Discretionary Fiscal Policy and Optimal Monetary Policy in a Currency Area*

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Abstract

The paper evaluates the effects of fiscal discretion in a currency area, where a common and independent monetary authority commits to optimally set the union-wide nominal interest rate. National governments implement fiscal policy by choosing government expenditure. The assumption of fiscal policy coordination across countries is retained in order to evaluate the costs exclusively due to discretion, leaving aside the free-riding problems stemming from non-cooperation. In such a context, nominal rigidities potentially generate a stabilization role for fiscal policy, in addition to the one of ensuring efficient provision of public goods. However, it is showed that, under discretion, aggregate fiscal policy stance is inefficiently loose and the volatility of government expenditure is higher than optimal. As an implication, the optimal monetary policy rule involves the targeting of union-wide fiscal stance, on top of inflation and output gap. The result questions the welfare enhancing role of government expenditure, as the proper instrument for stabilizing asymmetric shocks. In fact, discretion entails significant welfare costs, the magnitude depending on the stochastic properties of the shocks and, for plausible parameter values, it is not optimal to use fiscal policy as a stabilization tool.

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1 Introduction

Literature on optimal monetary and fiscal policy in currency areas is rapidly growing. In this context, the nominal exchange rate as a shock absorbing device is not available and, in the presence of nominal rigidities, fiscal policy is regarded as a potentially alternative instrument to deal with asymmetric shocks. Beetsma and Jensen (2004, 2005) and Galí and Monacelli (2005) characterize the optimal policy mix, under the assumptions of commitment of both monetary and fiscal policy, cooperation of fiscal authorities across countries and perfect coordination between the central bank and national governments. Two are the main results. Monetary policy stabilizes union average inflation and output gap. Fiscal policy only takes care of asymmetric shocks: average government expenditure is set at its efficient level and then is not used to stabilize the currency area as a whole.

These results constitute a useful benchmark. However, it is hard to believe that fiscal policy is set under commitment, cooperatively across countries and coordinating with the monetary authority. A strand of the literature tests the robustness of optimal policy results to the assumption of fiscal cooperation. We merely focus on the issue of fiscal discretion. Credibility and transparency have recently become the key guidelines in the practice of central banking and they certainly are the criteria inspiring the design of European monetary policy institutions. It is according to those principles that the European Central Bank has been assigned by statute the primary objective to maintain price stability. In contrast, even if within the limits imposed by the Stability and Growth Pact, fiscal policy is conducted in a discretionary fashion by national governments, whose tenure is limited in time and whose unique mildly binding constraints are represented by electoral promises.

Such an asymmetry poses some questions of particular interest. First, it is relevant to assess the effects of fiscal discretion, to investigate whether they undermine the achievement of the stabilization goals pursued by the monetary authority and to study the optimal response of monetary policy to potential misbehavior of national governments. While those issues concern a closed economy as well as a currency area, the evaluation of welfare costs stemming from fiscal discretion features some peculiarities that are specific to the case of a monetary union. In fact, those costs could offset the benefits of using fiscal policy as a stabilization tool, as an alternative to the nominal exchange rate. To answer these questions, we modify the framework built by Galí and Monacelli (2005) to allow for a policy game, where the central bank commits to the optimal monetary policy plan, taking into account that fiscal policy is acting under discretion.

The paper shows that discretionary governments generate an inefficiently loose aggregate fiscal stance, as long as the central bank faces a short-run trade-off. This is because the central bank and the government do not agree on the costs and benefits associated to monetary policy actions. In particular, governments evaluate monetary policy tightening as more recessionary. As a consequence, they have the incentive to deviate from the full commitment solution and to generate a public spending over-expansion in the case of a negative output gap. This leads to higher than optimal volatility of government expenditure and, through aggregate demand, to higher than optimal volatility either of aggregate inflation or aggregate output gap. Hence, fiscal discretion exacerbates the stabilization trade-off, making harder the job of the central bank in dampening union-wide fluctuations. If the monetary authority internalizes government misbehavior, the optimal policy rule involves the targeting of union-wide fiscal stance, on top of inflation and output gap.

Finally, we perform welfare analysis, resorting to second order approximation to households' lifetime utility as a welfare criterion. Not surprisingly fiscal discretion entails welfare costs, the magnitude depending on the stochastic properties of the shocks. In particular, for some plausible parameter values, the cost is higher than the benefit of addressing asymmetric shocks. Therefore, the model casts some doubts on the desirability of using fiscal policy as a stabilization tool, or at least opens the question of designing suitable institutional arrangements to cope with the problem of discretionary governments.

2 Literature Review

Several papers study monetary and fiscal interaction, both in closed and open economy.

Dixit and Lambertini (2003b) consider the case of a model where output is sub-optimally low, as inefficiencies arising from monopolistically competitive goods markets are not corrected by any production subsidy. The fiscal policy objective function is assumed to be social welfare, while monetary policy is delegated to a central bank with an inflation target more conservative than society, in the spirit of the proposal by Rogoff (1985). It is showed that the constrained efficient outcome can be implemented by assigning identical objectives to policy makers, being the output target the social optimum and the inflation target appropriately conservative. Dixit and Lambertini (2003a) assume policy makers to have the same inflation and output targets, but not necessarily the same weights, according to an ad-hoc quadratic objective function. It is showed that output and inflation goals can be achieved without the need for fiscal coordination across countries and without the need for monetary commitment, irrespectively of which authority moves first. Finally, Dixit and Lambertini (2001) show that under the more general case of different goals and weights, the conflict of objectives prevents both authorities to implement the desired outcomes. Our work differs from those contributions in two respects. First, we assume the central bank and the government to be benevolent, while they differ in their ability to commit to future policies. Second, the desired outcome is not implementable, as we allow for the presence of short-run stabilization trade-offs.

Faia (2005) studies the policy game arising in a currency area, where national governments independently choose domestic public spending and nominal debt. The Ramsey outcome is compared with a regime where all policy makers act under discretion and the common central bank is assumed to move after observing national governments' choices. In such a context, each government realizes both that the monetary authority has the incentive to deflate debt by loosening monetary policy and that the resulting inflation costs are shared among all area members. This generates a free riding problem, leading to an equilibrium characterized by higher than optimal debt, public spending and inflation. This contribution differs from ours, as the results abstract from the presence of nominal rigidities. In addition, monetary policy is not set optimally, because of the lack of commitment on the part of the central bank.

Adam and M. Billi (2007) investigate non-cooperative monetary and fiscal policy games in a closed economy featuring steady-state distortions under the assumption that policymakers cannot commit to future policies. In this environment, inflation and public spending upward biases emerge as the optimal response to the static distortions. The paper shows that appointing a central banker more conservative than society in terms of inflation targets improves steady-state welfare, at the small cost of generating some stabilization biases, arising because of departures from the assumption of benevolent policy makers. The authors also compute the optimal inflation rate, defined as the one that would be chosen by a Ramsey planner internalizing that fiscal variables are chosen in a discretionary fashion. That optimal inflation rate is conceptually the same as the one derived in our model. However, only its steady-state value is computed while we are interested in characterizing its state-contingent path. This is because we want to focus on the optimal monetary policy response to shocks under fiscal discretion. Moreover, our analysis is performed within a linear-quadratic framework without steady-state distortions. This allows to derive an explicit targeting rule specifying how the objectives of the central bank optimally relate to each other.

Finally, contributions by Sargent and Wallace (1981), Leeper (1991) and Woodford (2001) gave rise to an important strand of the literature that characterizes the optimal monetary and fiscal policy mix leaving aside coordination problems, by assuming that all policy variables are chosen by a unique authority. A representative, though not exhaustive, sample includes Ferrero (2005), Lambertini (2006), Leith and Wren-Lewis (2006) and Schmitt-Grohé and Uribe (2004, 2007) together with the authors cited above, Beetsma and Jensen (2004, 2005) and Galí and Monacelli (2005).

3 The Private Sector Equilibrium

The currency union is represented by a continuum of infinitely many countries indexed by i on the unit interval [0,1]. Each country is a small open economy whereas the union as a whole is assumed to be a closed economic system. The members of the currency area have symmetric preferences and are ex-ante identical in terms of technology and market structure, but they are subject to asymmetric shocks. Each economy is populated by infinitely many households and firms interacting on goods, labor and asset markets. Goods markets are imperfectly competitive and prices are set in staggered contracts with random duration. Labor markets are monopolistically competitive and labor mobility across countries is ruled out. Moreover, the wage mark-up is assumed to fluctuate exogenously around its mean value in order to create a meaningful policy trade-off at the union-wide level. Financial markets are complete and the law of one price is assumed to hold.

Monetary policy is in charge to set the union-wide nominal interest rate, while fiscal policy is responsible for choosing government expenditure and taxes. It is assumed for simplicity that the static distortion due to imperfect competition on goods and labor markets is undone by means of subsidies, while lump-sum taxes and transfers are available and they adjust so as to balance the government budget constraint at all times.

It is described next the private sector equilibrium as a function of monetary and fiscal policy.

3.1 Households

Each household in country i consumes a continuum of private and public goods and sells differentiated labor services to firms. Preferences are described by a utility function defined over private consumption, public expenditure and leisure

$$U_0^i = \sum_{t=0}^{\infty} \beta^t \left((1-\chi) log C_t^i + \chi log G_t^i - \frac{(N_t^i)^{1+\varphi}}{1+\varphi} \right) \tag{3.1}$$

C_t^i is a composite consumption good defined as

$$C_t^i = \frac{(C_{i,t}^i)^{1-\alpha} (C_{F,t}^i)^{\alpha}}{(1-\alpha)^{(1-\alpha)} \alpha^{\alpha}} \tag{3.2}$$

where $C_{i,t}^i$ is a CES aggregator of domestically produced varieties

$$C_{i,t}^i = \left[\int_0^1 C_{i,t}^i(j)^{\frac{\epsilon_p - 1}{\epsilon_p}} dj \right]^{\frac{\epsilon_p}{\epsilon_p - 1}} \tag{3.3}$$

$C_{i,t}^i(j)$ denotes the quantity consumed of variety j produced in country i and ϵ_p is the elasticity of substitution between varieties produced in the same country. $C_{F,t}^i$ is domestic consumption of imported varieties from the other members of the currency area

$$C_{F,t}^i = exp \int_0^1 log C_{f,t}^i df \tag{3.4}$$

and it is in turn a function of an aggregator combining all varieties j produced in each foreign country f

$$C_{f,t}^i = \left[\int_0^1 c_{f,t}^i(j)^{\frac{\epsilon_p - 1}{\epsilon_p}} dj \right]^{\frac{\epsilon_p}{\epsilon_p - 1}} \tag{3.5}$$

The parameter α can be interpreted as a measure either of home bias in private consumption or of opennes towards the rest of country members.[1]

Defining for each country i the aggregate price index of domestically produced goods (i.e. the producer price index) as

$$P_t^i = \left[\int_0^1 P_t^i(j)^{1-\epsilon_p} dj \right]^{\frac{1}{1-\epsilon_p}} \tag{3.6}$$

the union wide price index as

$$P_t^* = exp \int_0^1 log P_t^f df \tag{3.7}$$

and the consumer price index for each country i

$$P_{c,t}^i = (P_t^i)^{1-\alpha} (P_t^*)^{\alpha} \tag{3.8}$$

optimal intra-temporal allocation among varieties implies the following equations[2]

$$C_{i,t}^i(j) = \left(\frac{P_t^i(j)}{P_t^i} \right)^{-\epsilon_p} C_{i,t}^i \tag{3.9}$$

$$P_t^f C_{f,t}^i = P_t^* C_{F,t}^i \tag{3.10}$$

$$P_t^i C_{i,t}^i = (1-\alpha) P_{c,t}^i C_t^i \qquad P_t^* C_{F,t}^* = \alpha P_{c,t}^i C_t^i \tag{3.11}$$

Given optimal allocation of expenditure, the period budget constraint can be written as

$$P_{c,t}^i C_t^i + E_t \left\{ Q_{t,t+1} D_{t+1}^i \right\} \leq D_t^i + (1+\tau^w) W_t^i N_t^i + T_t^i \tag{3.12}$$

$W_t^i N_t^i$ is nominal labor income, τ_w^i is a proportional subsidy to labor income and T_t^i are lump-sum taxes. In addition, households hold a portfolio that is including state contingent assets and shares in foreign and domestic firms. D_{t+1}^i denotes the nominal payoff of the portfolio in $t+1$, $Q_{t,t+1}$ is the one-period ahead stochastic discount factor and it is such that $E_t\{Q_{t,t+1}\}R_t^* = 1$, where R_t^* is the risk-free nominal interest rate factor of the currency area.

Labor services offered by households are regarded by firms as imperfect substitutes, where the elasticity of substitution is equal to $\epsilon_w > 1$. As in the standard

[1]As long as $\alpha < 1$, because of the home bias, countries are consuming different consumption bundles. As a consequence, CPI inflation differentials may arise even if the law of one price is assumed to hold. Were absent the home bias, one would observe producer price inflation differentials only.

[2]Price indexes P_t^i, P_t^* and $P_{c,t}^i$ are defined so that the minimum cost of consumption bundles $C_{i,t}^i$, $C_{F,t}^i$ and C_t^i are respectively $P_t^i C_{i,t}^i$, $P_t^* C_{F,t}^i$, and $P_{c,t}^i C_t^i$. Moreover, $P_t^i C_{i,t}^i + P_t^* C_{F,t}^i = P_{c,t}^i C_t^i$.

monopolistic competition set up, total labor demand faced by each household is given by

$$N_t^i(h) = \left[\frac{W_t^i(h)}{W_t^i}\right]^{-\epsilon_w} N_t^i \tag{3.13}$$

where

$$N_t^i = \left[\int_0^1 N_t^i(h)^{\frac{\epsilon_w - 1}{\epsilon_w}} dh\right]^{\frac{\epsilon_w}{\epsilon_w - 1}} \tag{3.14}$$

is the aggregate labor index combining in the Dixit-Stiglitz from the total quantity sold of each variety and

$$W_t^i = \left[\int_0^1 \left(W_t^i(h)\right)^{1-\epsilon_w} dh\right]^{\frac{1}{1-\epsilon_w}} \tag{3.15}$$

can be interpreted as the aggregate wage, defined so that the minimum cost of the aggregate labor index $\int_0^1 N_t^i(h) W_t^i(h) dh$ is $W_t^i N_t^i$.

Utility maximization subject to the period budget constraints and labor demand yields the standard optimality conditions[3]

$$C_t^i (N_t^i)^{\varphi} = (1-\chi)\frac{W_t^i}{P_{c,t}^i} \tag{3.16}$$

$$\beta \left(\frac{C_t^i}{C_{t+1}^i}\right)\left(\frac{P_{c,t}^i}{P_{c,t+1}^i}\right) = Q_{t,t+1} \tag{3.17}$$

In order to introduce a tension between inflation and output gap stabilization, it is assumed from now on that the wage mark-up fluctuates exogenously around its mean value[4]. Hence, equation (3.16) is modified accordingly to include a random shock

$$exp\{\mu_t^w\} C_t^i (N_t^i)^{\varphi} = (1-\chi)\frac{W_t^i}{P_{c,t}^i} \tag{3.18}$$

$\mu_t^{w,i}$ follows an autoregressive process represented by

$$\mu_{t+1}^{w,i} = \rho_u \mu_t^{w,i} + \varepsilon_{t+1,u}^i \tag{3.19}$$

where $\varepsilon_{t,u}^i$ is white noise with standard deviation denoted by $\sigma_{\varepsilon,u}$. $\varepsilon_{t,u}^i$ and $\varepsilon_{t,u}^j$ are assumed to be uncorrelated for all t and for all $i \neq j$.

After rewriting (3.17) as a conventional Euler equation

$$\beta R_t^* E_t \left\{\left(\frac{C_t^i}{C_{t+1}^i}\right)\left(\frac{P_{c,t}^i}{P_{c,t+1}^i}\right)\right\} = 1 \tag{3.20}$$

[3]The wage equation already takes into account that the subsidy to labor income is set so as to offset market power

[4]The assumption could be rationalized by any real or nominal friction in the wage contracting process. See also Clarida, Galí and Gertler (1999), Galí (2003) and Woodford (2003)

complete financial markets imply the following international risk sharing condition[5]

$$C_t^i = C_t^f (S_{f,t}^i)^{1-\alpha} \tag{3.21}$$

where $S_{f,t}^i$ stands for the bilateral terms of trade between any country i and f and it is defined as

$$S_{f,t}^i = \frac{P_t^f}{P_t^i}$$

so that the effective terms of trade of any country i against the rest of the currency area are

$$\begin{aligned} S_t^i &= \frac{P_t^*}{P_t^i} \qquad (3.22) \\ &= exp \int_0^1 (logP_t^f - logP_t^i)\ df \\ &= exp \int_0^1 logS_{f,t}^i\ df \end{aligned}$$

Note finally that the terms of trade can be related to CPI by

$$P_{c,t}^i = P_t^i (S_t^i)^\alpha \tag{3.23}$$

this implying the following relation between CPI and domestic inflation

$$\pi_{c,t}^i = \pi_t^i + \alpha \Delta s_t^i \tag{3.24}$$

3.2 Firms

Each country is populated by a continuum of firms indexed by j on the unit interval $[0, 1]$, each producing a variety with a constant return to scale technology

$$Y_t^i(j) = A_t^i N_t^i(j) \tag{3.25}$$

Country-specific productivity is denoted by A_t^i and follows an autoregressive process represented by

$$logA_{t+1}^i = \rho_a logA_t^i + \varepsilon_{t+1,a}^i \tag{3.26}$$

where ε_t^i is white noise with standard deviation $\sigma_{\varepsilon,a}$. ε_t^i and ε_t^j are assumed to be uncorrelated for all t and all $i \neq j$.

[5] (3.21) holds under the assumption of symmetric initial conditions and initial zero net foreign asset holdings.

Prices are staggered à la Calvo, then in every period firms face a constant probability θ of changing the price. The optimal (log) price charged by firms that are allowed to re-optimize in period t is[6]

$$\overline{p}_t^i = \mu + (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t\left\{mc_{t+k}^i + p_{t+k}^i\right\} \tag{3.27}$$

where $\mu = log\frac{\epsilon_p}{\epsilon_p - 1}$ is the log of the optimal mark-up. mc_t stands for the log of the marginal cost and is equal to

$$mc_t^i = -log(1-\tau_p^i) + w_t^i - p_t^i - a_t^i + \mu_t^{w,i} \tag{3.28}$$

and τ_p^i is a proportional production subsidy. Finally, it can be easily shown that the aggregate production function is given by

$$Y_t^i Z_t^i = A_t^i N_t^i \tag{3.29}$$

where Z_t^i is defined as

$$Z_t^i = \int_0^1 \frac{Y_t^i(j)}{Y_t} dj \tag{3.30}$$

and represents a measure of relative price dispersion[7].

3.3 Government Expenditure

Define aggregate government expenditure as

$$G_t^i = \left[\int_0^1 G_t^i(j)^{\frac{\epsilon_p - 1}{\epsilon_p}} dj\right]^{\frac{\epsilon_p}{\epsilon_p - 1}} \tag{3.31}$$

where $G_t^i(j)$ is the quantity of public consumption of variety j. Note that, differently from households, government is assumed to consume only domestically produced goods.[8] Given G_t^i, the government chooses $G_t^i(j)$ so as to minimize expenditure. Hence the following condition has to be satisfied

$$G_t^i(j) = \left(\frac{P_t^i(j)}{P_t^i}\right)^{-\epsilon_p} G_t^i \tag{3.32}$$

[6]To a first order approximation.

[7]It can be proved that $log(Z)$ is a function of the cross sectional variance of relative prices and it is of second order.

[8]The assumption that the government consumes domestically produced goods only is not as strong as it may look like: the empirical evidence in fact is in favor of a considerably higher home bias in public consumption than private consumption.

3.4 Market Clearing

After defining aggregate output as

$$Y_t^i = \left[\int_0^1 Y_t^i(j)^{\frac{\epsilon_p - 1}{\epsilon_p}} dj \right]^{\frac{\epsilon_p}{\epsilon_p - 1}} \tag{3.33}$$

one can show that the clearing of all goods markets, along with conditions for optimal intra-temporal allocation among varieties[9], implies that

$$Y_t^i = A_t^i N_t^i = C_t^i (S_t^i)^\alpha + G_t^i \tag{3.34}$$

3.5 The Pareto Optimum

The Pareto efficient equilibrium is determined by solving the problem of a planner who wishes to maximize utility of the union as a whole

$$\int_0^1 U(C_t^i, N_t^i, G_t^i) di \tag{3.35}$$

subject to technology and resource constraints

$$Y_t^i = A_t^i N_t^i \tag{3.36}$$

$$Y_t^i = C_{i,t}^i + \int_0^1 C_{i,t}^f df + G_t^i \tag{3.37}$$

for all $i \in [0, 1]$ The corresponding first order conditions determine the following efficient outcome for country i

$$\overline{N}_t^i = 1; \quad \overline{Y}_t^i = A_t^i; \quad \overline{C}_t^i = (1 - \chi)(1 - \alpha)(A_t^i)^{1-\alpha}(A_t^*)^\alpha; \quad \overline{G}_t^i = \chi A_t^i \tag{3.38}$$

Aggregating over i yields the union-wide Pareto optimum

$$\overline{N}_t^* = 1; \qquad \overline{Y}_t^* = A_t^*; \qquad \overline{C}_t^* = (1 - \chi) A_t^*; \qquad \overline{G}_t^* = \chi A_t^* \tag{3.39}$$

The evolution of the terms of trade at an efficient equilibrium has to be

$$\overline{S}_t^i = \left(\frac{\overline{C}_t^i}{\overline{C}_t^*} \right)^{\frac{1}{1-\alpha}} = \frac{A_t^i}{A_t^*} \tag{3.40}$$

[9] For further details see Galí and Monacelli (2005).

3.6 Equilibrium Dynamics

As efficiency will constitute the benchmark for welfare analysis, it is convenient to describe the equilibrium dynamics in terms of deviation from first best outcomes. Let output, government expenditure and fiscal gaps be respectively defined as

$$\tilde{y}_t = y_t - \overline{y}_t; \qquad \tilde{g}_t = g_t - \overline{g}_t; \qquad \tilde{f}_t = \tilde{g}_t - \tilde{y}_t; \tag{3.41}$$

$\tilde{f}_t$ can be interpreted as the percentage deviation from efficiency of government expenditure, as a fraction of GDP. The steady state of the model coincides with the first best steady state because of two reasons. First, fiscal policy is assumed to subsidize production to undo the static distortion induced by monopolistic competition in the goods markets. The absence of distortionary taxation allows to restore static efficiency. Moreover, the choice of the subsidy is not influenced by the desire of manipulating terms of trade in a country's favor. This is because fiscal policy is assumed to be set cooperatively across countries.

One can show that country i's inflation and output gap are fully described by the following equations (in log deviations from the efficient steady state)

$$\pi_t^i = \beta E_t\{\pi_{t+1}^i\} + \lambda(1+\varphi)\tilde{y}_t^i - \lambda\frac{\chi}{1-\chi}\tilde{f}_t^i + \lambda\mu_t^{w,i} \tag{3.42}$$

$$\Delta\tilde{y}_t^i - \Delta\tilde{y}_t^* = \frac{\chi}{1-\chi}(\Delta\tilde{f}_t^i - \Delta\tilde{f}_t^*) - [(\pi_t^i - \pi_t^*) + (\Delta a_t^i - \Delta a_t^*)] \tag{3.43}$$

as a function of domestic fiscal policy $\{\tilde{f}_t^i\}$, given productivity differentials and the evolution of union-wide inflation and output gap, where the following definitions apply

$$\pi_t^* = \int_0^1 \pi_t^i di \qquad \tilde{y}_t^* = \int_0^1 \tilde{y}_t^i di \qquad \tilde{f}_t^* = \int_0^1 \tilde{f}_t^i di \tag{3.44}$$

and λ is a convolution of deep parameters

$$\lambda = \frac{(1-\theta)(1-\theta\beta)}{\theta}$$

Equation (3.43) is peculiar to the case of a currency area. It relates the evolution of output gap differentials to fiscal gap, inflation and productivity differentials. In particular, note that $\Delta a_t^i - \Delta a_t^*$ is the efficient change in the terms of trade. As in a monetary union the nominal exchange rate cannot adjust so as to keep the terms of trade at their efficient level, price stickiness implies that each country can increase its own output gap relatively to the average, by creating deflation and then pushing the terms of trade above their efficient level. Hence, other things equal, devaluations of the real exchange rate increase domestic output gap through a beggar thy neighbor policy.

Finally, after specifying a monetary policy rule, the equilibrium of the currency area as a whole can be determined using union-wide versions of the standard closed-economy Phillips and IS curves

$$\pi_t^* = \beta E_t\{\pi_{t+1}^*\} + \lambda(1+\varphi)\tilde{y}_t^* - \lambda\frac{\chi}{1-\chi}\tilde{f}_t^* + \lambda\mu_t^{w,*} \tag{3.45}$$

$$\tilde{y}_t^* = E_t\tilde{y}_{t+1}^* + \frac{\chi}{1-\chi}\tilde{f}_t^* - \frac{\chi}{1-\chi}E_t\tilde{f}_{t+1}^* - (r_t^* - E_t\{\pi_{t+1}^*\} - rr_t^*) \tag{3.46}$$

where rr_t^* is a function of TFP shocks

$$rr_t^* = \rho + E_t\{\Delta a_{t+1}^*\} \tag{3.47}$$

4 The Policy Problem

A second order approximation to the sum of utilities of union households around the efficient steady-state yields

$$W = -\frac{1}{2}\sum_{t=0}^{\infty}\beta^t\int_0^1\left(\frac{\epsilon_p}{\lambda}(\pi_t^i)^2 + (1+\varphi)(\tilde{y}_t^i)^2 + \frac{\chi}{1-\chi}(\tilde{f}_t^i)^2\right)di \tag{4.1}$$

Nominal rigidities, cost push disturbances and the asymmetry of shocks make it impossible to attain the Pareto efficient allocation. Therefore, the question of how to design monetary and fiscal policy rules is a non-trivial issue.

Following Beetsma and Jensen (2004, 2005), we solve the model by applying Aoki (1981) factorization of the variables into averages and differences from the average. As countries are ex-ante symmetric and of equal size, the factorization allows to split the full optimization programs of both authorities into a currency area part and a relative part, completely independent from each other. Defining country i inflation, output gap and fiscal gap differentials

$$\pi_t^{di} = \pi_t^i - \pi_t^* \qquad \tilde{f}_t^{di} = \tilde{f}_t^i - \tilde{f}_t^* \qquad \tilde{y}_t^{di} = \tilde{y}_t^i - \tilde{y}_t^* \tag{4.2}$$

the welfare function (4.1) and the constraints (3.42), (3.43), (3.44) and (3.46) can be rewritten as

$$W = W^* + W^d \tag{4.3}$$

$$\pi_t^* = \beta E_t\{\pi_{t+1}^*\} + \lambda(1+\varphi)\tilde{y}_t^* - \lambda\frac{\chi}{1-\chi}\tilde{f}_t^* + \lambda\mu_t^{w,*} \tag{4.4}$$

$$\tilde{y}_t^* = E_t\tilde{y}_{t+1}^* + \frac{\chi}{1-\chi}\tilde{f}_t^* - \frac{\chi}{1-\chi}E_t\tilde{f}_{t+1}^* - (r_t^* - E_t\{\pi_{t+1}^*\} - rr_t^*) \tag{4.5}$$

$$\pi_t^{di} = \beta E_t\{\pi_{t+1}^{di}\} + \lambda(1+\varphi)\tilde{y}_t^{di} - \lambda\frac{\chi}{1-\chi}\tilde{f}_t^{di} + \lambda(\mu_t^{w,i} - \mu_t^{w,*}) \tag{4.6}$$

$$\Delta\tilde{y}_t^{di} = \frac{\chi}{1-\chi}\Delta\tilde{f}_t^{di} - [\pi_t^{di} + (\Delta a_t^i - \Delta a_t^*)] \tag{4.7}$$

$$\int_0^1 \pi_t^{di}di = 0 \qquad \int_0^1 \tilde{y}_t^{di}di = 0 \qquad \int_0^1 \tilde{f}_t^{di}di = 0 \tag{4.8}$$

where

$$W^* = -\frac{1}{2}E_0\sum_{t=0}^{\infty}\beta^t\left(\frac{\epsilon_p}{\lambda}(\pi_t^*)^2 + (1+\varphi)(\tilde{y}_t^*)^2 + \frac{\chi}{1-\chi}(\tilde{f}_t^*)^2\right) \tag{4.9}$$

$$W^d = -\frac{1}{2}E_0\sum_{t=0}^{\infty}\beta^t\int_0^1\left(\frac{\epsilon_p}{\lambda}(\pi_t^{di})^2 + (1+\varphi)(\tilde{y}_t^{di})^2 + \frac{\chi}{1-\chi}(\tilde{f}_t^{di})^2\right)di \tag{4.10}$$

To retrieve country-i variables, it is sufficient to apply (4.2).

5 Perfect Coordination

Before studying monetary and fiscal policy interaction, it is useful to look as a benchmark at the case of perfect coordination, where the two authorities share the same objectives and operate under the same regime. We first recall the full commitment solution for the currency area as a whole, derived by Galí and Monacelli (2005). Then, we derive the policy mix under discretion. It is interesting to note that, under both regimes, it is completely indifferent whether monetary and fiscal policy are chosen by a single authority or simultaneously chosen by two independent authorities that are taking as given the policy instrument of the other. These findings are reminiscent of the ones by Dixit and Lambertini (2003b) and Adam and M. Billi (2007), even though in the context of a different model. The crucial assumption driving the result is that there is not any disagreement about the targets and about the costs and benefits associated to policy actions.

The optimal policy under commitment for the currency area is defined by a rule for the fiscal gap $\{\tilde{f}_t^*\}$ and the union-wide nominal interest rate $\{r_t^*\}$ that maximize (4.9) subject to (4.4)[10]. The optimal policy mix implies

$$\lambda^{-1}\epsilon_p \pi_t^* + \lambda^{-1}\Delta\tilde{y}_t^* = 0 \tag{5.1}$$

$$\tilde{f}_t^* = -\tilde{y}_t^* \tag{5.2}$$

(5.1) and (5.2) define the second best, or equivalently the constrained efficient allocation in terms of union-wide variables.

Under discretion policy makers do not choose once and for all the state-contingent path of policy instruments, they are rather allowed to re-optimize in every period. As a consequence, they do not take into account the impact of current choices on past variables through the expectation channel. The resulting policy mix is

$$\lambda^{-1}\epsilon_p \pi_t^* + \lambda^{-1}\tilde{y}_t^* = 0 \tag{5.3}$$

$$\tilde{f}_t^* = -\tilde{y}_t^* \tag{5.4}$$

Equations (5.1), (5.2), (5.3) and (5.4) correspond exactly to the standard rules that would characterize a closed economy sharing preferences and technology of the union's member countries. The features of optimal monetary policy and its advantages over a discretionary regime are well known facts in the literature. However, it may be useful to recall that (5.1) and (5.3) differ because the latter overlooks the marginal gain of committing to future deflations in terms of current output gap, $\lambda^{-1}\tilde{y}_t^*$, which is in fact appearing lagged one period in (5.1) but not in (5.3). In the event of an adverse cost-push shock, committed policy makers can contain inflationary pressures though a lower interest rate increase (a lower output contraction), simply by announcing future higher rates (lower future inflation). Through this mechanism, it is possible to smooth the impact of the shock over time. Such a policy is not time consistent and then it cannot

[10] The IS equation, (4.5), can be implemented ex-post, by choosing the interest rate consistently with optimal inflation, output and fiscal gaps

be implemented under discretion, as it would not be credible. It follows that discretionary policy makers would evaluate the policy tightening implemented by a committed authority in the face of an adverse cost-push shock as too recessionary.

In addition, some interesting conclusions about fiscal policy can be drawn. First, (5.2) implies

$$\tilde{g}_t^* = 0 \tag{5.5}$$

Hence, in the optimal policy mix, government expenditure is set to its first best level, or equivalently, fiscal policy is not used as a stabilization tool. Therefore, the central bank is the only responsible for addressing aggregate fluctuations. This is due to the asymmetry of costs associated to the use of the policy instruments. The absence of transaction frictions allows to vary the nominal interest rate, without generating welfare costs. On the contrary, fluctuations in government expenditure are costly, as they imply a departure from efficient public goods provision.

In addition, under perfect coordination, irrespectively of the policy regime, (5.5) still holds. Hence, discretion per se does not produce inefficiency losses in public goods provision. This ceases to be true when monetary policy optimally reacts to governments' lack of commitment, as it will be clear in the following sections.

6 Optimal Monetary Policy under Fiscal Discretion

We turn now to the case where monetary and fiscal policy are conducted by two independent authorities, sharing the same objectives. Only the latter is able to credibly commit to future policies, while the fiscal policy maker chooses the fiscal gap sequentially, i.e. she solves the policy problem in each period, in order to determine the current instrument only. Because of the lack of commitment, the government cannot directly control future fiscal gaps. As a consequence, the impact of current actions on past expectations is not internalized. Being private sector forward looking, this is costly as long as policy choices are subject to time inconsistency problems. As in Dixit and Lambertini (2003a), we model strategic interaction as a Stackelberg game. The committed authority, the central bank in our case, is assumed to be the leader, while fiscal policy is the follower. As such, the latter takes the union-wide nominal interest rate as given in each period and the IS equation is perceived to be a constraint imposed by monetary policy. The model is solved by backward induction: after solving for the fiscal rule of the government, the central bank determines at time zero the optimal state contingent path of output, inflation and fiscal gaps, taking into account the fiscal policy reaction function. In the remainder of the section, we first define the policy game. Then, we characterize the equilibrium of the currency area as a whole and of the representative country. We refer to the appendix for derivations.

Definition 6.1 *Discretionary fiscal policy is defined as the solution to the following problems. The currency area problem consists in selecting a fiscal policy rule for the union-wide fiscal gap* $\{\tilde{f}_t^*\}_{t=0}^{\infty}$ *maximizing (4.9) subject to (4.4) and (4.5), given the union-wide nominal interest rate and the exogenous stochastic processes. Finally, optimization of the welfare function (4.10) subject to (4.6), (4.7) and (4.8) determines the state-contingent path of fiscal gap differentials* $\{\tilde{f}_t^{di}\}_{t=0}^{\infty}$*, for all* $i \in [0, 1]$

Before defining the monetary policy problem, observe that fiscal policy fully determines inflation, output and fiscal gap differentials. The result reflects the fact that monetary policy does not have enough instruments to stabilize fluctuations of single country variables. Two are the main implications. First, given the constraints imposed by national governments, the central bank has one degree of freedom to choose the union-wide policy rule, but she does not have any leverage on differentials. Equivalently, the monetary authority has to solve the union-wide part of the optimization program, while the relative part is determined by the constraints. Second, there is no strategic interaction, and then no policy game, as far as single country stabilization issues are concerned. The solution to the relative part of the fiscal optimization problem is completely irrelevant for the policy game, which in turns determines currency area equilibrium only.

Definition 6.2 *Optimal monetary policy under fiscal discretion is defined as the state contingent path for the common interest rate* $\{r_t^*\}$*, together with the associated union-wide policy outcomes,* $\{\pi_t^*\}$*,* $\{\tilde{y}_t^*\}$ *and* $\{\tilde{f}_t^*\}$ *maximizing welfare (4.9) subject to (4.4)* ***and*** *the union-wide fiscal rule.*

6.1 Union-wide Equilibrium

The union-wide fiscal policy rule is

$$\tilde{f}_t^* = -\tilde{y}_t^* - \varphi(\tilde{y}_t^* + \epsilon_p \pi_t^*) \tag{6.1}$$

while the targeting rule of the central bank is

$$\epsilon_p \pi_t^* + \Delta \tilde{y}_t^* = \chi(1 + \varphi \epsilon_p \lambda)(\tilde{f}_t^* + \tilde{y}_t^*) - \chi(\tilde{f}_{t-1}^* + \tilde{y}_{t-1}^*) \tag{6.2}$$

The equilibrium of the currency area as a whole is fully described by the rules (6.1) and (6.2), together with the union-wide Phillips curve (4.4). A comparison of (6.1) and (6.2) with the rules characterizing the case of perfect coordination allows to gain some important economic insights:

- As it has been stressed in section 5, governments evaluate policy tightening as more recessionary than a central bank who is able to manipulate expectations. The disagreement about the costs and benefits associated to monetary policy actions generates inefficient public spending over-expansion in case of negative output gaps. Therefore, fiscal policy exacerbates the trade-off faced by the monetary authority as long as she is also concerned about fiscal gap stabilization. Note that if the central bank behaves in a discretionary fashion, the deviation of government expenditure from its commitment level vanishes[11]. A committed central bank could still set the nominal interest rate so as to eliminate completely government over-reaction. However, she should accept the inflation and output gap variability associated to full discretion. This would not be optimal and a combination of positive inflation, output and fiscal gap variability is preferred.

- Optimal monetary policy involves the targeting of fiscal gap deviations from the full commitment (second best) level. In particular, coherently with the reaction function of the government, higher deviations call for higher inflation or higher output gap. This allows the central bank to reduce government over-reaction. Moreover, if the government does not deviate from the full commitment solution, the monetary policy rule (6.2) converges to (5.1).
- As in the standard case, optimal monetary policy under fiscal discretion is inertial: the lagged fiscal gap appears in the targeting rule. Then, for given future fiscal gaps, the central bank commits to tighten future monetary policy in the event of an increase of the current fiscal gap above its second best level. This improves the current trade-off between inflation and fiscal gap stabilization by reducing expected future inflation.
- In the absence of cost-push shocks, the full commitment solution can be implemented even in the case of fiscal discretion. Keeping inflation and output at their natural level eliminates any incentive of over-expansion on the part of the government. In fact, absent any short-run stabilization trade-off, time inconsistency is not an issue as the efficient allocation is feasible.

Finally, note that the equilibrium evolution of the currency area as a whole is exactly the same that would be observed in a closed economy sharing preferences and technology of the union's member countries. Hence, from now on, all starred variables can be interpreted either as union-wide or closed economy variables.

6.2 Equilibrium in The Representative Country

The representative country part of the problem is more involved than the case of the currency area, as the lagged values of fiscal and output gap appear in equation (4.7). This means that expectations of future variables cannot be taken as given. In fact, even restricting to Markov strategies, one has to take into account that in any stationary equilibrium expectations of future states will depend on their own lags. To solve the model we use the same method as Clarida et al. (1999) and

[11] It can also be proved that in such a case the Lagrange multiplier attached to the IS equation in the fiscal policy problem is equal to zero. This is because, despite the lack of coordination there is no disagreement between the two authorities so that monetary policy does not impose any constraint on fiscal policy

Beetsma and Jensen (2004, 2005). What has to be taken as given is how private sector expectations react to current policy, rather than expectations. Hence, we conjecture that expectations are a linear function of current states for some arbitrary coefficients. Those coefficients are defined to be such to coincide with the parameters entering the state space representation of the rational expectation equilibrium [12]. We refer to the appendix for all technical details and we report below the fiscal policy rule for country i

$$\begin{aligned}\varphi\epsilon_p\lambda\pi_t^{di} + (1+\varphi)(d_1 - \lambda\varphi)\tilde{y}_t^{di} + (1+\varphi)d_1\tilde{f}_t^{di} &= \\ \beta E_t\left[\varphi\epsilon_p\lambda\pi_{t+1}^{di} + (1+\varphi)\tilde{y}_{t+1}^{di} + \tilde{f}_{t+1}\right]\end{aligned} \tag{6.3}$$

where

$$d_1 = 1 + \beta(1 - c_1) + \lambda(1+\varphi) \tag{6.4}$$

and c_1 is a state space coefficient defined in the appendix. It is immediate to see that the fiscal policy rule is entirely forward looking. This is because, due to the lack of commitment, the government fails to internalize the effect of policy on past expectations.

7 Impulse Responses and Second Moments

7.1 The Currency Area

Let each country be subject to cost-push shocks following the process (3.19). Aggregating across countries and applying the definition $\mu_t^{w,*} = \int_0^1 \mu_t^{w,i} di$ yields

$$\mu_{t+1}^{w,*} = \rho_u \mu_t^{w,*} + \varepsilon_{t+1,u}^* \tag{7.1}$$

where $\varepsilon_{t,u}^* = \int_0^1 \varepsilon_{t,u}^i di$ is white noise with standard deviation denoted by $\sigma_{\varepsilon,u}$. Given the stochastic process (7.1), equations (6.1), (6.2) and the union-wide Phillips curve allow to compute the impulse response functions of starred variables. They can be interpreted either as the response of a closed economy or as the response of the currency area to a shock hitting every member country i. Structural parameters are the same as in Galí and Monacelli (2005) and they are reported in Table 1. φ is set equal to 3, implying a labor supply elasticity of 1/3. The elasticity of substitution among goods and labor types, ϵ_p and ϵ_w are equal to 6, which is consistent with average mark-ups of 20 percent. θ and β are respectively set to 0.75 and 0.99. The steady-state share of government spending in output, $\gamma = \chi$, is parameterized to 0.25, the average of final government consumption for the euro zone. TFP standard deviation is calibrated to the conventional value 0.0071. Two alternative calibrations for serial correlation have been chosen: $\rho_u = 0.95$ and $\rho_u = 0$. Figures 1 and 2 display the response of

[12]This is a conventional fixed point problem that can be easily solved either via undetermined coefficients or through some recursive numerical method.

output gap, fiscal gap and inflation to a cost-push shock, under the two regimes of full commitment and discretionary fiscal policy. Table 2 and 3 report percentage standard deviations of inflation, output, fiscal and government expenditure gaps. We normalize to one the relative standard deviation of the cost-push shock with respect to TFP. Sensitivity analysis of welfare to changes in the standard deviation and the serial correlation are postponed to section 8. Some features are worth to be stressed:

- Under fiscal discretion, the fiscal gap response to cost-push shocks is significantly stronger. The volatility of public spending translates through aggregate demand into higher than optimal volatility either of aggregate inflation or aggregate output gap. Fluctuations in the fiscal gap can only be dampened either by tolerating more volatile inflation or by over-stabilizing the output gap. Which option is preferred by the central bank depends on the persistence of the shock. As suggested by Table 2 and 3, the first one is preferred when the serial correlation of the shock is high.
- Although the fiscal rule targets contemporaneous variables, monetary policy can induce inertia by suitably choosing her policy instrument. In fact, the central bank has a first mover advantage over the government, who takes monetary policy as given. This is evident from Figure 2, showing the case of serially uncorrelated cost-push shocks.
- Comparing Figures 1 and 2, it is immediate to see that higher serial correlation magnifies fiscal policy over-reaction to a negative cost push shock, implying persistently higher inflation.

7.2 The Representative Country

As it has been previously stressed, there is no strategic interaction at the country level: fiscal policy is "alone" in the task of addressing asymmetric shocks. This meaning that our discretionary fiscal policy is the same as in Beetsma and Jensen (2004, 2005). In fact, our results are in line with theirs, even if the first order conditions are not directly comparable. Figures 3 and 4 report impulse responses to TFP and cost-push shocks respectively. Serial correlation of both shocks is set to 0.95. Note that the response of country-i variables and of differentials from the union-average coincide in the case of a country-specific shock with zero mass, as union-wide variables are unaffected. This is not the case when all countries are simultaneously hit by shocks.

In the absence of nominal rigidities, asymmetric shocks to productivity would require the terms of trade to adjust in order to keep output and public spending at their first best level. However, when prices are sticky inflation fluctuations are costly and it is optimal to smooth price changes over time, by allowing a temporary departure of output from efficiency. In the transition to the steady state, an expansionary fiscal policy reduces the cost in terms of output, both under discretion and commitment. However, under discretion the effect of the shock on prices is persistently stronger, since the government cannot control expectations to improve current stabilization trade-offs. On the other hand, output and fiscal gaps are less volatile than optimal.

In the case of a cost-push shock, fiscal stance is tightened. Monetary policy cannot stabilize national business cycles and government expenditure is the only available instrument to address the distortions induced by sticky prices and inefficient fluctuations in the wage mark-up. Therefore, it is not possible to close all the gaps: national governments have to choose a combination of positive inflation and negative output gap. As a consequence, the fiscal gap has to fall in order to counteract inflationary pressures, by contracting aggregate demand. Again, under commitment the fiscal authority manipulates private sector expectations in order to improve the trade-off at the time the shock hits the economy. On the contrary, a discretionary government generates on impact more volatile responses to shocks. Moreover, prices, output gap and fiscal gap are higher than optimal during the transition to the steady state.

Table 4 and 5 report percentage standard deviations of differentials: the lack of commitment worsens inflation stabilization so much that the fiscal authority is induced to stabilize output and fiscal gap more than optimally. Hence, discretionary fiscal policy is less active than it should. The result does not contradict the fact that the fiscal stance is inefficiently loose at the currency area level. As all governments are over-reacting to shocks, the union-wide fiscal gap is fluctuating too much, while fiscal gap differentials are fluctuating too little.

8 Welfare Analysis

Recent literature claims that, in a currency area, a committed fiscal policy enhances welfare through the stabilization of asymmetric shocks. After evaluating the costs generated by fiscal discretion, we ask whether the result survives when governments act in a discretionary fashion, without coordinating with the central bank. We compute welfare as a function of serial correlation and of relative standard deviation of the cost-push shock. All welfare differences across regimes are measured in consumption equivalents, i.e. the percentage variation of steady state consumption under the benchmark policy that is making agents indifferent to the alternative policy regime.

Figure 5 plots the contour sets of the cost generated by discretion, with respect to full commitment. Not surprisingly, discretion entails welfare costs. This is due to two reasons: on one hand, the union-wide fiscal gap is too volatile, making harder the job of the central bank in stabilizing inflation and output gap. On the other hand, discretion leads to sub-optimal fluctuations of inflation, output and fiscal gap differentials. The relative importance of the two components is assessed in Figure 6, displaying the fraction of the total cost due to inefficient union-wide fluctuations. Note that this is the least important part of the cost (always less than a half). The intuition is that, while monetary policy can at least partially cope with fiscal misbehavior at the union level, there is no possibility to influence single country variables and then the behavior of differentials.

Given the cost stemming from fiscal discretion, it is interesting to ask whether it is sensible to use public spending as an instrument to stabilize national business cycles, rather than confining governments to the role of efficiently providing public goods. To answer this question, we compare welfare under full commitment and under fiscal discretion against the case of inactive fiscal policy, meaning expenditure set at its efficient level at all times. Figure 7 plots the welfare gain of the full commitment solution. The stabilizing role of fiscal policy always generates welfare gains, the magnitude depending on the stochastic properties of the shocks. Figure 8 displays welfare differences between the fiscal discretion regime and the case of inactive fiscal policy. Such differences can be decomposed into two parts. The first is always negative and captures the cost arising from the fact that the fiscal stance is inefficiently loose at the union level. The second component measures differences due to fluctuations in inflation, output and fiscal gap differentials: it can be positive or negative, depending whether the welfare improving role of fiscal policy survives to discretion. Figures 9 and 10 show the two components. For most of parameter combinations, the only cost imposed by fiscal discretion is represented by excessive fiscal gap variability at the union level. But, interestingly, for some parameter combinations, even the positive role of fiscal policy in stabilizing asymmetric shocks is compromised by the inability of steering inflation expectations due to lack of commitment.

Overall, welfare analysis casts some doubt, at least for some plausible calibrations of parameters, on the desirability of using fiscal policy to address asymmetric shocks.

9 Conclusion

This paper studies the optimal monetary and fiscal policy mix in a currency area, where only the central bank is able to commit to future policies. The contribution of the paper is twofold. First, we show that the optimal reaction on the part of monetary policy to fiscal discretion involves the targeting of union-wide fiscal stance, on top of inflation and output gap stabilization. Moreover, we perform welfare analysis and we find that the costs generated by discretion may offset the benefits of using fiscal policy for stabilization purposes. In those cases, it is welfare enhancing to confine governments to the role of efficiently providing public goods. The result opens the question of designing a suitable institutional framework coping with the problem of fiscal discretion.

The issue deserves further theoretical and empirical investigation. In particular, some relevant distortions the paper is abstracting from could push welfare results in opposite directions, either strengthening or weakening our argument. In fact, on one hand the introduction of distortionary taxation and debt may worsen the effects of discretionary fiscal policy as emphasized by Leith and Wren-Lewis (2006). In this perspective, our analysis would just provide a lower bound of the costs generated by the lack of commitment on the fiscal side. On the other hand, transaction frictions would reduce the cost of using public spending as a stabilization instrument, relatively to the nominal interest rate. This provides a motive for the use of government expenditure as a union-wide stabilization tool, even under full commitment.

A Appendix Perfect Coordination

Defining country i inflation, output gap and fiscal gap differentials

$$\pi_t^{di} = \pi_t^i - \pi_t^* \qquad \tilde{f}_t^{di} = \tilde{f}_t^i - \tilde{f}_t^* \qquad \tilde{y}_t^{di} = \tilde{y}_t^i - \tilde{y}_t^* \tag{A.1}$$

the welfare function (4.1) and the constraints (3.42), (3.43), (3.44) and (3.46) can be rewritten as

$$W = W^* + W^d \tag{A.2}$$

$$\pi_t^* = \beta E_t\{\pi_{t+1}^*\} + \lambda(1+\varphi)\tilde{y}_t^* - \lambda\frac{\chi}{1-\chi}\tilde{f}_t^* + \lambda\mu_t^{w,*} \tag{A.3}$$

$$\tilde{y}_t^* = E_t\tilde{y}_{t+1}^* + \frac{\chi}{1-\chi}\tilde{f}_t^* - \frac{\chi}{1-\chi}E_t\tilde{f}_{t+1}^* - (r_t^* - E_t\{\pi_{t+1}^*\} - rr_t^*) \tag{A.4}$$

$$\pi_t^{di} = \beta E_t\{\pi_{t+1}^{di}\} + \lambda(1+\varphi)\tilde{y}_t^{di} - \lambda\frac{\chi}{1-\chi}\tilde{f}_t^{di} + \lambda(\mu_t^{w,i} - \mu_t^{w,*}) \tag{A.5}$$

$$\Delta\tilde{y}_t^{di} = \frac{\chi}{1-\chi}\Delta\tilde{f}_t^{di} - [\pi_t^{di} + (\Delta a_t^i - \Delta a_t^*)] \tag{A.6}$$

$$\int_0^1 \pi_t^{di} di = 0 \qquad \int_0^1 \tilde{y}_t^{di} di = 0 \qquad \int_0^1 \tilde{f}_t^{di} di = 0 \tag{A.7}$$

where

$$W^* = -\frac{1}{2}\sum_{t=0}^{\infty}\beta^t\left(\frac{\epsilon_p}{\lambda}(\pi_t^*)^2 + (1+\varphi)(\tilde{y}_t^*)^2 + \frac{\chi}{1-\chi}(\tilde{f}_t^*)^2\right) + tips \tag{A.8}$$

$$W^d = -\frac{1}{2}\sum_{t=0}^{\infty}\beta^t\int_0^1\left(\frac{\epsilon_p}{\lambda}(\pi_t^{di})^2 + (1+\varphi)(\tilde{y}_t^{di})^2 + \frac{\chi}{1-\chi}(\tilde{f}_t^{di})^2\right) di + tips \tag{A.9}$$

Concerning the optimal policy mix under commitment for the currency area as a whole we simply refer to Galí and Monacelli (2005).

We solve the currency area optimization problem under discretion by restricting to Markov perfect equilibria. Since the problem does not involve endogenous state variables, future variables are functions of future exogenous states only. As a consequence, a discretionary government that cannot manipulate private beliefs has to take expectations as given. Therefore, the currency area problem reduces to a sequence of static problems. Maximizing (A.8) subject to (A.3) with respect to inflation, output and fiscal gaps yields

$$\frac{\epsilon_p}{\lambda}\pi_t^* + \nu_{\pi,t}^* = 0 \tag{A.10}$$

$$(1+\varphi)\tilde{y}_t^* - \lambda(1+\varphi)\nu_{\pi,t}^* = 0 \tag{A.11}$$

$$\frac{\chi}{1-\chi}\tilde{f}_t^* + \lambda\frac{\chi}{1-\chi}\nu_{\pi,t}^* = 0 \tag{A.12}$$

Combining (A.10)-(A.12) the policy rules (5.3) and (5.4) can be easily obtained.

B Appendix: The Discretionary Fiscal Policy Problem

The fiscal policy problem can be split in two independent parts. The currency area problem consists in selecting a fiscal policy rule for the union-wide fiscal gap $\{\tilde{f}_t^*\}_{t=0}^{\infty}$ maximizing (A.8) subject to (A.3) and (A.4), given the union-wide nominal interest rate and the exogenous stochastic processes. Finally, optimization of the welfare function (A.9) subject to (A.5), (A.6) and (A.7) determines the state-contingent path of fiscal gap differentials $\{\tilde{f}_t^{di}\}_{t=0}^{\infty}$, for all $i \in [0,1]$.

B.1 The Currency Area Problem

First order conditions are the following

$$\frac{\epsilon_p}{\lambda}\pi_t^* + \psi_{\pi,t}^* = 0 \tag{B.1}$$

$$(1+\varphi)\tilde{y}_t^* - \lambda(1+\varphi)\psi_{\pi,t}^* + \psi_{r,t}^* = 0 \tag{B.2}$$

$$\frac{\chi}{1-\chi}\tilde{f}_t^* + \lambda\frac{\chi}{1-\chi}\psi_{\pi,t}^* - \frac{\chi}{1-\chi}\psi_{r,t}^* = 0 \tag{B.3}$$

together with the constraints (A.3) and (A.4), where $\psi_{\pi,t}^*$ and $\psi_{r,t}^*$ are the lagrange multipliers respectively associated to (A.3) and (A.4). The system can be equivalently rewritten as

$$\frac{\epsilon_p}{\lambda}\pi_t^* + \psi_{\pi,t}^* = 0 \tag{B.4}$$

$$(1+\varphi)\tilde{y}_t^* - \lambda(1+\varphi)\psi_{\pi,t}^* + \psi_{r,t}^* = 0 \tag{B.5}$$

$$\tilde{f}_t^* = -\tilde{y}_t^* - \varphi(\tilde{y}_t^* + \epsilon_p\pi_t^*) \tag{B.6}$$

where (B.6) is the fiscal policy rule reported in the text, (6.1), and the first two equations, given the solution that the central bank wants to implement, serve the only purpose to determine lagrange multipliers.

B.2 The Representative Country Problem

The differential part of the fiscal optimization program is more involved than the currency area problem, as, even restricting to Markov strategies, in any stationary equilibrium endogenous variables depend on their own lags. This is because the lagged values of fiscal and output gaps enter equation (A.6). As an implication, expectations cannot be taken as given. Therefore, we conjecture that the private sector forecasts future variables as linear functions of current states for some arbitrary coefficients. At the rational expectation equilibrium, those coefficients are defined to be such to coincide with the true fundamental parameters of the state space representation. To keep the problem tractable, we substitute out inflation using its definition

$$\pi_t^{di} = p_t^{di} - p_{t-1}^{di} \tag{B.7}$$

and the fact that

$$y_t^{di} = \frac{\chi}{1-\chi} f_t^{di} - \left[p_t^{di} + (a_t^i - a_t^*) \right] \tag{B.8}$$

This allows to reduce the number of endogenous states, by replacing (A.6) with (B.8). The equivalent optimization program features two controls, y_t^{di} and f_t^{di}, and an endogenous state, p_t^{di}. It is guessed that

$$p_t^{di} = c_1 p_{t-1}^{di} + c_2(a_t^i - a_t^*) + c_3(\mu_t^i - \mu_t^*) \tag{B.9}$$

equation (B.8) can be used in the Phillips curve to write f_t^{di} in terms of current and past states only

$$\begin{aligned} \tilde{f}_t^{di} = & \frac{1-\chi}{\chi\lambda\varphi} \left[1 + \beta(1-c_1) + \lambda(1+\varphi)\right] p_t^{di} - \frac{1-\chi}{\chi\lambda\varphi} p_{t-1}^{di} \\ & + \frac{1-\chi}{\chi\lambda\varphi} \left[\lambda(1+\varphi) - \beta\rho c_2\right] (a_t^i - a_t^*) \\ & - \frac{1-\chi}{\chi\lambda\varphi} (\lambda + \beta\rho c_3)(\mu_t^i - \mu_t^*) \end{aligned} \tag{B.10}$$

Plugging (B.10) back into (B.8) yields

$$\begin{aligned} \tilde{y}_t^{di} = & \left\{ \frac{1}{\lambda\varphi} \left[1 + \beta(1-c_1) + \lambda(1+\varphi)\right] - 1 \right\} p_t^{di} - \frac{1}{\lambda\varphi} p_{t-1}^{di} \\ & + \left\{ \frac{1}{\lambda\varphi} \left[\lambda(1+\varphi) - \beta\rho c_2\right] - 1 \right\} (a_t^i - a_t^*) \\ & - \frac{1}{\lambda\varphi} (\lambda + \beta\rho c_3)(\mu_t^i - \mu_t^*) \end{aligned} \tag{B.11}$$

The problem consists in minimizing the value function

$$V_t = min \left\{ \frac{\varepsilon}{\lambda} (p_t^{di} - p_{t-1}^{di})^2 + (1+\varphi)(\tilde{y}_t^{di})^2 + \frac{\chi}{1-\chi} (\tilde{f}_t^{di})^2 + \beta E_t V_{t+1} \right\} \tag{B.12}$$

subject to (B.10) and (B.11). The corresponding first order condition is

$$\begin{aligned} & \frac{2\varepsilon}{\lambda} (p_t^{di} - p_{t-1}^{di}) + 2(1+\varphi) \left\{ \frac{1}{\lambda\varphi} \left[1 + \beta(1-c_1) + \lambda(1+\varphi)\right] - 1 \right\} \tilde{y}_t^{di} \\ & + \frac{2}{\lambda\varphi} \left[1 + \beta(1-c_1) + \lambda(1+\varphi)\right] \tilde{f}_t^{di} + \beta E_t \frac{\partial V_{t+1}}{\partial p_t} = 0 \end{aligned} \tag{B.13}$$

Updating one period ahead the envelope condition

$$\frac{\partial V_t}{\partial p_{t-1}} = -\frac{2\varepsilon}{\lambda} (p_t^{di} - p_{t-1}^{di}) - \frac{2(1+\varphi)}{\lambda\varphi} \tilde{y}_t^{di} - \frac{2}{\lambda\varphi} \tilde{f}_t^{di} \tag{B.14}$$

and substituting it in (B.13) yields equation (6.3) in the text.

C Appendix: The Monetary Policy Problem

The central bank has to choose a state contingent path for the union-wide policy outcomes $\left\{\pi_t^*, \tilde{y}_t^*, \tilde{f}_t^*\right\}_{t=0}^{\infty}$ in order to maximize W^* subject to (4.4) and (B.6). The nominal interest rate is chosen ex-post, consistently with the union-wide IS equations. The associated first order conditions are

$$\frac{\epsilon_p}{\lambda}\pi_t^i + \Delta\xi_{\pi,t}^* + \varphi\epsilon_p\xi_{f,t}^* = 0 \tag{C.1}$$

$$(1+\varphi)\tilde{y}_t^* - \lambda(1+\varphi)\xi_{\pi,t}^* + (1+\varphi)\xi_{f,t}^* = 0 \tag{C.2}$$

$$\frac{\chi}{1-\chi}\tilde{f}_t^* + \lambda\frac{\chi}{1-\chi}\xi_{\pi,t}^* + \xi_{f,t}^* = 0 \tag{C.3}$$

where $\xi_{\pi,t}^*$, $\xi_{f,t}^*$ are the lagrange multipliers respectively associated to (4.4) and (B.6). (C.2) and (C.3) allow to express lagrange multipliers as functions of output and fiscal gaps

$$\xi_{\pi,t}^* = \frac{1-\chi}{\lambda}\tilde{y}_t^* - \frac{\chi}{\lambda}\tilde{f}_t^* \tag{C.4}$$

$$\xi_{f,t}^* = -\chi(\tilde{y}_t^* + \tilde{f}_t^*) \tag{C.5}$$

Substituting back into (C.1) yields the monetary policy rule (6.2) in the text.

Table 1: **Baseline Calibration**

Parameter	Value
φ	3
$\epsilon_p = \epsilon_w$	6
θ	0.75
β	0.99
$\gamma = \chi$	0.25
ρ_a	0.95
$\sigma_{\varepsilon,a}$	0.0071

Table 2: **Percentage standard deviations of union-wide variables in the case of serially correlated cost-push shocks**.Cost-push shock standard deviation is set equal to TFP standard deviation.

$\rho = 0.95$	**Inflation**	**Output Gap**	**Fiscal Gap**	**Gov. Exp. Gap**
Discretionary Fiscal	0.0451	0.4630	1.0845	0.6351
Full Commitment	0.0209	0.5093	0.5093	0

Table 3: **Percentage standard deviations of union-wide variables in the case of serially uncorrelated cost-push shocks**. Cost-push shock standard deviation is set equal to TFP standard deviation.

$\rho = 0$	**Inflation**	**Output Gap**	**Fiscal Gap**	**Gov. Exp. Gap**
Discretionary Fiscal	0.0580	0.3301	0.4906	0.3548
Full Commitment	0.0621	0.3046	0.3046	0

Table 4: **Percentage standard deviations of differentials**. Cost-push shock standard deviation is set equal to TFP standard deviation.

$\rho = 0.95$	**Inflation**	**Output Gap**	**Fiscal Gap**	**Gov. Exp. Gap**
Discretionary Fiscal	0.3748	0.6475	3.0429	2.7601
Full Commitment	0.3264	0.7384	3.4430	3.4526

Table 5: **Percentage standard deviations of differentials**. Cost-push shock standard deviation is set equal to TFP standard deviation.

$\rho = 0$	**Inflation**	**Output Gap**	**Fiscal Gap**	**Gov. Exp. Gap**
Discretionary Fiscal	0.3801	0.3719	2.8466	2.8205
Full Commitment	0.3399	0.3690	3.4473	3.4847

Figure 1: **Impulse responses to a union-wide cost-push shock.** Serial correlation has been set to 0.95. Parameters are calibrated as in Table 1.

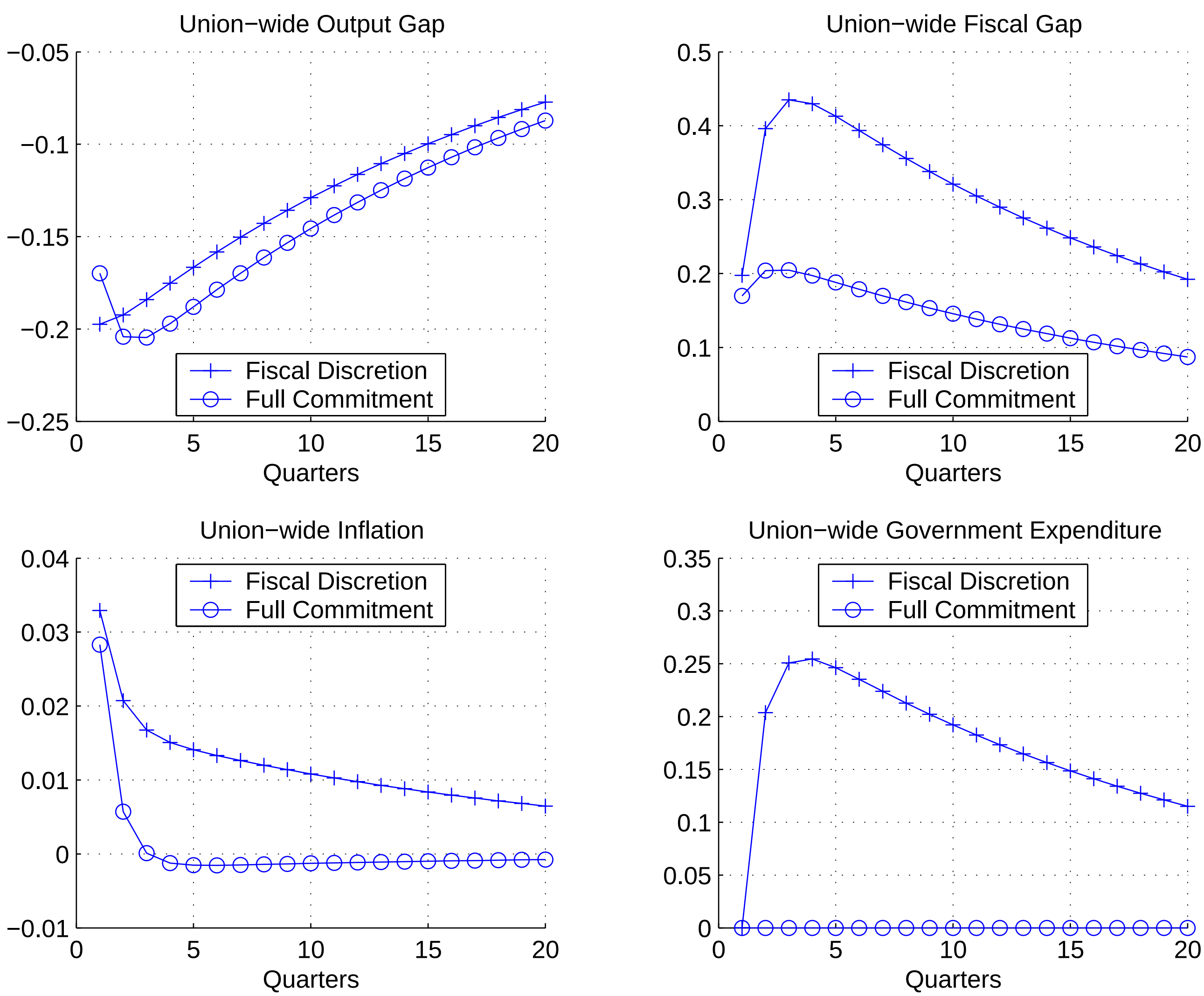


Figure 2: **Impulse responses to a union-wide cost-push.** Serial correlation has been set to 0. Parameters are calibrated as in Table 1.

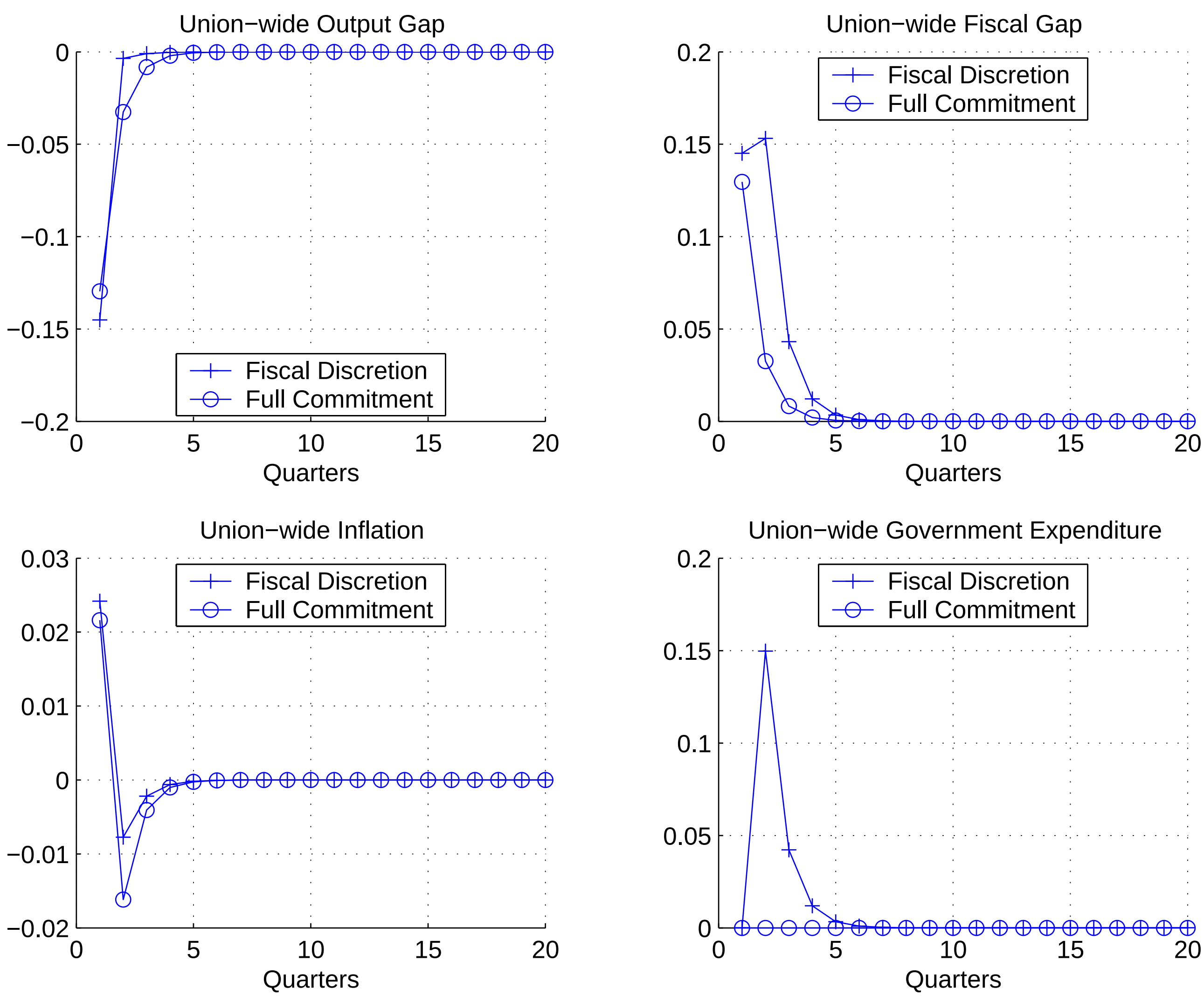


Figure 3: **Impulse responses to a single-country TFP shock.** Serial correlation has been set to 0.95. Parameters are calibrated as in Table 1.

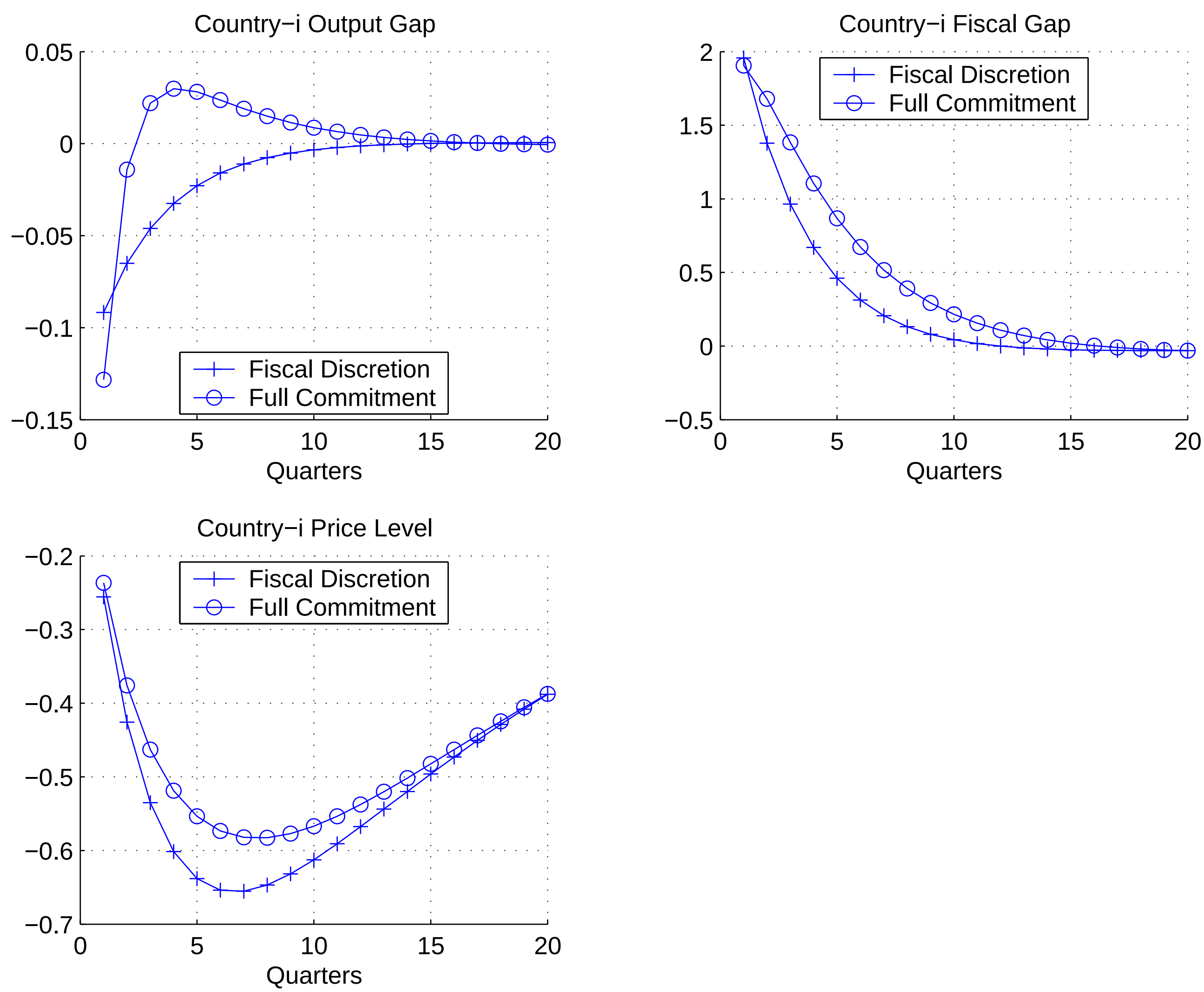


Figure 4: **Impulse responses to a single-country cost-push shock.** Serial correlation has been set to 0.95. Parameters are calibrated as in Table 1.

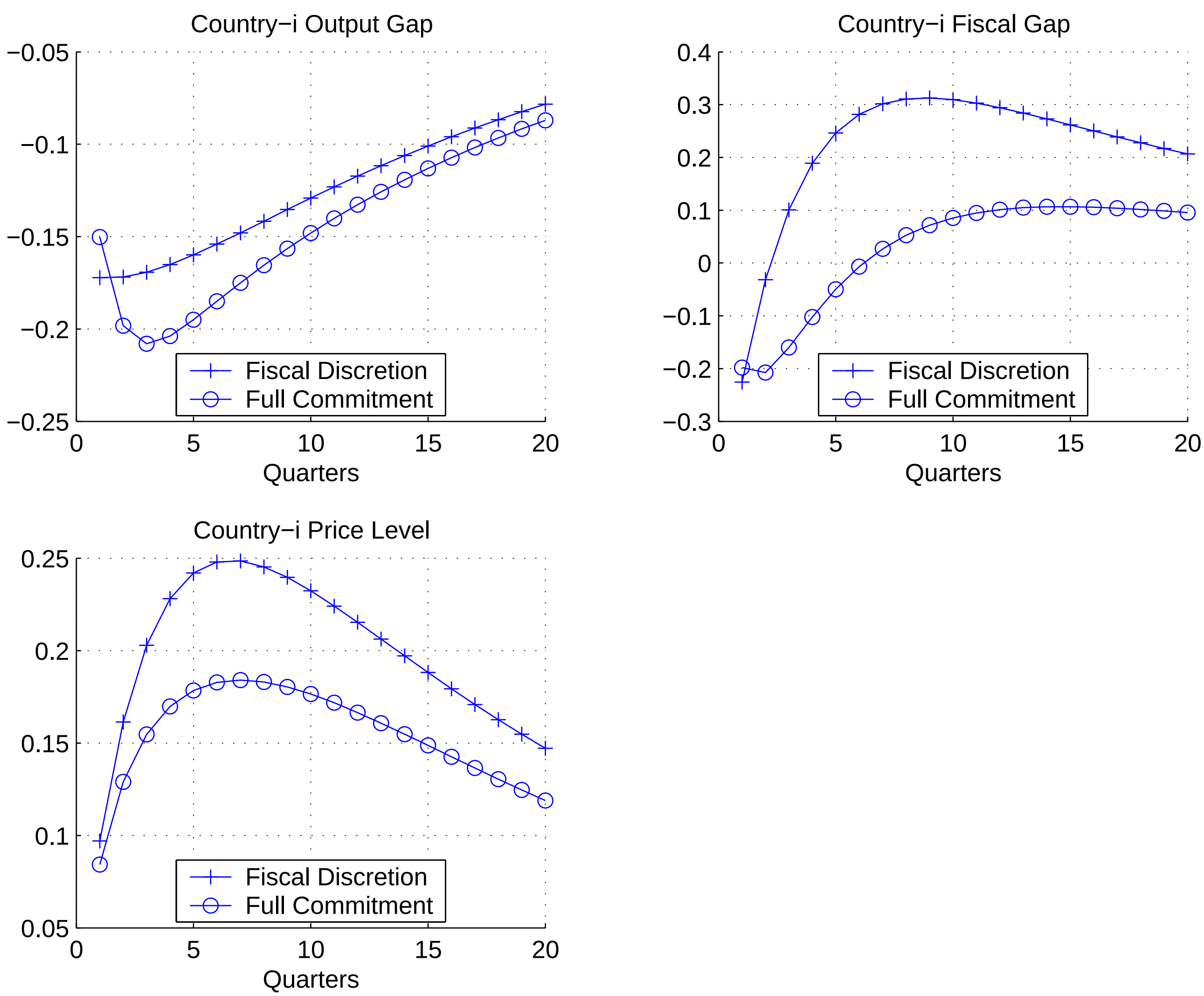


Figure 5: **Welfare cost of discretion.** Contour sets of the welfare cost of discretion as a function of cost-push shock serial correlation and relative standard deviation. Welfare cost is measured in consumption equivalents, i.e. as the percentage decrease of steady state consumption under full commitment in order to be indifferent to the fiscal discretion regime.

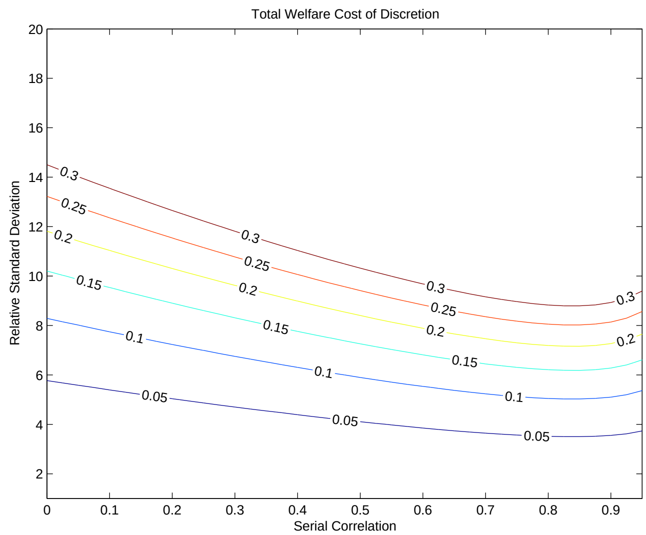


Figure 6: **Welfare cost of discretion: union-wide component.** The graph displays contour sets of the union-wide component as a fraction of the total cost of discretion. The cost is measured in consumption equivalents.

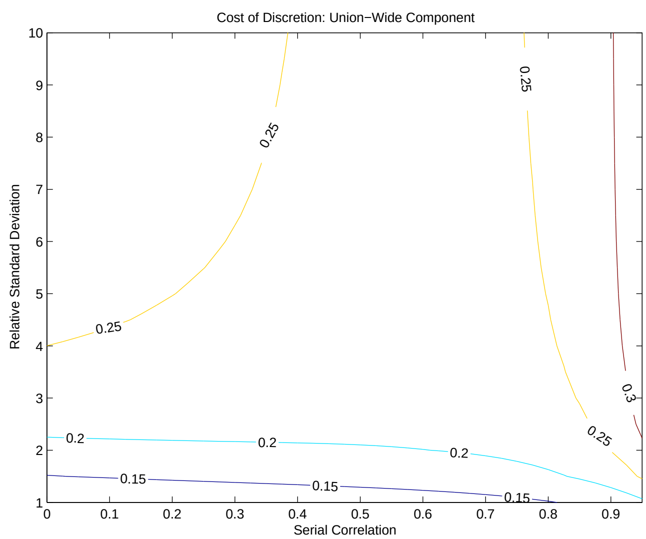


Figure 7: **Welfare gain from committed fiscal policy.** The gain is computed with respect to inactive fiscal policy, i.e. a regime where fiscal policy is constrained to efficient provision of public goods.

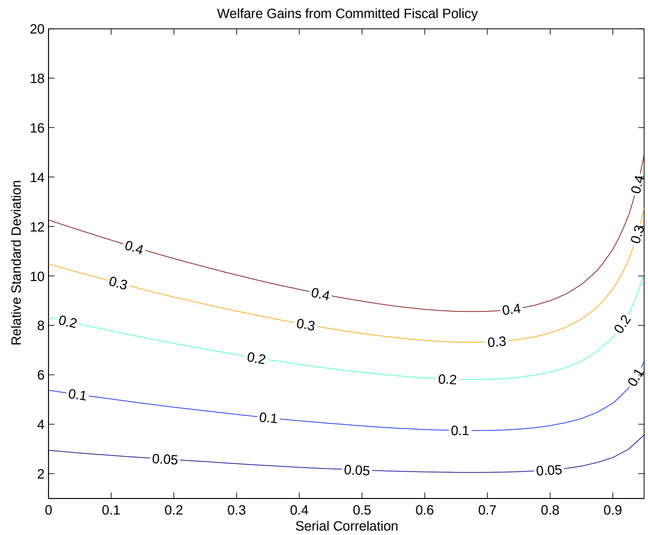


Figure 8: **Welfare gain from discretionary fiscal policy.** The gain is computed with respect to inactive fiscal policy.

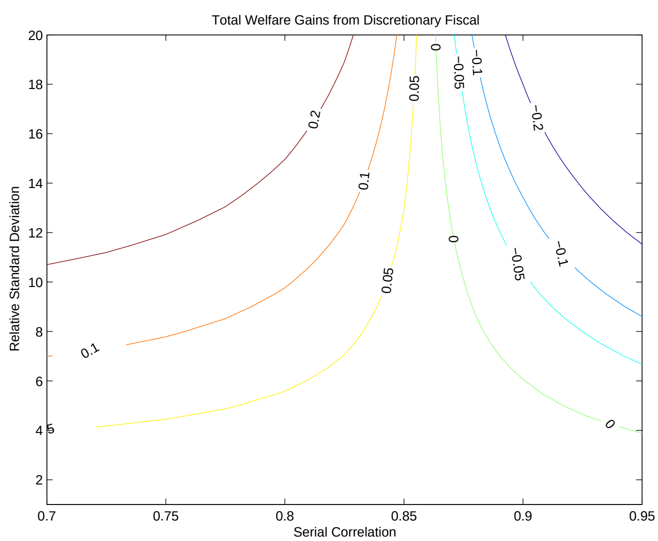


Figure 9: **Welfare gain from discretionary fiscal policy: union-wide component.**

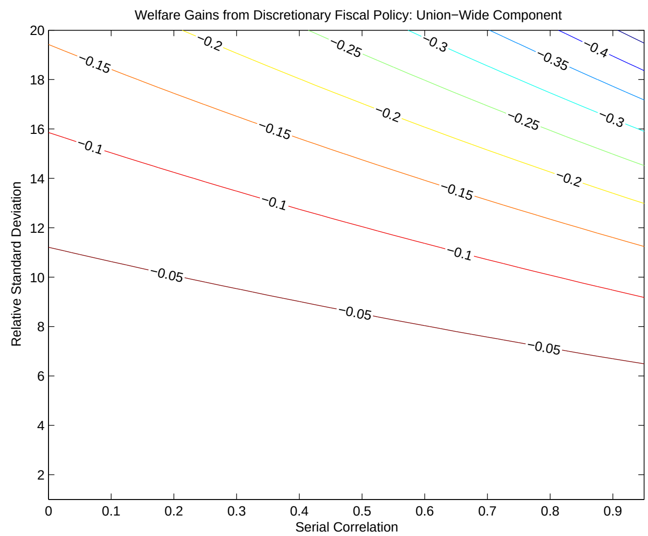
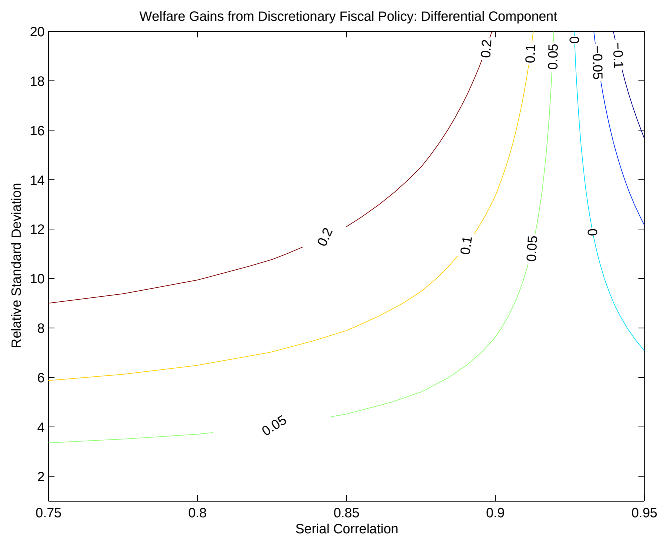


Figure 10: **Welfare gain from discretionary fiscal policy: differential component.**



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