehat{R}_{t+1} - E_t \pi_{t+1}) \tag{27}$$

Risk sharing implies that regional consumption differentials depend on the evolution of the terms of trade:

$$c_t = c_t^* + \frac{(1-\alpha_H-\alpha_F)}{\sigma} s_t \tag{28}$$

The domestic inflation rate depends on the domestic marginal costs and expectations of future price setting:

$$\pi_{Ht} = \delta_\gamma mc_t + \beta E_t \pi_{Ht+1} \tag{29}$$

where $\delta_\gamma = \frac{1-\gamma}{\gamma}(1-\gamma\beta)$. In turn, marginal costs are determined by:

$$mc_t = (\sigma + v)c_t + v(1-\alpha_H)\widehat{g}_t + v\alpha_F \widehat{g}_t^* + \xi_s s_t + \frac{\tau^{lH}}{1-\tau^{lH}}\tau_t^{lH} - vz_t^s \tag{30}$$

where $\xi_s = v\alpha_F\left(\left[\eta(1-\alpha_H)\frac{\alpha_H}{\alpha_F} + (1-\alpha_F)\right] - \frac{1-\alpha_H-\alpha_F}{\sigma}\right) + \alpha_H$.and $\widehat{g}_t = g_t + z_t^d$, $\widehat{g}_t^* = g_t^* + z_t^{d*}$

Equations (29) and (30) are crucial for understanding the results. Regional fiscal policy affects domestic inflation because it affects labor market variables. Taxes on labor income affect real wages and, thus, marginal costs (see equation (16)), while increases in government spending affect marginal costs through their impact on demand and, thus, employment (captured here by parameter v). Foreign fiscal policy also affects domestic marginal costs because of its impact on domestic demand and employment (captured by the parameter $v\alpha_F$). This last effect depends on the degree of openness of the foreign economy, α_F. If foreign preferences are completely home-biased , i.e., $\alpha_F = 0$, increases in foreign spending do not affect domestic output and, thus, domestic employment. However, with trade links increases in foreign demand change domestic marginal costs.

Terms of trade movements also change real marginal costs (terms of trade externality). Producers set domestic prices but they minimize costs discounting wages with CPI prices. With no international price discrimination CPI prices are directly affected by changes in relative prices. However, as the economies become autarkic, the importance of the terms of trade for domestic inflation declines ($\xi_s \longrightarrow 0$ as $\alpha_H, \alpha_F \longrightarrow 0$). Notice that since regional prices are sticky and the exchange rate is fixed, movements in the terms of trade are sluggish, and are only slowly affected by changing economic conditions.

The definition of the terms of trade together with the fixity of the nominal exchange rate implies that relative inflation differentials correspond one-to-one to changes in the terms of trade:

$$\pi_{Ht}^* - \pi_{Ht} = \Delta s_t \tag{31}$$

while the definition of CPI at home and abroad implies:

$$\pi_t = \pi_{Ht} + \alpha_H \Delta s_t, \quad \pi_t^* = \pi_{Ht}^* - \alpha_F \Delta s_t \tag{32}$$

The demand for real money balances is given by:

$$m_t = \frac{\sigma}{\varepsilon} c_t - \frac{1}{\varepsilon} R_t \tag{33}$$

In the money market equilibrium the sum of demands in each region should equal real money balances.

$$m_t^U = m_t + m_t^* + (\beta_H - \beta_F)(1-\alpha_H-\alpha_F)s_t \tag{34}$$

The goods market equilibrium implies that regional output is determined by:

$$y_t = c_t + (1-\alpha_H)\widehat{g}_t + \alpha_F \widehat{g}_t^* + \frac{\xi_s - \alpha_H}{v} s_t \tag{35}$$

Hence, regional output depends on domestic consumption, domestic and foreign government spending and the terms of trade.

Finally, if we define nominal primary deficits as $D_t^H = P_t(\widehat{G}_t - T_t)$, the evolution of real regional deficit and debt in a loglinear form is:

$$\frac{d^H}{y} d_t^H = \left[\frac{g}{y} - (1-\alpha_H)(1+v)\right]\widehat{g}_t - \alpha_F(1+v)\widehat{g}_t^* + (1+v)z_t^s - \frac{\tau^{lH}}{1-\tau^{lH}}\tau_t^{lH} - \tau^H \tau_t^H \tag{36}$$

$$\frac{b^H}{y} b_{t+1}^H + \beta_H \frac{m}{y}(m_{t+1} - m_t) + \left(\frac{b^H}{y} + \beta_H \frac{m}{y}\right) E_t \pi_{t+1} = \frac{b^H}{y}(1+R) b_t^H + \frac{b^H}{y} R R_t + \frac{d^H}{y} d_t^H \tag{37}$$

Equations (27) - (37) together with their foreign counterparts and policy rules for the fiscal and the monetary authorities completely characterize the equilibrium.

3 The Constant inflation - constant tax equilibrium

The equilibrium of the economy is suboptimal because firms have market power, there are nominal rigidities and distortionary taxation. While in the literature it is common to use taxes/subsidies to eliminate the monopolistic competitive distortion (see e.g. Rotemberg and Woodford (1998)), we will not do this since here taxes are used for cyclical stabilization purposes. Instead, we will assume that $\theta \to \infty$. In this way, the size of the monopolistic competitive distortion becomes minimal. We also assume that the liquidity services of money are small. By doing so, we eliminate the monetary distortion that would make the Friedman rule optimal.

Sticky prices create two distortions in a monetary union. First there is an unequal allocation of profits for identical firms within each region and, second, there are inertial movements in the terms of trade and inefficient reallocation of resources in the presence of region-specific asymmetric shocks (see for example, Pappa (2004)). For the equilibrium with no price distortions to be implemented, marginal costs have to be constant. If marginal costs were constant, the inertia in the terms of trade would not have any detrimental effects for the reallocation of resources in the two economies. In this sense, domestic inflation targeting, would guarantee both union-wide inflation stability and the elimination of the distortions that inertial relative price movements cause in the reallocation of resources[2].

However, a central bank seeking regional price stability cannot obtain it by solely using the nominal interest rate as an instrument since there are more targets than instruments. Since regional fiscal policy (distortionary taxes, or spending) can affect regional marginal costs it can naturally be used together

[2] In different frameworks, Andersen (2000) and Von Hagen and Mundschenk (2002)) show the presence of inflation differentials creates incentives for policy competition among regional fiscal authorities and Collard and Dellas (2004) find that in a closed economy with distortionary taxes the case of perfect price stability, although not optimal, it implies insignificant welfare costs.

with the nominal interest rate for pursuing regional inflation stability. Since we assume that agents' utility from public spending is small (i.e., $\epsilon \to 0$) , the systematic use of government spending as a stabilization tool does not create additional distortions in the economy.

The only remaining distortion in the economy is income taxation which is assumed to be non zero in the steady state. Since distortionary taxation is a feature of the real world, we want to maintain it in our analysis. For that reason, we use as a benchmark for our comparisons a second best equilibrium where distortionary taxes are constant and regional inflation rates are constant as well. This equilibrium is closer to the optimal one than any other alternative policy arrangement. Such an equilibrium is characterized by the following conditions:

$$\begin{aligned} \tau_t^{lH} &= \tau_t^{lF} = 0, \qquad \forall t \\ \pi_t^u &= \pi_{Ht} = \pi_{Ht}^* = 0 \end{aligned} \tag{38}$$

Government spending in the desired equilibrium is then determined by:

$$\begin{aligned} g_t &= \frac{1-\alpha_F}{1-\alpha_F-\alpha_H} z_t^s - \frac{\alpha_F}{1-\alpha_F-\alpha_H} z_t^{s*} - \frac{(1-2\alpha_F)\varepsilon}{1-\alpha_F-\alpha_H} \frac{\sigma+v}{2v\sigma} m_t^U - z_t^d \\ g_t^* &= \frac{1-\alpha_H}{1-\alpha_F-\alpha_H} z_t^{s*} - \frac{\alpha_H}{1-\alpha_F-\alpha_H} z_t^s - \frac{(1-2\alpha_H)\varepsilon}{1-\alpha_F-\alpha_H} \frac{\sigma+v}{2v\sigma} m_t^U - z_t^{d*} \end{aligned} \tag{39}$$

Thus, regional expenditure in the benchmark equilibrium should systematically respond to regional fiscal shocks (z_t^d) and union-wide monetary policy (m_t^U), and be procyclical with respect to supply shocks. The intuition for such a counterintuitive prediction is as follows: An increase in domestic productivity decreases marginal costs and, thus, leads to expectations of lower inflation in the future. Therefore, government spending should increase so as to stimulate demand and, thus, counteract the effect that an increase in domestic productivity has on marginal costs and, thus, on domestic inflation.

Notice that in (39), if $\alpha_F \neq \alpha_H$, changes in domestic regional productivity, or in monetary policy induce larger systematic responses in domestic government expenditure in smaller regions. Also, domestic spending should be less reactive to foreign productivity shocks in smaller regions.

The level of output in our benchmark policy arrangement depends positively on regional productivity shocks and negatively on aggregate monetary policy.

$$\begin{aligned} \overline{y}_t &= z_t - \frac{\varepsilon}{2v} m_t^U \\ \overline{y}_t^* &= z_t^* - \frac{\varepsilon}{2v} m_t^U \end{aligned} \tag{40}$$

4 Constraints on real regional debt and deficits.

The previous section has highlighted an important feature of our economy: in a monetary union the most advantageous reallocation of resources can be achieved when the terms of trade are constant and regional inflations stabilized. In this section we study the macroeconomic effects of imposing constraints

on real regional debt and deficits. In particular, we assume that regional fiscal authorities cooperate and commit to follow zero real deficit and debt policies.

The presence of debt and deficit constraints does not impede the achievement of an equilibrium where both regional and union-wide inflation are stable. This is true independently of the kind of taxation used to finance government spending and the symmetry of regions, or of shocks. In other words, real regional debt and deficit constraints can be used as decentralized rules to implement an equilibrium with regional inflation stability. This result is perhaps surprising. To grasp the intuition notice that in an equilibrium where the central bank commits to union-wide inflation targeting, the following conditions hold:

$$\pi_t^u = \beta_H \pi_t + \beta_F \pi_t^* = 0 \tag{41}$$

$$\pi_t = -\frac{\beta_H}{\beta_F}\pi_t^* = -\beta_F(1-\alpha_H-\alpha_F)\Delta s_t \tag{42}$$

Substituting (41) and (42) in the equation for the accumulation of regional debt (37), we have:

$$\frac{b^H}{y}b_{t+1}^H = \frac{b^H}{y}(1+R)b_t^H + \omega_s E_t \Delta s_{t+1} + \frac{d^H}{y}d_t^H \tag{43}$$

$$\frac{b^F}{y}b_{t+1}^F = \frac{b^F}{y}(1+R)b_t^F + \omega_s E_t \Delta s_{t+1} + \frac{d^F}{y}d_t^F \tag{44}$$

where $\omega_s = (1-\alpha_H-\alpha_F)\left[\frac{b^H}{y}\left[\beta_F + \frac{1-\varepsilon(\beta_H-\beta_F)}{2\beta}\right] + \beta_H \frac{m}{y}\frac{\varepsilon\beta_H - 1}{\varepsilon}\right]$.

Let the constraints in regional deficits and debts take the form:

$$\begin{aligned} b_t^H &= b_t^F = 0, \forall t \\ d_t^H &= d_t^F = 0, \forall t \end{aligned} \tag{45}$$

Then, equations (43) and (44) imply that the terms of trade are constant and by (42) and (32) domestic regional and CPI inflations are constant as well. To gain additional insights, we separately analyze the case of lump sum and income taxation .

It is trivial to show that when lump-sum taxes are available zero deficit and debt rules can replicate the benchmark equilibrium. With no distortionary taxation and a zero deficit rule, lump sum taxes can always be changed to satisfy the deficit rule without creating distortions in the economy. On the other hand, inspection of (43) and (44) indicates that a policy of constant regional real debt, under constancy of deficits, is equivalent to a policy of zero regional inflation differentials (i.e., $\Delta s_{t+1} = 0$) and, thus, from (32) and (42) of constant domestic prices. Hence, movements in government spending are the same as those obtained in (39).

With income taxation, taxes affect real marginal costs and tax revenues are endogenous. These two characteristics are essential to understand why an equilibrium of zero regional inflation variability can be obtained when local authorities are constrained by strict debt and deficit rules. For example, suppose the economy is subject to a positive demand shock which increases deficits, domestic real marginal costs and the terms of trade. The domestic fiscal authorities can either increase taxation, or decrease the

systematic component of spending to satisfy the constraint on regional deficit. Increases in domestic taxation, however, decrease after tax wages and, thus, increase domestic marginal costs and prices, while decreases in domestic spending do the opposite. Because of the constraint on real debt, the local fiscal authorities will prefer to do the latter.

When a positive productivity shock occurs, increases in productivity affect tax revenues. A productivity shock increases or decreases labor supply depending on the income and the substitution effects. For instance, if the income dominates the substitution effect, productivity shocks tend to decrease labor and, thus, tax revenues. Suppose that the substitution effect is stronger and that tax revenues increase after a productivity shock. Then fiscal authorities will have to reduce taxes or increase spending so as to maintain constant real deficits. On the other hand, the increase in productivity reduces domestic marginal costs and prices. If the local authorities reduce taxation after the positive shock, they will reduce prices even further, decreasing the value of domestic real debt. Thus, to satisfy both debt and deficit constraints, the local authorities must increase spending so as to counteract the effects of the productivity shock on marginal costs.

The equilibrium under distortionary income taxation satisfies the following two conditions:

$$\left[\frac{g}{y}-(1-\alpha_H)(1+v)\right]\widehat{g}_t-\alpha_F(1+v)\widehat{g}_t^*+(1+v)z_t^s=\frac{\tau^{lH}}{1-\tau^{Hl}}\tau_t^{lH} \tag{46}$$

$$mc_t=\frac{v}{2}(z_t^s-z_t^{s*})+\rho_s s_t+v(\frac{1}{2}-\alpha_H)\widehat{g}_t-v(\frac{1}{2}-\alpha_F)\widehat{g}_t^*+\frac{1}{2}\frac{\tau^{lH}}{1-\tau^{Hl}}\tau_t^{lH}-\frac{1}{2}\frac{\tau^{lF}}{1-\tau^{lF}}\tau_t^{lF}=0 \tag{47}$$

where $\rho_s=\left[\xi_s+\frac{(\sigma+v)(1-\alpha_H-\alpha_F)}{2\sigma}+\frac{\sigma+v}{v}(\alpha_F-\alpha_H)\right]$. Equation (46) implies constancy of real deficits and (47) determines real marginal costs. In equilibrium, taxes on nominal income and government spending move to guarantee the constancy of real regional debt and deficits. Government spending is determined by:

$$g_t=\zeta_{gy}z_t^s-\zeta_{gy}^*z_t^{s*}+\zeta_m m_t^U-z_t^d \tag{48}$$

where $\zeta_{gy}=\frac{v(1-\alpha_F-\frac{g}{y})}{\frac{g}{y}^2-\frac{g}{y}(2-\alpha_H-\alpha_F)+(1-\alpha_F-\alpha_H)}$, $\zeta_{gy}^*=\frac{v\alpha_F}{\frac{g}{y}^2-\frac{g}{y}(2-\alpha_H-\alpha_F)+(1-\alpha_F-\alpha_H)}$

and $\zeta_m=(\sigma+v)(1-2\alpha_F-\frac{g}{y})\frac{\varepsilon}{2\sigma}$, while taxes on nominal income are determined by (46).

In sum, although the policies described by (46) and (48) can guarantee zero regional inflation variability, they imply positive and variable levels of income taxation and, thus, a welfare inferior outcome. Even though regional inflation is stabilized, output deviates from its ideal path. We show this for a numerical version of the model in Figure 1 (parameter values are in Table 1). In response to a technology shock, income taxes respond to the shock and output is below its benchmark path while both union-wide and regional inflation are stabilized.

Notice that both constraints on deficits and debt are necessary for generating constant regional inflations. If, for example, real debt constraints were not imposed, fiscal authorities would satisfy deficit constraints by increasing domestic inflation since such a policy would reduce their real debt

burden. Upper-limits restrictions on deficits or debt may also generate positive regional inflations. For example, upper limits on deficits would not implement our benchmark equilibrium. To see this, suppose that the domestic economy is subject to a productivity shock which decreases domestic marginal costs and reduces deficits. If regional fiscal authorities are subject to upper deficit limits they might not react to the shock and let domestic prices fall relative to foreign ones. Also, restrictions on debt and deficit to GDP ratios might not work in this framework. This is because such restrictions might imply inaction after productivity shocks and this would increase the gap between domestic and foreign prices.

Inflation differentials do exist in the Euro area, see e.g., ECB Report on Inflation Differentials in the Euro Area (2003). The analysis of this section suggests that they might be due to the fact that the SGP poses upper limits, or to the fact that restrictions are defined on the ratios of the relevant fiscal variables to GDP and not on their real value.

To conclude, regional inflation stabilization requires tight constraints in deficit and debts. The cost is that with such restrictions, output is uniformly below its potential and the equilibrium obtained is associated with welfare losses.

5 Non-Cooperative Regional Fiscal Policies

In a non-cooperative Nash equilibrium, monetary policy is determined by the Central Bank and each fiscal authority maximizes its expected utility subject to the domestic constraints, knowing central bank policy and taking as given the actions of the foreign fiscal policymaker. The policies we wish to analyze are those under commitment. Although the assumption of fiscal policy commitment might seem unrealistic, we adopt it here, since our scope is to identify whether the benchmark zero regional inflation - zero tax equilibrium can be implemented as a Nash allocation with independent fiscal authorities. Since we are not interested in the distortions produced by the limited horizon of fiscal policymakers, our analysis is meaningful and not restrictive in any sense.

5.1 Fiscal Loss Function

In order to be able to construct a Nash equilibrium we need to choose a loss function for the regional fiscal authorities. To do so we first assume that the preferences of a country for inflation and output stabilization are independent of the international policy arrangement employed. Second, if fiscal policy is to substitute monetary policy for domestic stabilization purposes, the policy objective must be similar. Benigno and Woodford (2003) have derived an analytical expression for welfare based on consumers preferences in a closed economy with preferences, technologies and distortions which look like ours. Such an expression depends on deviations of output and inflation from their targets. Therefore, the welfare criterion for fiscal authorities we employ depends on deviations of domestic inflation and output

from their benchmark value[3]. Note that the fiscal loss function should take into account not only the distortions associated with sticky prices, but also the ones induced by taxes. Hence, the objective for fiscal authorities is:

$$\begin{gathered} W_t^i = E_0 \left\{ \tfrac{1}{2} \sum_{t=0}^{\infty} \beta^t L_t^i \right\} \text{ for } i = H, F \\ \text{with } L_t^H = \{\lambda(y_t - \overline{y}_t)^2 + \pi_{Ht}^2\} \\ \text{and } L_t^F = \{\lambda(y_t^* - \overline{y}_t^*)^2 + \pi_{Ht}^{*2}\} \end{gathered} \tag{49}$$

where $\overline{y}_t, \overline{y}_t^*$ are determined by (40) and $\lambda = 0.2$, is a constant measuring the relative weight that the fiscal authority gives to domestic output stabilization. This constant depends non-linearly on structural parameters of the model, such as, the intertemporal elasticity of substitution, the labor supply elasticity, the elasticity of substitution among varieties of goods, the degree of price stickiness, the steady state tax rate and the ratio of government spending to total output and to total surplus.

5.2 The Nash equilibrium

Each fiscal authority at the beginning of time chooses a government spending path to minimize (49) subject to the domestic aggregate conditions and taking as given foreign policy variables. Taxes are selected to make real deficits constant.

The optimality conditions, in both the case of lump sum and income taxes, are given by:

$$\begin{gathered} \lambda(y_t - \overline{y}_t) - \lambda\beta^{-1}(y_{t-1} - \overline{y}_{t-1}) - \delta_\gamma \sigma \pi_{Ht} = 0 \\ \lambda(y_t^* - \overline{y}_t^*) - \lambda\beta^{-1}(y_{t-1}^* - \overline{y}_{t-1}^*) - \delta_\gamma \sigma \pi_{Ht}^* = 0 \end{gathered} \tag{50}$$

The conditions in (50) together with constant deficit rules, and equations (27) to (37) and their foreign counterparts, determine the dynamics of the Nash equilibrium. Because the problems solved by the fiscal authorities do not have closed form solutions, we resort to simulations to study the outcomes of this policy arrangement.

5.2.1 Calibration

We consider two specifications of the model: one with two equally sized countries and one with a large and a small one. In the first case,we calibrate the model to the German and the French economy, while in the latter case we replace France with Portugal. Time is taken to be quarters. We set the discount factor $\beta = 1.03^{-1/4}$, so as the annual real interest rate equals 4%. The parameter v measures the curvature of the disutility of labor. Empirical evidence suggests that wage elasticities lie in the interval [0.1, 1] (see Gali, Gertler and Lopez-Salido (2002)). We set the elasticity of labor supply to 0.3. The degree of price stickiness, measured by γ, is equal to 0.75, so that pricing contracts last for a year on average. When countries are symmetric, we set $\alpha_H = \alpha_F = 0.2$, when they are asymmetric, we set $\alpha_H = 0.05$ for the large country and $\alpha_F = 0.45$ for the small country. This implies that the size of the

[3] In open economies deviations of terms of trade from target may also enter the loss function of independent central banks. However, as shown in Pappa (2004) the latter do not replicate the optimal movements in the terms of trade because of terms of trade externalities.

large economy is nine times larger than the one of the small economy. The elasticity of substitution between home and foreign goods is set to 1.5. The coefficient of relative risk aversion σ is set to 2.

Table 1: Parameter values used in the simulations

Parameter	Description	Value
β	Discount factor	$1.03^{-1/4}$
$\alpha_H=\alpha_F$	Symmetric relative region size $\beta_H=\beta_F=0.5$	0.2
$\alpha_H\neq\alpha_F$	Asymmetric relative region size, $\beta_H=0.90$, $\beta_F=0.10$	0.45, 0.05
ψ	Preference parameter for leisure	0.5
σ	Relative risk aversion	2.0
η	International elasticity of substitution	1.5
χ	Preference parameter for real money balances	0.023
$\in$	Preference parameter for government consumption	0.01
$1/\nu$	Labor supply elasticity	0.3
γ	Probability that a firm is unable to change its price	0.75
$\theta/(\theta-1)$	Gross steady state mark-up	1.00
$B^H/Y^H = B^F/Y^F$	Debt to GDP ratio	2.4
$G/Y = G^*/Y^*$	Spending to GDP ratio	0.2
M/Y	Money to GDP ratio	2.5
$\tau^{IH} = \tau^{IF}$	Tax on nominal income	0.30
x	Coefficient on interest rate in money supply	0.0
Γ	AR(1) parameters on productivity shocks	$\Gamma=\begin{bmatrix}0.906 & 0.088\\ 0.088 & 0.906\end{bmatrix}$
Δ	AR(1) parameter on government spending shocks	$\Delta=\begin{bmatrix}0.42 & 0.0\\ 0.0 & 0.42\end{bmatrix}$
D	Standard deviation of technology innovations	$D=\begin{bmatrix}0.0082 & 0.26\\ 0.26 & 0.0082\end{bmatrix}$
ID	Standard deviation of government innovations	$ID=\begin{bmatrix}0.00214 & 0.0\\ 0.0 & 0.00214\end{bmatrix}$

Steady state inflation in both regions and union-wide is zero while the debt to GDP ratio in the steady state equals 2.4 (so that debt is 60% of a years GDP) and government expenditure to GDP is 0.20. Both figures roughly correspond to the average debt to GDP ratio and government spending to GDP ratio for Germany France, and Portugal the early years after the creation of the EMU (See, e.g., the Euro Area Statistics (EAS) database of the ECB). The average tax rate on nominal income is set to 0.3 and the parameter χ is set to zero.

Government spending is assumed to follow independent AR(1) processes, and domestic and foreign productivity processes are allowed to be correlated across countries. The entries of the matrices Γ, Δ, D, and ID are in the last rows of Table 1, which also summarizes the choice for all parameters.

5.2.2 The Nash allocation

The constant inflation - constant tax equilibrium can be sustained as a Nash equilibrium with constant deficits and debts with lump sum but not with income taxes. This happens because the loss function in (49) introduces a trade-off between inflation stabilization and deviations of output from potential. For inflation to be zero in each period taxes need to vary and, thus, output will deviate from its potential value. This trade-off is absent with lump sum taxes, since the variability of lump sum taxation does

not generate deviations of actual output from potential.

With income taxation and deficit rules the Nash equilibrium does not replicate the benchmark equilibrium. This occurs because fiscal authorities faced with the inflation/output trade-off move spending more relative to taxation to meet the deficit requirements and, as a result, are unable to stabilize domestic marginal costs and, thus, inflation. The variability of inflation and of the terms of trade in the Nash equilibrium increases with λ. For $\lambda = 0$, the trade-off disappears while, as λ increases, domestic inflation and hence the terms of trade become more variable.

In Figure 1 we plot the paths of domestic output, inflation, marginal costs, taxes and spending under the Nash and under the cooperative equilibrium when a domestic productivity shock occurs. The figure confirms the intuition. In the non-cooperative equilibrium taxes move less. Therefore, output's response is closer to the potential in the Nash equilibrium than under cooperation. However, as suggested, marginal costs move and inflation is different from zero both at regional and at aggregate level.

To summarize, one important conclusion emerges from our analysis. While with cooperation, debt and deficit constraints help to achieve regional inflation stability, under non-cooperation debt and deficit rules impede inflation stability. Nevertheless, the non-cooperative arrangement induces output to follow its potential, while this is not the case in the cooperative arrangement. Hence, both regimes (cooperative and non-cooperative) with debt and deficit constraints produce welfare inferior outcomes. In the next section we search for alternative policy arrangement that bring the economy closer to the preferred benchmark.

6 Decentralized Equilibrium

The fiscal constraints we have used in the last two sections have been chosen to mimic balance budget and SGP type of restrictions. However, they are very rigid, and since they are difficult to implement, they are bound to be violated in practice. Moreover, they do not allow to reproduce our benchmark allocation; depending on the policy arrangement output is either below its potential, or regional inflation differentials and union-wide inflation are different from zero. The scope of this section is to develop decentralized rules where the fiscal authorities can respond to the state of the economy that approximate the benchmark equilibrium and can be implemented as a Nash equilibrium. These rules mimic some of the rules proposed in practice to flexibilize the SGP.

In our model the decentralized economy is described by equations (27) through (37). To complete the characterization of equilibrium we need to define how monetary and fiscal policies are conducted. We assume that monetary policy follows an interest rate rule that targets union-wide inflation. That is,

$$R_t = v_\pi \pi_t^u \tag{51}$$

Note that given the multiplicity of fiscal instruments (taxes and spending), there is a multiplicity of

rules that could be used to bring the economy to the constant inflation - constant taxes equilibrium.

We assume that taxes are used to consolidate real debt and are determined by[4]:

$$\tau_t = \tau_{t-1} + \zeta_b(b_t^H - b^H) + \zeta_{\Delta b}(b_t^H - b_{t-1}^H) \tag{52}$$

where $\tau_t = \tau_t^H, \tau_t^{lH}$ depending on the type of taxes. The speed of adjustment parameters $\zeta_b = .0025$, $\zeta_{\Delta b} = .075$ for the tax rule in (52) are taken from Mitchell, Sault, Wallis (2000).

Given a path for taxes, real regional deficits and, thus, spending are functions of last period deficits and of current domestic inflation:

$$\begin{aligned} d_{t+1}^H &= v_d^H d_t^H - v_{\pi_H}\pi_{Ht}, \\ d_{t+1}^F &= v_d^F d_t^F - v_{\pi F}\pi_{Ft} \end{aligned} \tag{53}$$

In searching for fiscal rules that implement the constant inflation - constant tax equilibrium we search for values of $v_d^i, v_{\pi_i}, i = H, F$ that minimize the variance of the deviations of inflation, output and the terms of trade from the benchmark equilibrium, and, thus, welfare losses relative to the benchmark equilibrium.

6.1 Approximate Fiscal Policy Rules

The optimizing values of the four coefficients in (53), when lump-sum and income taxes are used, in the case of symmetric and asymmetric countries are in Table 2.

Table 2: Optimizing deficit rule coefficients

Coefficients	$\mathbf{v}_\pi$	$\mathbf{v}_d^H$	$\mathbf{v}_d^F$	$\mathbf{v}_{\pi_H}$	$\mathbf{v}_{\pi_F}$
Lump-sum taxes					
SYMMETRY	1.5	0.95	0.95	2.5	2.5
ASYMMETRY, $\alpha_H < \alpha_F$	1.6	0.95	0.95	1.2	7.5
Income taxes					
SYMMETRY	1.3	0.95	0.95	3.4	3.4
ASYMMETRY, $\alpha_H < \alpha_F$	1.4	0.95	0.95	1.3	9.4

Two features of the approximating rules need some discussion. First, coefficients differ for different types of taxation. Taxes on labor income imply more aggressive regional fiscal policies and less aggressive monetary policy, while the opposite is true with lump sum taxes. With both types of taxes, changes in inflation alter real debt and, thus, the path of taxes. However, the need for inflation stability is more critical in the case of distortionary taxation since increases in lump sum taxes do not produce deviations from the benchmark equilibrium. Second, smaller countries have larger coefficients on regional inflation since regional fiscal policy is a more appropriate instrument to achieve domestic inflation stabilization.

[4] Von Hagen, Hallet and Strautch (2001), Alesina and Perotti (1997) have suggested that successful consolidations in industrialised countries involve alterations of expenditure rather than changes in taxes. Instead, we assume fiscal consolidation through taxation and regional stabilization through expenditure to minimize the welfare costs of variable taxation.

When the central bank targets the average inflation rate, the inflation of regions with higher consumption shares receives more weight in the calculation of union-wide inflation and, as a result, local stabilization in these regions is achieved by the union-wide objective. Smaller countries, on the other hand, receive low weights in the union-wide inflation objective. Hence, the existence of active fiscal policy is crucial for achieving inflation stability in these regions.

6.2 Is the Decentralized Equilibrium Sustainable?

The critical question for policy is whether regional fiscal authorities have incentives to deviate from the rules posted in the decentralized equilibrium. If domestic fiscal authorities seek to reproduce the benchmark path for output and stabilize domestic inflation, they want to smooth tax changes and price fluctuations in equilibrium. This is because variable distortionary taxes make the distance between actual and potential output larger. As we have seen, the benchmark allocation cannot be supported as a Nash equilibrium under debt and deficit constraints because of the existing trade-off between inflation stabilization and distortionary tax movements. By construction, in the proposed decentralized equilibrium, tax smoothing and inflation stabilization motives are no longer in contrast: increases in the variability of domestic inflation increase the variability of nominal income taxes. Therefore, stabilization of the former can be achieved via stabilization of the latter. For that reason, the decentralized equilibrium is sustainable. That is, if fiscal policy follows the rules in (52) and (53), and monetary policy follows the rule in (51), none of the three authorities will have incentives to deviate from the proposed equilibrium.

To understand why this is the case, note that regional inflation stabilization is compatible with union-wide inflation stabilization. Hence, the central bank will have no incentives to deviate from the prescribed rules. Suppose region H is subject to a positive demand shock. This shock increases deficits and marginal costs and, thus, inflation in region H. If the fiscal authority in region H follows the rule (53) and the central bank the rule (51), the interest rate will increase and deficits will decrease. Since tax smoothing is necessary for accomplishing the fiscal authorities' objective, government spending has to decrease after the initial expansion. The rise in the interest rate increases the debt burden, while the reduction in deficits reduces it. As a result, debt hardly changes in equilibrium. Hence, price stability can be achieved with no changes in taxes. If the fiscal authorities of country H were to deviate from the prescribed rule, e.g. by not changing government spending, the rise in the interest rate and the increase in deficit would lead to increases in taxes, marginal costs and, thus, domestic inflation.

Similarly, in response to a positive productivity shock, marginal costs fall. To comply with the rules interest rates should fall as well, while deficits should increase via an increase in government spending. The changes of the interest rate and deficits leave debt almost unchanged and domestic price stability is accompanied by tax smoothing. On the other hand, deviations of the fiscal authority from the rule in (53) imply tax variability therefore they will not occur in equilibrium.

7 Conclusions and extensions

Both the academic literature and policy circles have extensively discussed the role of fiscal policy in monetary unions. On the one hand, fiscal policy has been very often seen as a source of economic instability since decentralized fiscal authorities might not internalize the effects that fiscal expansions have on union-wide variables. On the other hand, local fiscal policy can substitute for the nominal exchange rate as stabilization instrument and, thus, represents an additional tool which can be used to achieve multiple policy objectives in a currency area.

The Stability and Growth Pact (SGP) in the Euro area was adopted to balance the adverse effects of regional fiscal policy with the need of using fiscal policy as a stabilization tool. However, the rigid and uniform requirements for deficit and debt limits and the lack of the right enforcement mechanisms led to violations of these limits and undermined the credibility of the European fiscal framework. In response to the failure to comply with the limits, European politicians currently plan changes in the practical implementation of the Pact. Although, budget and debt requirements are not abandoned, the reforms put more emphasis on debt and regional idiosyncrasies and allow for more flexibility in budgetary rules.

Our analysis of the macroeconomic and welfare consequences of fiscal constraints provides some logic behind the presence of fiscal constraints suggesting that they can in fact deliver complete inflation stability when fiscal authorities cooperate, or regional output stability when fiscal authorities do not cooperate. However, both objectives cannot be achieved at the same time. Instead, we show that flexible fiscal rules, as opposed to rigid and nonenforceable constraints, can produce regional inflation and output stability. The rules we employ are in the spirit of the SGP reform: they are transparent, easy to monitor, adaptable to a changing economic reality and implementable and resemble the ones suggested by Von Hagen et al. (2001) and Blanchard and Giavazzi (2003).

Three extensions of our analysis can make our conclusions more generally applicable. While the new SGP will put a lot of emphasis on the long run sustainability of public finances, our analysis has disregarded the issue of debt constraints and questions concerning its practical implementation. Hence, future research should be geared towards the objective of defining policies that support long run sustainability of public finance in decentralized equilibria with one monetary and many fiscal authorities. Second, the analysis has been conducted using lump sum and income taxes. However, in our set up it is not clear which kind of distortionary taxes should be used to implement the constant regional inflation - constant tax equilibrium. Extensions using consumption and capital taxes are in our future agenda. Third, our decentralized rules assume that government spending reacts almost instantaneously to domestic inflation. It is well known that the ability of fiscal policy to react to current conditions is limited. Therefore, allowing for different planning horizons for monetary and fiscal authorities and/or allowing for feedback rules which respond to average lagged inflation (say over the last year) can make our conclusions more appreciable to policymakers.

Appendix

We approximate our model both around a symmetric steady state and an asymmetric steady state where the two regions are characterized by different degrees of home bias in consumption, and, thus, unequal size. In both steady states there is no inflation, no shocks and the debt positions for the two regions are symmetric. We use variables without time subscripts to indicates steady state values.

a.**Symmetric Steady State**

The steady state conditions of the model for the symmetric case are summarized as follows:

$$1 + R = \frac{1}{\beta} \tag{a1}$$

$$\frac{P}{P_H} = \frac{P^*}{P_H^*} = S = q = 1 \tag{a2}$$

$$\frac{C^*}{Y^*} = \frac{C}{Y} = 1 - \frac{G}{Y} \tag{a3}$$

$$w = w^* = \frac{\psi}{1 - \tau^{lH}} (Y)^v C^\sigma, \quad Y = Y^* \tag{a4}$$

$$Y = Y^* = \left(\frac{\chi}{1 - \beta} \right)^{\frac{1}{\sigma + \varepsilon}} \frac{M}{Y}^{-\frac{\varepsilon}{\sigma - \varepsilon}} \frac{C}{Y}^{\frac{\sigma}{\sigma - \varepsilon}} \tag{a6}$$

Finally, the lump sum tax is determined by:

$$R \frac{B^H}{Y} + \frac{G^H}{Y} - \tau^{lH} w - \tau^H = 0 \tag{a7}$$

b **Asymmetric Steady State**

Markups are constant in the steady state and equal to $\frac{\theta}{\theta - 1}$, implying that the real wage satisfies:

$$w \frac{P}{P_H} = \frac{\theta - 1}{\theta} = \psi \frac{l^v C^\sigma}{(1 - \tau^{lH})} \frac{P}{P_H} \tag{b1}$$

a similar equation holds for the foreign wages. Moreover, the ratio of CPI to domestic prices is determined by:

$$\frac{P}{P_H} = \left[(1 - \alpha_H) + \alpha_H S^{1-\eta} \right]^{\frac{1}{1-\eta}} \tag{b2}$$

and in the foreign economy:

$$\frac{P}{P_H^*} = \left[(1 - \alpha_F) + \alpha_F S^{\eta-1} \right]^{\frac{1}{1-\eta}} \tag{b3}$$

Moreover. the risk sharing condition implies that:

$$C = C^* (\varrho q)^{1/\sigma} \tag{b4}$$

where the real exchange rate is given by $q = P^*/P$, or:

$$q(S) = \frac{\left[(1 - \alpha_F) + \alpha_F S^{\eta-1} \right]^{\frac{1}{1-\eta}}}{\left[(1 - \alpha_H) + \alpha_H S^{1-\eta} \right]^{\frac{1}{1-\eta}}} S \tag{b5}$$

If we solve the equations for wages in the two region together with the money demands equations in both regions:

$$\chi\left(\frac{M}{P}\right)^{-\varepsilon} = \beta R C^{-\sigma} \tag{b6}$$

we will find a relationship between the real exchange rate and the terms of trade of the form:

$$S = q^{\frac{v}{\varepsilon}} \varrho^{\frac{v}{\varepsilon}-1} \tag{b7}$$

the solution for the terms of trade will then determine consumption and output at home and abroad and as before equation a7 will determine the level of lump sum taxes which in this case will differ in the two regions.

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Figure 1: Responses to a domestic productivity shock