Fiscal delegation in a monetary union: Instrument assignment and stabilization properties*

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Abstract. Motivated by the failure of fiscal rules to eliminate deficit bias in Europe, this paper analyzes an alternative policy regime in which each member state government delegates at least one fiscal instrument to an independent authority with a mandate to avoid excessive debt. Other fiscal decisions remain in the hands of member governments, including the allocation of spending across different public goods, and the composition of taxation.

We compare long run debt accumulation and the response to public spending shocks in dynamic games representing several different institutional configurations, including a *status quo* monetary union scenario with many local governments, a monetary union with a single federal government, and various fiscal delegation scenarios, as well as a social planner's solution.

In our numerical simulations, delegation of budget balance responsibilities to a national or union-wide fiscal authority implies large long-run welfare gains due to much lower steady-state debt. The presence of the fiscal authority also *reduces* the welfare cost of fluctuations in the demand for public spending, in spite of the fact that the authority imposes considerable "austerity" when it responds to fiscal shocks.

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1 Introduction

The legacy of high debt in the aftermath of recent global financial crises leaves policy makers searching for stronger frameworks to ensure fiscal sustainability, especially in Europe. In this context, many countries have now established agencies independent of government with a mandate to monitor fiscal trends and to assess compliance with fiscal rules. In this paper, we study the effects of a more ambitious form of fiscal delegation, in which an independent authority is given direct control of one or more fiscal instruments, with a mandate to ensure long-run budget balance.

That is, we study a regime in which member state governments maintain control of almost all their fiscal decisions, except for a single instrument, which would instead be set by an outside agency, independent of the government, with the goal of avoiding excessive debt accumulation. While this type of fiscal delegation might benefit any country that suffers from deficit bias, it is probably more politically realistic in Europe, where core countries worry about ballooning peripheral debt, while peripheral countries fret about their inability to unilaterally protect themselves against financial panics and speculative attacks. These concerns highlight the possibility of a mutually beneficial accord, in which institutions to prevent the propagation of sovereign and banking risks are made available to any peripheral countries that delegate control of at least one powerful fiscal instrument to an agency of the European Union, such as the European Fiscal Authority. Compared with existing fiscal rules and the intrusive monitoring that comes with activation of the Excessive Deficit Procedure, delegating a fiscal instrument to Brussels could both prove to be a more credible guarantee of fiscal sustainability from creditors' point of view, and simultaneously, a less burdensome constraint on national fiscal sovereignty from debtors' point of view.

In previous work (Basso and Costain, forthcoming 2016) we studied how delegation of fiscal instruments to an independent authority affects long-run, steady-state debt accumulation in a monetary union. We identified several distinct mechanisms through which an independent fiscal authority would tend to restrain debt growth: first, the debt aversion induced by its mandate; second, its greater patience, compared with the elected government; and third, the internalization of free-riding problems associated with decentralized fiscal choices in a monetary union. However, our model was based on the (probably unrealistic) assumption that an independent fiscal authority would control debt issuance directly. While our previous paper assumed that the government chose taxes and the fiscal authority issued the debt, so that public spending was determined as a residual, our main specification in the present paper assumes that the

government chooses public spending and the fiscal authority chooses the tax rate, implying that debt is determined as a residual. And rather than studying steady-state implications only, the present paper studies cyclical stabilization too.

Our motivation for studying fiscal delegation is based on Rogoff's (1985) analysis of central bank independence: delegating discretionary control of monetary instruments can solve the problem of inflationary bias, without requiring an inflexible commitment to low inflation under all circumstances, as long as the central bank's preferences incorporate a countervailing, anti-inflationary bias. Likewise, an independent authority with a mandate for low debt or low deficits might successfully combat deficit bias, as long as it controls instruments of sufficient power to make debt control feasible. While this possibility has not featured prominently in the current Eurozone debate, frameworks like this have been proposed for many countries and regions, including Australia and New Zealand (Ball (1997), Gruen (1997)); the US (Blinder (1997), Seidman and Lewis (2002)); Latin America (Eichengreen, Hausmann, and von Hagen (1999)); and the European Union (von Hagen and Harden (1995); Wren-Lewis (2002); Wren-Lewis (2011); Calmfors (2003); Wyplosz (2005); Costain and de Blas (2012a)). But despite these many proposals, there has been very little theoretical work to evaluate the effects of policy delegation in a fiscal context.

We carry out our analysis in a reduced-form macroeconomic model in which output is decreased by taxes and increased by surprise inflation, under the assumption that society values low inflation, high output, and high public spending. We study how the equilibrium of the dynamic policy game differs depending on which instruments are controlled by each of the institutions considered (member state governments, the central bank of the monetary union, and independent fiscal authorities either at the national or union-wide level). All the policy institutions are assumed to be benevolent planners, but (as in Rogoff, 1985) we assume that their different mandates lead them to weight the components of social welfare differently. In particular, we make two key assumptions about institutional preferences: (1) elected institutions are more impatient than nonelected ones, and (2) an institution mandated to achieve a simple, feasible, quantitative goal will value that goal more strongly than the rest of the society does. Since institutions differ in their preferences, the irrelevance of instrument assignment found by Dixit and Lambertini (2003) does not apply.

Building on a simple macroeconomic model and a simple approach to institutional preferences has two big advantages. First, it allows us to solve our dynamic game in a fully nonlinear way, computing the economic dynamics and the welfare implications in steady state and along transition paths and in response to stochastic shocks. In our numerical simulations, delegation to a fiscal authority implies a large decrease in

steady-state debt, inflation, and tax burdens. The implied level of social welfare lies closer to that achieved by a committed social planner than to that of the *status quo* monetary union. On the other hand, one might conjecture that these long-run gains from fiscal discipline come at the cost of less effective stabilization of shocks. However, this is not true: we find instead that establishing a fiscal authority *reduces* the welfare cost of fluctuations in the demand for public spending, in spite of the fact that the authority imposes considerable "austerity" when it responds to fiscal shocks. We look at the cost of fluctuations in two different ways, both from an *ex ante* perspective (expected losses due to future variance around the mean path), and also from an *ex post* perspective (the welfare loss due to suffering a large negative shock to the fiscal balance). From either perspective, the welfare cost of fluctuations is smaller in an economy with a fiscal authority than it is in the *status quo* monetary union.

A second advantage of our simple setup is that it allows us to focus on the details of the policy game, both in terms of instrument assignment and in terms of the timing of moves. Each policy maker in our framework acts as a discretionary Ramsey planner, and in equilibrium each planner must anticipate how its own control variables impact debt and thereby impact the future choices of the other planners. A crucial observation is that the Euler equation that determines debt evolution reflects the impatience of the policy maker that actually chooses debt. Thus, when we assume that the government or the fiscal authority controls the debt, the discount factor of that agent enters the formula that determines the long-run deficit level. But under the more realistic instrument assignment in which the government chooses public spending, the fiscal authority chooses the tax rate, and the central bank chooses the inflation rate, all three of these instruments jointly determine the debt level, and all three policy makers' discount factors play a role in the dynamics. Inflation bias becomes more severe in this case, and the fiscal authority becomes less effective at controlling debt accumulation. Nonetheless, our main conclusions about the advantages of fiscal delegation remain unchanged.

In the remainder of this section, we briefly review related literature. We then define the economic environment of our model and solve an appropriate social planner's problem in Section 2. Then, in Section 3, we define a series of policy games representing different institutional configurations; we compute equilibria of these games and discuss their long-run and short-run implications for debt, inflation, and social welfare. Section 4 discusses how fiscal delegation might be implemented, in practice, in the European context. Finally, Section 5 concludes.

1.1 Related literature

Economists from Mundell (1961) to Farhi and Werning (2015) have emphasized the fiscal challenges implied by joining a monetary union. Many recent analyses focus on speculative attacks: by giving up their ability to emit currency independently, member states (like emerging economies that suffer from "original sin") become vulnerable to attacks on their sovereign debt (Eichengreen and Wyplosz (1998); De Grauwe (2012)), and to a "doom loop" between the banking sector and the public sector (Bruche and Suarez (2010); Pisani-Ferry (2012)). The literature on monetary and fiscal interactions (*e.g.* Leeper (1991); Sims (2013)) also points to the fragility of monetary unions: the set of monetary and fiscal rules consistent with solvency and equilibrium determinacy is likely to be reduced by joining a monetary union (Bergin (1998); Sims (1999); Leith and Wren-Lewis (2011)). Further analysis of the fiscal vulnerability of monetary unions comes from the literature on deficit bias. While Dixit and Lambertini (2003) constructed an example in which joining a monetary union has no effect on policy outcomes if all policy makers have identical objective functions, many other authors argue that, when policy makers' preferences differ in plausible ways, for instance due to the effect of democratic politics (Alesina and Tabellini (1990), Battaglini (2011)), monetary union increases deficit bias (Beetsma and Bovenberg (1999); Buti, Roeger, and In't Veld (2001); Beetsma and Jensen (2005); Chari and Kehoe (2007)).

Following Rogoff (1985), biases produced by excessively impatient policy makers who face incentives to break past promises may be effectively tackled through policy delegation. Since the mid 1990s, with monetary delegation becoming the norm worldwide to combat inflation bias, many economists have suggested also delegating some fiscal responsibilities to an institution independent of the government, as a way to tame the increasing public debts observed in developed economies (see Debrun, Hauner, and Kumar (2009); Hagemann (2010); and Costain and de Blas (2012a) for surveys). The literature distinguishes *fiscal councils*— which monitor but do not implement fiscal policy actions— from *independent fiscal authorities* (IFAs), which would make some of the fiscal decisions currently taken by the government. Fiscal councils are widespread today, and are mandated by the recent European "Fiscal Compact" treaty (European Council (2012)), but IFAs remain hypothetical. Two main types of IFA have been proposed. On one hand, the IFA might set a deficit target, at the start of the annual budget cycle, which the government is bound to respect; alternatively, it might exercise executive control over some fiscal instrument with a strong budgetary impact.[1] Some

[1]Proposals in the first class include von Hagen and Harden (1995); Eichengreen, Hausmann, and von Hagen (1999); and Wyplosz (2005); those in the second class include Ball (1997); Gruen (1997); Seidman and Lewis (2002); Wren-Lewis (2002); and Costain and de Blas (2012a). Calmfors (2003) considers proposals of both types.

authors (see Hagemann (2010), Sec. II.C; or Calmfors (2011), Sec. 1) take the nonexistence of IFAs today as evidence of their inviability, arguing that delegation is less appropriate for fiscal than for monetary policy since fiscal decisions are multidimensional, complex, and political. This view would be valid if fiscal policy were entirely delegated, as monetary policy has been. But it is less convincing if, as is more likely, only a small subset of fiscal decisions were delegated. Our analysis compares the implications of delegating different fiscal instruments, namely, debt issuance or the overall level of taxes.[2]

Even if fiscal delegation proves effective for reducing deficit bias, it is also important to ask how it affects the stabilization of shocks, which may require countercyclical policies and accomodative changes in debt levels. Leith and Wren-Lewis (2011) look at monetary and fiscal interactions when sovereign debt is present. They find that stabilization of fiscal shocks is heavily influenced by the effect of inflation on the competitiveness of each union member, requiring optimal policy from a country perspective to change debt gradually. Our reduced form model does not have variations of terms of trade, which could amplify the shortcomings of fiscal delegation in providing adequate stabilization. However, as opposed to the framework there, we solve for both the dynamics and the steady state under discretion and find that the debt biases under a monetary union are strong such that any gains of using debt issuance during the transition is offset such that welfare is higher under fiscal delegation. Gnocchi and Lambertini (2016) also focus on public debt under a distortionary steady state, but as opposed to us they always retain monetary policy commitment. Leeper, Leith, and Liu (2016) also stress the importance of non-linear effects incorporated in models of monetary-fiscal policy interaction solved using global methods. They find that in a single country model, lack of commitment generates debt stabilization bias, as is the case in our model. Interestingly, they find that for high levels of debt, monetary policy is used more heavily; inflation and lower rates are used to reduce debt.

In contrast to the framework we study here, many high-profile calls for European institutional reforms have assumed that achieving adequate protection against speculative attacks and banking crises makes full political integration inevitable (*e.g.* De Grauwe (2012), Soros (10 April 2013), or Pisani-Ferry (2012)). We agree that getting fiscal policy right is crucial for strengthening monetary policy, but we argue that the necessary reforms are more limited than is commonly supposed. What is essential is that European authorities must be able to ensure long-run national budget balance,

[2]From a political economy perspective, Alesina and Tabellini (2007) and Eggertsson and Borgne (2010) discuss which kinds of choices are appropriate for delegation from politicians to unelected technocrats.

and for this they must control at least *one* fiscal instrument of sufficient power in each member state. In accord with the principle of subsidiarity, all other fiscal decisions can remain at the national level. Sims (September 20, 2012) likewise stresses that fiscal discipline requires European control over some instrument with a strong impact on each national budget, but he argues that further fiscal integration is neither necessary nor likely to prove politically feasible. Similarly, some limited European tax powers form an essential backstop for banking union, as envisioned by Schoenmaker and Gros (2012) or Obstfeld (2013), but further fiscal integration is not required under these proposals.

2 The economic environment

Our setup extends the reduced-form framework of Beetsma and Bovenberg (1999, BB99) and Basso and Costain (2016). Our paper does not attempt to explain the imperfections in public institutions' decisions, such as excessive impatience or deficit bias, which have been discussed extensively in the political economy literature. Instead, our aim is to model these features parsimoniously in order to study how equilibrium outcomes differ across games in which policy variables are controlled by different sets of institutions. In particular, we investigate how systematic policy biases are damped or enhanced by different institutional configurations, for a typical country in a monetary union. To address the effects on a typical country, we assume all countries are symmetric (both assumptions also simplify the math).[3]

Time is discrete. Several regions $j \in \{1, 2, ...J\}$ each benefit from local public spending, and face region-specific budget constraints. These regions might be considered nations, or subnational areas. Together, they form a monetary union, in which a single inflation rate applies.

2.1 Social welfare and budget constraints

Let time t private-sector output in country j be $x_{j,t}$. Our main assumption about the macroeconomy is that actual output increases relative to its "natural" level $\underline{x}_{j,t}$ if inflation π_t is higher than expected inflation, π_t^e, while distorting taxes $\tau_{j,t}$ push it below $\underline{x}_{j,t}$:

$$x_{j,t} \;=\; \underline{x}_{j,t} + \nu(\pi_t - \pi_t^e - \tau_{j,t}). \tag{1}$$

[3]Small asymmetries between countries leave our results qualitatively unchanged; see footnote 8. For differences in country size and in the form of interest rate contagion, see footnotes **??** and 6.

Social welfare decreases quadratically as output, inflation, and government services $g_{j,t}$ deviate from their bliss points. The bliss point for inflation is assumed to be zero. The loss function for region j is[4]

$$L_{Sj} \;=\; E_0 \sum_{t=0}^{T} \beta_S^t \left\{ \alpha_{\pi S} \pi_t^2 + \left(x_{j,t} - \tilde{x}_{j,t}\right)^2 + \alpha_{gS} \left(g_{j,t} - \tilde{g}_{j,t}\right)^2 \right\}. \tag{2}$$

Here $\tilde{x}_{j,t}$ and $\tilde{g}_{j,t}$ are the bliss points for output and government spending.[5] The weights $\alpha_{\pi S} > 0$ and $\alpha_{gS} > 0$ represent the relative importance of deviations of inflation and public services from their bliss points; without loss of generality the weight on output deviations is set equal to one. The discount factor for social welfare is $\beta_S < 1$.

Since we are modeling a set of independent states that lack consensus for full political integration, we assume that policy is constrained by a budget constraint for each region. We write total government expenditure in region j at time t as $p^g_{j,t} g_{j,t}$, where $g_{j,t}$ is the amount of public services delivered, and $p^g_{j,t}$ is the price (in consumption units) of public services. Region j has only two sources of revenues for its expenditures, both of which are distortionary: tax revenues $\tau_{j,t}$, and seignorage revenues $\kappa\pi_t$ (assumed to be linear in inflation). Now, let $\bar{d}_{t-1} = \frac{1}{J}\sum_{j=1}^{J} d_{j,t-1}$ be the real average debt level in the monetary union at the end of period $t-1$, where $d_{j,t-1}$ represents the real debt of region j. We impose the following budget constraint on region j:

$$d_{j,t} = \left[R(\bar{d}_{t-1}) + \chi(\pi_t^e - \pi_t)\right] d_{j,t-1} + p^g_{j,t} g_{j,t} - \tau_{j,t} - \kappa\pi_t. \tag{3}$$

Here, $R(\bar{d}_{t-1})$ represents the expected real interest rate, while $R(\bar{d}_{t-1}) + \chi(\pi_t^e - \pi_t)$ is the *ex post* real interest rate, after inflation is realized. This formulation embodies two key assumptions of our model: nominal debt, and interest rate contagion. Parameter $\chi \in [0,1]$ can be interpreted as the fraction of debt that is nominal, which therefore loses real value in response to surprise inflation. Interest contagion effects are modeled by assuming that the interest rate depends on average debt in the union, $\bar{d}_{t-1}$, rather than country j's own debt. Thus, increased debt of region j raises the interest rate on bonds issued by all union members (and likewise their debt affects the interest rate

[4] Alesina and Tabellini (1987) derive an output relation of the form (1) from a more complete model. Leith and Wren-Lewis (2011) derive a social welfare function of the form (2) from a New Keynesian framework with government spending in the utility function.

[5] The bliss points $\tilde{x}_{j,t}$ and $\tilde{g}_{j,t}$ should be interpreted as extremely high levels of private and public consumption that are unlikely to be budget-feasible.

facing region j).[6] For simplicity, we assume a linear functional form:

$$R(\bar{d}_t) = 1 + r_0 + \delta \bar{d}_t = \frac{1}{\beta_S} + \delta \bar{d}_t, \tag{4}$$

which says that savers are willing to hold a "target" debt level $\bar{d}^* \equiv 0$ when the interest rate just compensates their time preference rate.[7] In addition to (3), debt must respect an infinite horizon "no-Ponzi" condition, which simply means that expected interest payments on debt suffice to make it worthwhile for the private sector (with the appropriate discount rate) to hold the bonds.

Total public services in region j, $g_{j,t}$, are a constant-elasticity aggregate of a variety of differentiated services $g_{j,k,t}$:

$$g_{j,t} = \left(\int_0^1 \omega_{j,k,t} \left(g_{j,k,t} \right)^{\frac{\eta-1}{\eta}} dk \right)^{\frac{\eta}{\eta-1}}. \tag{5}$$

where $\eta > 1$, and $\omega_{j,k,t} > 0$ are weights on the different services k. Total government spending is a sum over all public goods, $\int_0^1 g_{j,k,t} dk$. Spending is allocated to minimize the cost of the aggregate public services provided:

$$p^g_{j,t} g_{j,t} \equiv \min_{\{g_{j,k,t}\}_{k=0}^1} \int_0^1 g_{j,k,t} dk \quad \text{s.t.} \quad \left(\int_0^1 \omega_{j,k,t} \left(g_{j,k,t} \right)^{\frac{\eta-1}{\eta}} dk \right)^{\frac{\eta}{\eta-1}} \geqslant g_{j,t}. \tag{6}$$

Equation (6) serves to define the price of government services, $p^g_{j,t}$. We assume that $\omega_{j,k,t}$ is independently and identically distributed for all j, k, and t.

We consider two possible scenarios for the public spending decision. On one hand, the fiscal policy maker may know the distribution of $\omega_{j,k,t}$, but not observe its realization. Then it is optimal to allocate spending equally across all goods, so that

$$p^g_{j,t} = q^H \equiv (E\omega)^{\frac{\eta}{1-\eta}}. \tag{7}$$

At the opposite extreme, the policy maker may observe $w_{j,k,t}$ before choosing $g_{j,k,t}$. In this case, it is optimal to allocate more spending to the most-demanded services, according to the first-order condition

$$\frac{g_{j,k,t}}{g_{j,l,t}} = \left(\frac{\omega_{j,k,t}}{\omega_{j,l,t}} \right)^{\eta}. \tag{8}$$

This more efficient allocation makes aggregate public services less expensive:

$$p^g_{j,t} = q^L = (E\omega^{\eta})^{\frac{1}{1-\eta}} < q^H. \tag{9}$$

[6] Broto and Perez-Quiros (2013) present empirical evidence on interest rate contagion in Europe. Our formulation oversimplifies contagion; in practice some countries have been "safe havens", benefitting form *lower* interest rates when the market began to distrust peripheral European debt. Our interest rate specification is best seen as representing contagion across peripheral countries. Delegation to a fiscal authority might be less relevant for a safe-haven country; but the presence of a safe-haven country does not negate our analysis of the role of fiscal delegation for peripheral countries.

[7] But this is just a normalization. Assuming $R(\bar{d}_t) = \frac{1}{\beta_S} + \delta(\bar{d}_t - \bar{d}^*)$, where $\bar{d}^*$ is an arbitrary target for debt, does not alter the qualitative results. So for simplicity, we set the target to zero.

2.2 Scenario P: A planning solution

Given these objectives and constraints, we next establish a welfare benchmark for our economy. For relevance in the European context, we consider a Ramsey planner who maximizes social welfare taking market equilibrium conditions *and region-specific budget constraints* as given. Our planner does not represent any existing European institution, as it has unrealistic advantages in information and decision-making, but it is useful as a benchmark against which hypothetical institutions can be compared, when budgets are not aggregated across regions. For this purpose, we study an *omniscient, committed, cooperative Pareto planner*:

- *Omniscient*: the planner observes $\omega_{j,k,t}$ before choosing $g_{j,k,t}$. This makes aggregate public spending relatively inexpensive: $p^g_{j,t} = q^L$.
- *Committed*: the planner can credibly commit to choose the inflation rate it has previously announced. Therefore the inflation rate chosen by the planner is the rate expected by the public: $\pi_t = \pi^e_t$.
- *Cooperative*: the planner chooses the policy variables for all regions $j \in \{1, ..., J\}$, and thus internalizes any externalities across borders.
- *Pareto*: the planner obeys a distinct budget constraint for each region, maximizing social welfare insofar as this does not require transfers across regions.

Let $\vec{d}_{t-1} \equiv \{d_{j,t-1}\}_{j=1}^J$ be the vector of real debts of all the regions in the monetary union at the beginning of period t, and let $\vec{\epsilon}_t$ be a vector of exogenous shocks. We write the planner's value function as $V^P_t(\vec{d}_{t-1}, \vec{\epsilon}_t)$, the maximized value of $-L^S_j$, summed across all regions j. The value attainable satisfies the following Bellman equation:

$$V^P_t\left(\vec{d}_{t-1}, \vec{\epsilon}_t\right) = \max_{\pi_t, \{d_{j,t}, \tau_{j,t}, g_{j,t}\}_{j=1}^J} \frac{-1}{2}\left\{\alpha_{\pi S}\pi_t^2 + \frac{1}{J}\sum_{j=1}^J\left[\left(\underline{x}_{j,t} - \nu\tau_{j,t} - \tilde{x}_{j,t}\right)^2 + \alpha_{gS}\left(g_{j,t} - \tilde{g}_{j,t}\right)^2\right] + \beta_S E_t V^P_{t+1}\left(\vec{d}_t, \vec{\epsilon}_{t+1}\right)\right\}$$

$$\text{s.t.} \quad d_{j,t} = R\left(\bar{d}_{t-1}\right)d_{j,t-1} + q_L g_{j,t} - \tau_{j,t} - \kappa\pi_t \quad \forall j. \tag{10}$$

The first-order conditions for inflation and taxes yield two simple intratemporal properties of the planner's solution. In each period and region, the marginal cost of tax distortions is set equal to the marginal benefit of public spending:

$$\nu\hat{x}_{j,t} = \frac{\alpha_{gS}}{q_L}\hat{g}_{j,t}, \tag{11}$$

where $\hat{x}_{j,t} = x_{j,t} - \tilde{x}_{j,t}$ and $\hat{g}_{j,t} = g_{j,t} - \tilde{g}_{j,t}$ and are the deviations of output and public spending from their bliss points. And at each time, the marginal cost of inflation equals the *average* marginal benefit of public spending:

$$\frac{\alpha_{gS}}{q_L}\bar{\hat{g}}_t \;=\; -\frac{\alpha_{\pi S}}{\kappa}\pi_t, \tag{12}$$

where $\bar{\hat{g}}_t = J^{-1}\sum_j \hat{g}_{j,t}$. Thus, while (11) trades off distortions within region j at time t, (12) links region-specific distortions with union-wide inflation.

Intertemporally, the Euler equation on $d_{j,t}$ trades off region-j public expenditures at times t and $t+1$, adjusted for the impact of increased region-j debt on the interest rate faced by all regions k:

$$\hat{g}_{j,t} \;=\; \beta_S R(\bar{d}_t)\hat{g}_{j,t+1} + \beta_S R'(\bar{d}_t)\sum_{k=1}^{J}\frac{d_{k,t}}{J}E_t\hat{g}_{k,t+1}. \tag{13}$$

Assuming all regions are symmetric, we can then rewrite the dynamics in aggregate terms. The budget constraints aggregate into a single equation governing average debt, and we can use (12) to express the Euler equation in terms of inflation only:[8]

$$\bar{d}_t = R(\bar{d}_{t-1})\bar{d}_{t-1} - \tilde{\kappa}_P\pi_t + \bar{\tilde{z}}_t, \tag{14}$$

$$\pi_t = \beta_S\left(R(\bar{d}_t) + R'(\bar{d}_t)\bar{d}_t\right)E_t\pi_{t+1}, \tag{15}$$

where

$$\bar{\tilde{z}}_t \;=\; \frac{1}{J}\sum_{j=1}^{J}\left(\frac{\tilde{x}_{j,t} - \underline{x}_{j,t}}{\nu} + q_L\tilde{g}_{j,t}\right) \tag{16}$$

is a union-wide demand indicator, and

$$\tilde{\kappa}_P = \kappa + \frac{\alpha_{\pi S}}{\kappa\alpha_{gS}}\left(q_L^2 + \frac{\alpha_{gS}}{\nu^2}\right). \tag{17}$$

Together, (15) and the interest rate formula (4) imply that the planner chooses zero debt in steady state. Given the steady-state level of the demand shifter $\bar{\tilde{z}}$, we can also calculate steady state inflation from (14):

$$\bar{d}^P_{ss} = 0 \quad \text{and} \quad \pi^P_{ss} = \frac{\bar{\tilde{z}}}{\tilde{\kappa}_P}. \tag{18}$$

[8] If countries are not symmetric, then (15) only holds approximately. The exact equation is then $\pi_t = \beta_S\left(R(\bar{d}_t) + R'(\bar{d}_t)\bar{d}_t\right)\pi_{t+1} - \beta_S R'(\bar{d}_t)\frac{\alpha_{gS}\kappa}{\alpha_{\pi S}q_L}Cov_{t+1}(\hat{g}_{k,t+1}, d_{k,t})$. But the covariance term is negligible when differences between countries are small, so all results stated in this paper are robust to small cross-country differences.

3 Policy games

3.1 Policy makers' objectives

Next, we study equilibrium outcomes when several policy-making institutions interact. Each one acts to minimize a loss function that resembles (2), but may have a different discount factor or different weighting coefficients on the loss terms. As we mentioned in the introduction, our preference assumptions reflect two simple principles. Policy makers subject to democratic election are assumed to be impatient; and policy makers subject to a mandate reflecting a simple, quantitative goal are assumed to value that goal more strongly than society at large.

Our model of the *status quo* monetary union consists of a central bank C that interacts with many regional governments G_j. The central bank chooses inflation for the whole monetary union. It sums losses symmetrically across all J regions, with weight $\alpha_{\pi C} > \alpha_{\pi S}$ on inflation, weight $\alpha_{xC} \equiv 1$ on output, and weight $\alpha_{gC} = \alpha_{gS}$ on public spending. Each regional government G_j chooses some fiscal variables for region j, and its loss function L_{Gj} only includes terms related to region j. It places weight $\alpha_{\pi G} = \alpha_{\pi S}$ on inflation, weight $\alpha_{xG} \equiv 1$ on output, and weight $\alpha_{gG} = \alpha_{gS}$ on public spending.

Our alternative institutional scenarios will include other types of players. One scenario considered is the replacement of the regional governments by a single federal government G that controls fiscal variables in all regions j. The federal government's loss function will include terms for all regions j, weighted with the same coefficients that characterize the regional governments in the status quo scenario: weight $\alpha_{\pi G} = \alpha_{\pi S}$ on inflation, weight $\alpha_{xG} \equiv 1$ on output, and weight $\alpha_{gG} = \alpha_{gS}$ on public spending.

We also study scenarios in which some fiscal instruments are delegated to a debt-averse fiscal authority. The fiscal authority may be established by and for region j, in which case we will call it F_j, and we will then assume its loss function considers region j terms only. Alternatively, it may be a union-wide institution, in which case we will call it F, and we will assume that it sums losses across all regions. The coefficients of the loss functions of F_j and F are weight $\alpha_{\pi F} = \alpha_{\pi S}$ on inflation, weight $\alpha_{xF} \equiv 1$ on output, weight $\alpha_{gF} = \alpha_{gS}$ on public spending, and weight $\alpha_{dF} > 0$ on debt. Note that the fiscal authority is the only player that cares specifically about the debt level, which does not appear in the social welfare function. We will sometimes use the notation $\alpha_{dC} = \alpha_{dG} \equiv 0$ to emphasize the fact that the central bank and the governments do not incorporate the debt level in their welfare functions.

Table 1: *Baseline parameter assumptions**

	Society and planner	Central bank	Government	Fiscal authority
Discount factor β_i	$0 < \beta_S < 1$	$\beta_C = \beta_S$	$0 < \beta_G < \beta_S$	$\beta_G < \beta_F \leqslant \beta_S$
	$\beta_S R(0) = 1$			
Spending coefficient α_{gi}	$\alpha_{gS} > 0$	$\alpha_{gC} = \alpha_{gS}$	$\alpha_{gG} = \alpha_{gS}$	$\alpha_{gF} = \alpha_{gS}$
Inflation coefficient $\alpha_{\pi i}$	$\alpha_{\pi S} > 0$	$\alpha_{\pi C} > \alpha_{\pi S}$	$\alpha_{\pi G} = \alpha_{\pi S}$	$\alpha_{\pi F} = \alpha_{\pi S}$
Debt coefficient α_{di}	$\alpha_{dS} = 0$	$\alpha_{dC} = 0$	$\alpha_{dG} = 0$	$\alpha_{dF} > 0$

*Coefficients of loss functions for agents $i \in \{S, C, G, F\}$.

Note that all these policy institutions are essentially benevolent, valuing the same goals as society and the planner. However, their different roles may imply some differences in priorities, reflected in the differences in their weighting coefficients, which are summarized in Table 1. The government is more impatient than society, due to the short time horizons of electoral politics. Since the fiscal authority is insulated from political pressures, it is more patient than the government (at most, equally patient as the social planner). This is one of the reasons why the fiscal authority may display less deficit bias than the government. All three institutions $i \in \{C, G, F\}$ value public spending to the same degree as society. But the central bank is assumed to have a mandate to achieve a target inflation rate; it therefore dislikes inflation variability more strongly than society does.[9] Likewise, even though the debt level has no direct impact on social welfare, we assume that the fiscal authority has a mandate to stabilize debt around some target level, and that this is reflected in its preferences. Therefore its objective includes a positive coefficient on deviations of debt from its target, while other agents place zero weight on this term.

Given the abstract nature of our quadratic objective functions, the baseline assumptions in Table 1 do not guarantee the existence of an equilibrium with intuitively reasonable properties. This requires several other natural restrictions.

- We say that the central bank exhibits *moderate inflation aversion* when its preferences satisfy the following inequality:

$$\alpha_{\pi C} \;<\; \frac{1+\kappa}{\kappa}\alpha_{\pi S}. \tag{19}$$

  As in Chari and Kehoe (2007) and BB99, governments anticipate that the central bank will adjust inflation in response to their debt choices. *Moderate inflation*

[9] Alesina and Tabellini (2007) discuss why society may prefer to delegate tasks with quantifiable objectives to bureaucrats, instead of leaving them up to the democratic government.

aversion implies that inflation rises *more than is optimal* when debt increases. This inflation response underlies one of the common pool problems that generate debt biases in our model. A central bank exhibits *efficient inflation aversion* if (19) holds with equality (in this case the inflationary bias due to inefficiently low output is corrected.)

- Furthermore, we assume that steady-state assets of the public sector are not excessively large:

$$R(d_{ss}) + R'(d_{ss})d_{ss} \ > \ 1, \tag{20}$$

and

$$d_{ss} \ > \ -\frac{\varpi}{\chi\kappa}, \tag{21}$$

where $\varpi = \kappa\left(\frac{\alpha_{gG}}{\alpha_{gC}} + \kappa\right) + \frac{\alpha_{\pi C}}{\alpha_{gC}}\left(q_L^2 + \frac{\alpha_{gG}}{\nu^2}\right)$. When (20) does *not* hold, this means assets are so large that *saving less in steady state* would imply *more interest income in steady state.*[10] Likewise, (21) must hold under a reasonable parameterization, because as $d \to -\frac{\varpi}{\chi\kappa}$ government wealth is becoming so large that the central bank wishes to create an arbitrarily large surprise *deflation* in order to increase the real value of public assets.

- Finally, since the objective function is quadratic, if the interest rate declines very slowly with assets there may exist a steady-state public asset level sufficient to finance the utility bliss point out of interest income alone. This unrealistic scenario is ruled out by assuming *scarcity*, defined as follows:

$$\bar{\bar{z}} \ > \ \frac{r_0^2}{4\delta}. \tag{22}$$

3.2 The generic policy game

First, consider a policy maker I_j who acts in region j only, where $I \in \{G, F\}$. The generic decision problem of such a policy maker can be written as follows:

$$V_t^{Ij}\left(\vec{d}_{t-1}, \vec{\epsilon}_t\right) \ = \ \max_{\Theta_t^{Ij}} \ \frac{-1}{2}\left\{\alpha_{\pi I}\pi_t^2 + \left(\underline{x}_{j,t} + \nu(\pi_t - \pi_t^e - \tau_{j,t}) - \tilde{x}_{j,t}\right)^2 + \alpha_{gI}\left(g_{j,t} - \tilde{g}_{j,t}\right)^2 + \alpha_{dI}\left(d_{j,t} - \tilde{d}_{j,t}\right)^2\right\}$$

$$+ \ \beta_I E_t V_{t+1}^{Ij}\left(\vec{d}_t, \vec{\epsilon}_{t+1}\right) \ + \ \Lambda_t^{Ij}\left[d_{j,t} - \left(R\left(\bar{d}_{t-1}\right) + \chi(\pi_t^e - \pi_t)\right)d_{j,t-1} + \tau_{j,t} + \kappa\pi_t - q_{j,t}g_{j,t}\right]. \tag{23}$$

[10] Assuming that (4) holds (a linear interest rate), (20) is equivalent to $d_{ss} > -\frac{r_0}{2\delta}$.

This problem may represent the decision of a local government G_j or a local fiscal authority F_j. The set of instruments controlled by the policy maker at time t is denoted Θ_t^{Ij}. The objective function contains quadratic losses as inflation, output, public spending, and debt deviate from their bliss points; these losses are weighted according to the coefficients of the policy maker in question. (The fiscal authority is assumed to care about the debt level, but the government does not, so $\alpha_{dF} > \alpha_{dG} \equiv 0$). The discount rate varies across institutions; we assume $0 < \beta_G < \beta_F \leq \beta_S < 1$. Λ_t^{Ij} represents the multiplier on the policy maker's time t budget constraint. The price of public services $g_{j,t}$ differs with instrument assignment; we assume that $q_{j,t} = q_L$ if public spending is allocated across services by a local decision maker, and is higher ($q_{j,t} = q_H$) if spending is instead chosen by a central authority of the monetary union.

Alternatively, we may consider a policy maker $I \in \{C, G, F\}$ who controls instruments affecting all regions $j \in \{1, 2, \ldots J\}$.

$$V_t^I\left(\vec{d}_{t-1}, \vec{\epsilon}_t\right) = \max_{\Theta_t^I} \frac{-1}{2}\left\{\alpha_{\pi I}\pi_t^2 + \frac{1}{J}\sum_{j=1}^{J}\left[\left(\underline{x}_{j,t} + \nu(\pi_t - \pi_t^e - \tau_{j,t}) - \tilde{x}_{j,t}\right)^2 + \alpha_{gI}\left(g_{j,t} - \tilde{g}_{j,t}\right)^2 + \alpha_{dI}\left(d_{j,t} - \tilde{d}_{j,t}\right)^2\right]\right\}$$
$$+ \beta_I E_t V_{t+1}^I\left(\vec{d}_t, \vec{\epsilon}_{t+1}\right) + \frac{1}{J}\sum_{j=1}^{J}\Lambda_{j,t}^I\left[d_{j,t} - \left(R\left(\bar{d}_{t-1}\right) + \chi(\pi_t^e - \pi_t)\right)d_{j,t-1} + \tau_{j,t} + \kappa\pi_t - q_{j,t}g_{j,t}\right]. \tag{24}$$

Controls versus residuals

This way of writing policy makers' decision problems implies that all the endogenous variables that are affected by the choices of player $I \in \{G_j, F_j, C, G, F\}$ are included in that player's choice set, Θ_t^I. But two cases should be distinguished. If a given variable y_t appears *only* in the choice set of one particular player I, then this means that player I can unilaterally determine the value of y_t. In this case, we will refer to y_t as a *control variable* of player I.

On the other hand, sometimes a variable y_t appears in the choice sets Θ_t^I and $\Theta_t^{I'}$ of two different players I and I'. In particular, the presence of a binding budget constraint in each period t means that some variable y_t must effectively be determined by the constraint, conditional on the controls chosen by the players. We will then refer to y_t as a *residual variable*. For example, in some of the games we study in section 3.3, inflation is chosen by the central bank, while taxes and debt are chosen by the government(s); the quantity of public spending is then determined as the equilibrium outcome of these simultaneous choices subject to the budget constraint. Thus, in these games, public spending $g_{j,t}$ will be a residual variable, appearing in the choice sets

of government G_j and the central bank C. In some of the games studied in section 3.4, inflation is chosen by the central bank, while taxes and spending are chosen by the government(s); new debt issuance $d_{j,t}$ is then a residual variable determined in equilibrium by the budget constraint, appearing in the choice sets $\Theta_t^{G_j}$ and Θ_t^C. These differences in instrument assignment are quantitatively important in our simulations.

Welfare measures

To compare the policy implications across regimes, it will be helpful to define notation for the social welfare function. Social welfare varies with the policy regime that is in place; it is also a function of the current state of the economy. Therefore, we define the social welfare function of region j,

$$W_j^{\mathcal{S}}(\vec{d}, \vec{\epsilon}) \;=\; -L_{Sj}, \tag{25}$$

as the negative of the loss function of region j, defined by (2), evaluated in the equilibrium that occurs under institutional framework $\mathcal{S}$, when the vector of current debt levels is $\vec{d}$ and the vector of current shocks is $\vec{\epsilon}$. Note that the welfare of region j depends not only on its own debt d_j, but on the whole vector $\vec{d}$ of regional debts, and it varies also with the current shock. We can then define overall social welfare (which the planner seeks to optimize) as

$$W^{\mathcal{S}}(\vec{d}, \vec{\epsilon}) \;=\; \frac{1}{J}\sum_{j=1}^{J} W_j^{\mathcal{S}}(\vec{d}, \vec{\epsilon}). \tag{26}$$

The subscript ss will represent a symmetric steady state. To compare institutional scenarios $\mathcal{S}$, we report debt $d_{ss}^{\mathcal{S}}$ and inflation $\pi_{ss}^{\mathcal{S}}$; by definition, these are calculated under the assumption that all countries are parameterized in a symmetic way. Likewise, as a welfare benchmark, we report social welfare $W_{ss}^{\mathcal{S}}$ in this symmetric steady state, where

$$W_{ss}^{\mathcal{S}} \;\equiv\; W^{\mathcal{S}}(\vec{d}_{ss}^{\mathcal{S}}, \vec{0}). \tag{27}$$

Here, $\vec{d}_{ss}^{\mathcal{S}}$ represents the vector in which all elements equal $d_{ss}^{\mathcal{S}}$.

Policy functions and solution method

We will study symmetric equilibria in which shocks, if any, affect all countries equally. Under this assumption, the Euler equation system implied by any institutional scenario can be used to solve for the policy functions describing policy makers' choices.[11]

[11] We focus on Markov-perfect equilibria, in which actions depend on the current debt of each region j, as well as exogenous shocks, but in which no other state variable is needed. That is, we rule out equilibria with more complex forms of history dependence, such as reputational effects.

For example, a symmetric solution of scenario P (the planner's problem) can be characterized by two policy functions: an inflation function $\pi_t = I^P(\bar{d}_{t-1}, \epsilon_t)$, and a gross borrowing function $\bar{d}_t = B^P(\bar{d}_{t-1}, \epsilon_t)$. Using the fact that $R(d) + R'(d)d = \beta_S^{-1} + 2\delta d$, we can write the planner's Euler equations (14)-(15) in terms of the policy functions as follows:

$$B^P(\bar{d}_{t-1}, \epsilon_t) = R(\bar{d}_{t-1})\bar{d}_{t-1} - \tilde{\kappa}_P I^P(\bar{d}_{t-1}, \epsilon_t) + \bar{\tilde{z}}_t, \tag{28}$$

$$I^P(\bar{d}_{t-1}, \epsilon_t) = \beta_S \left(\beta_S^{-1} + 2\delta B^P(\bar{d}_{t-1}, \epsilon_t)\right) E_t I^P(B^P(\bar{d}_{t-1}, \epsilon_t), \epsilon_{t+1}). \tag{29}$$

Euler equation systems similar to (28)-(29) also characterize the equilibria of the other institutional scenarios $\mathcal{S}$. We solve the functional equations for each scenario, approximating the policy functions using Chebyshev polynomials, and evaluating expectations using Gauss-Hermite quadrature. The policy functions can then be used to simulate the dynamics implied by each scenario, and to perform welfare calculations. In particular, the steady-state debt level in any scenario $\mathcal{S}$ is defined as the fixed point of the gross borrowing function when shocks are zero:[12]

$$d_{ss}^{\mathcal{S}} \;=\; B^{\mathcal{S}}(d_{ss}^{\mathcal{S}}, 0). \tag{30}$$

3.3 Policy games with debt as a control variable

We now compare several policy environments in which debt is a control variable. While it might seem that debt is inevitably controlled by some player, this is not necessarily true, as we discussed in section 3.2. Since a budget constraint applies in our model at all t, some variable must be determined in each period by the constraint, as a residual. Since debt is a control variable in the scenarios considered in this section, some other variable must adjust to satisfy the budget constraint. For now, we assume that the adjusting variable is public spending, but we will explore other assumptions later.

[12]For some simulations, we will solve (28)-(29) under the assumption that the process ϵ has zero variance, making the model deterministic. In these simulations, $d_{ss}^{\mathcal{S}}$ represents the nonstochastic steady state of the model. But we can also solve for the fixed point of (30) using the borrowing function $B^{\mathcal{S}}$ from a stochastic simulation. In that case, $d_{ss}^{\mathcal{S}}$ may be called the "stochastic steady state", meaning the point to which the dynamics converge conditional on an arbitrarily long sequence of shocks equal to zero.

3.3.1 Institutional scenarios

Scenario MU: Status quo model of a large monetary union

First, consider a scenario resembling the Eurozone today, with a single central bank that chooses inflation π_t for the whole union, while J regional governments G_j each choose regional taxes τ_{jt} and regional debt d_{jt}. Given τ_{jt}, d_{jt}, and π_t, government j spends the resources it has available, according to budget constraint (3), so public spending g_{jt} is determined as a residual. Thus, the central bank's choice set is $\Theta_t^C \equiv \{\pi_t, \{g_{j,t}\}_{j=1}^J\}$, and government j's choice set is $\Theta_t^{G_j} \equiv \{\tau_{jt}, d_{jt}, g_{j,t}\}$. The market's inflation expectations π_t^e are determined at the beginning of t, rationally anticipating the outcome of the game between the bank and the governments, but all policy makers act under discretion. So while policy makers take π_t^e as given, nonetheless in equilibrium $\pi_t = \pi_t^e$ at all times. As long as $\alpha_{gG} = \alpha_{gS}$, the government trades off output versus public spending according to (11), just as the OCCPP planner does. But the dynamics of the monetary union differ from those of the planning problem in several intuitive ways. Since the central bank cannot commit, it is tempted to choose higher inflation than that expected by the public. So it trades off inflation against public spending according to

$$\frac{\alpha_{gS}}{q_L}\bar{\hat{g}}_t \;=\; -\frac{\alpha_{\pi C}\pi_t}{1+\kappa+\chi\bar{d}_{t-1}} \;\equiv\; -\alpha_{\pi C}\breve{\pi}_t, \tag{31}$$

where we have defined an adjusted inflation variable, $\breve{\pi}_t \equiv \frac{\pi_t}{1+\kappa+\chi\bar{d}_{t-1}}$. Comparing (31) to (12), we see that the central bank tends to choose more inflation than the planner would, especially when debt is high. On the other hand, if it dislikes inflation more than the public and the planner do ($\alpha_{\pi C} > \alpha_{\pi S}$), this will partially offset the inflation bias caused by its lack of commitment.

Plugging (11) and (31) into the period budget constraint (3), we find that average debt in the monetary union evolves according to

$$\bar{d}_t \;=\; R(\bar{d}_{t-1})\bar{d}_{t-1} - \breve{\kappa}(\bar{d}_{t-1})\breve{\pi}_t + \bar{\tilde{z}}_t, \tag{32}$$

where $\breve{\kappa}(\bar{d}_{t-1}) \equiv \kappa(1+\kappa+\chi\bar{d}_{t-1}) + \frac{\alpha_{\pi C}}{\alpha_{gS}}\left(q_L^2 + \frac{\alpha_{gS}}{\nu^2}\right)$. Under the parameter assumptions of Table 1, if $\bar{d}_{t-1} \geq 0$ and the central bank exhibits *moderate inflation aversion*, then $\breve{\kappa}(\bar{d}_{t-1}) < (1+\kappa+\chi\bar{d}_{t-1})\tilde{\kappa}_P$, which says that due to the central bank's lack of commitment, the monetary union has more inflation, relative to its level of private output and public spending, than the planner's solution does.

Next, consider the Euler equation that governs fiscal policy over time. If country j is large, its choice of d_{jt} will affect the interest rate (both for its own debt and for other union members); its debt will also influence the choices of other decision makers

at time $t+1$. But we will simplify by focusing on the limit of a large monetary union ($J=\infty$) in which each individual country is infinitesimal. In this case, government j ignores all the spillovers from its debt, and the region-j Euler equation simplifies to[13]

$$\hat{g}_{j,t} \;=\; \beta_G R(\bar{d}_t) E_t \hat{g}_{j,t+1}. \tag{33}$$

When all countries are symmetric, we can use (31) to rewrite the Euler equation in terms of inflation:

$$\breve{\pi}_t \;=\; \beta_G R(\bar{d}_t) E_t \breve{\pi}_{t+1}. \tag{34}$$

This differs from the planner's Euler equation in two ways. First, since government j controls debt, (34) reflects the government's discount factor, instead of that of the planner. Second, since country j's debt is a negligible part of the debt of the union, government j knows that it cannot unilateraly affect the interest rate, so the R' term seen in (15) disappears. Both of these effects imply faster inflation growth in the monetary union than in the planner's solution; since (11) and (31) link inflation to $\bar{\hat{x}}_t$ and $\bar{\hat{g}}_t$, the output and public spending loss terms also grow more quickly in the monetary union than the planner would wish. Rapid growth of these distortions represents deficit bias: it means that the economy suffers relatively small distortions in the near term, but finances the resulting deficit by accumulating debt, which must be paid off in the future by suffering larger distortions in the long run.

Scenario I: A single country with its own monetary policy

The deficit bias suffered by a monetary union can also be seen by comparing it to the case of a single country with its own independent central bank. The instrument assignment is identical to the monetary union environment ($\Theta_t^C \equiv \{\pi_t, g_t\}$, $\Theta_t^G \equiv \{\tau_t, d_t, g_t\}$) but we focus on the case $J=1$, instead of the opposite extreme $J=\infty$.

The tradeoffs between output, public spending, and inflation are unchanged, so (11) and (31) still apply. Therefore the equation governing per capita debt is the same as in the monetary union:[14]

$$d_t \;=\; R(d_{t-1})d_{t-1} - \breve{\kappa}(d_{t-1})\breve{\pi}_t + \tilde{z}_t. \tag{35}$$

[13]For a detailed derivation of the first-order conditions for this model, see Basso and Costain (2016). The online appendix of that paper includes derivation of the envelope conditions and the Euler equations in the case of finite J, in which each country j is non-negligible and therefore the effects of its debt decision on subsequent choices cannot be ignored.

[14]Since there is only one country, per capita debt now refers to the debt d_t of that country, instead of union-wide average debt $\bar{d}_t$.

The differences show up in the Euler equation, which becomes[15]

$$\breve{\pi}_t \;=\; \beta_G E_t \left(R(d_t) + R'(d_t)d_t + \left(\gamma + \chi \frac{\alpha_{\pi G}}{\alpha_{\pi C}} \right) \frac{\partial \pi_{t+1}}{\partial d_t} \right) \breve{\pi}_{t+1}. \tag{36}$$

As in scenario MU, the discount factor in the Euler equation is β_G, reflecting government impatience, which raises inflation growth. But other terms in the Euler equation slow down inflation growth, relative to a monetary union. The government of a single country recognizes that its debt affects the interest rate it pays, so the term $R'(d_t)d_t$ appears in the Euler equation, which reduces inflation growth whenever $d_t > 0$. Second, the central bank has an incentive to create surprise inflation (i) to boost output and (ii) to decrease the real cost of servicing nominal debt; the strength of these incentives goes through the parameters γ and χ, respectively.[16] Given the bank's lack of commitment, the government of a single country knows that its debt will influence central bank inflation, and hence it cuts its deficit to correct for these inflation bias terms. Again, this reduces inflation growth, compared with scenario MU, where each government regards the impact of its own debt as negligible.

Scenario G: A federal government for a monetary union

Creating a single government for the monetary union makes its political structure formally identical to a single country, so our analysis of the $J = 1$ case applies. Therefore, as we argued above, two forms of deficit bias should disappear when a monetary union adopts a single government. Like a single country, but unlike a small member of a monetary union, a federal government internalizes the effect of its debt on the interest rate it pays. This gives it an incentive to accumulate less debt than member states of a monetary union do. Similarly, the federal government recognizes the fact that the central bank will raise inflation in response to any rise in the average debt level, whereas small member states in a monetary union would fail to internalize this effect and would therefore choose more debt on average.

However, in the European context, this setup has a major disadvantage. It gives up "subsidiarity": spending decisions are taken at the union level, where less information is available, and therefore public services are more expensive than they would be if they were allocated locally. Therefore we now impose the following budget constraint:

$$d_{j,t} \;=\; \left(R\left(\bar{d}_{t-1}\right) + \chi(\pi_t^e - \pi_t) \right) d_{j,t-1} + q_H g_{j,t} - \tau_{j,t} - s_{j,t} - \kappa \pi_t. \tag{37}$$

[15] To solve equations (35)-(36), we can rewrite them in terms of d and $\breve{\pi}$ only, using the fact that $\pi(d) = (1 + \kappa + \chi d)\breve{\pi}(d)$ to substitute out $\pi'(d) = (1 + \kappa + \chi d)\breve{\pi}'(d) + \chi\breve{\pi}(d)$.

[16] Under the parameter assumptions of Sec. 3.1, including *moderate inflation aversion*, we have $0 < \gamma < 1$. It can also be shown, under weak assumptions, that $\frac{\partial \pi}{\partial d} > 0$. Therefore these additional terms in the Euler equation reduce inflation growth.

with public services at price $q^H > q^L$.

The relation between inflation, public spending, and output would then be

$$\bar{\hat{g}}_t = -\frac{\alpha_{\pi C} q_H}{\alpha_{gS}} \breve{\pi}_t, \tag{38}$$

$$\bar{\hat{x}}_t = -\frac{\alpha_{\pi C}}{\nu} \breve{\pi}_t. \tag{39}$$

Comparing with the corresponding relations for the monetary union, (12) and (31), (38)-(39) show that the relation between inflation and output is unchanged, but that for any given level of inflation and debt, the distance of government services from their bliss point is increased.

Summarizing, the dynamics are analogous to (35)-(36), except that they now refer to average debt over the whole union.

$$\bar{d}_t = R(\bar{d}_{t-1})\bar{d}_{t-1} - \breve{\kappa}^G(\bar{d}_{t-1})\breve{\pi}_t + \bar{\tilde{z}}_t^G, \tag{40}$$

$$\breve{\pi}_t = \beta_G E_t \left(R(\bar{d}_t) + R'(\bar{d}_t)\bar{d}_t + \left(\gamma + \chi \frac{\alpha_{\pi G}}{\alpha_{\pi C}} \right) \frac{\partial \pi_{t+1}}{\partial \bar{d}_t} \right) \breve{\pi}_{t+1}, \tag{41}$$

The other difference from scenario I is that these equations reflect more expensive public services, which changes the coefficients in the equations as follows:

$$\breve{\kappa}^G(\bar{d}_{t-1}) \equiv \kappa(1 + \kappa + \chi \bar{d}_{t-1}) + \frac{\alpha_{\pi C}}{\alpha_{gS}} \left(q_H^2 + \frac{\alpha_{gG}}{\nu^2} \right), \tag{42}$$

$$\bar{\tilde{z}}_t^G \equiv J^{-1} \sum_j \left(\nu^{-1}(\tilde{x}_{j,t} - \underline{x}_{j,t}) + q_H \tilde{g}_{j,t} \right). \tag{43}$$

Scenario Fj: Delegation to regional fiscal authorities

While a federal government would avoid some aspects of the deficit bias that plagues a monetary union, establishing such a government seems a very distant prospect in Europe today. Just to mention a few of the most critical problems involved, setting up a central or federal government for Europe would require (1) convincing local politicians to give up power in favor of new central institutions; (2) harmonizing local laws and constitutions sufficiently to permit European governance; and (3) finding ways to efficiently address local decisions via central or federal institutions. Even if these challenges could be overcome (probably very slowly) from a technical perspective, establishing legitimacy of new European institutions would remain (insurmountably?) difficult, all the more so as nationalism has grown with recent crises.

This motivates us to ask whether delegation of fiscal instruments might serve as a shortcut to achieving credible long-run debt sustainability, avoiding many of the dilemmas listed above. Delegating just one (or a few) fiscal instruments might have a

very large impact on budget balance, but would involve less surrender of power by local politicians than the establishment of a federal government. Relatively fewer changes to laws and constitutions would be required, and most local fiscal decisions would remain under local control. Therefore, we now analyze the macroeconomic implications of some policy games involving delegated fiscal powers.

First, we consider region-specific delegation. Concretely, we consider policy games in which the central bank chooses inflation for the union, and regional governments choose taxes and allocate public spending, but the choice of how much debt to issue is delegated to an independent regional fiscal authority F_j. The overall quantity of local public spending is treated as a residual variable; thus the instrument assignments are given by $\Theta_t^C \equiv \{\pi_t, \{g_{j,t}\}_{j=1}^J\}$, $\Theta_t^{G_j} \equiv \{\tau_{jt}, g_{j,t}\}$, and $\Theta_t^{F_j} \equiv \{d_{jt}, g_{j,t}\}$. That is to say, the amount of money spent by government G_j is only partly under its control (through its choice of taxes), but the allocation of these funds across different uses is left entirely in its hands.

In analogy with our assumption about the preferences of an independent central bank, we assume that a mandate to avoid excessive debt causes the fiscal authority to act as if it dislikes debt more than society as a whole. In the case of the central bank, this means that the loss parameter on inflation is larger for the central bank than it is for society; in the case of the fiscal authority, this means that the loss parameter α_{dF} on debt is strictly positive, whereas for society it is zero.

As in scenario MU, analysis is greatly simplified by considering a symmetric equilibrium with many small countries. Formally, assuming all countries are symmetric and $J = \infty$ implies that each country is infinitesimal, so it ignores the impact of its own debt on interest rates, inflation, and other countries' debt. Then the Euler equation is

$$\hat{g}_{j,t} + \frac{q_L \alpha_{dF}}{\alpha_{gF}} d_{j,t} \;=\; \beta_F R(\bar{d}_t) E_t \hat{g}_{j,t+1}. \tag{44}$$

Assuming a symmetric equilibrium, we can then rewrite the dynamics in terms of inflation and average debt:

$$\bar{d}_t \;=\; R(\bar{d}_{t-1})\bar{d}_{t-1} - \breve{\kappa}(\bar{d}_{t-1})\breve{\pi}_t + \bar{\tilde{z}}_t \tag{45}$$

$$\breve{\pi}_t \;=\; \frac{\alpha_{dF}}{\alpha_{\pi C}} \bar{d}_t + \beta_F R(\bar{d}_t) E_t \breve{\pi}_{t+1} \tag{46}$$

where $\bar{d}_t$, $\breve{\kappa}(d_{t-1})$ and $\bar{\tilde{z}}_t$ were defined earlier, and we have simplified using the restrictions from Table 1. Comparing (32)-(34), the equilibrium system for scenario MU, with (45)-(46), we see two effects of the fiscal authority that inhibit inflation growth. First, for a given $\bar{d}_t$, inflation grows more slowly in the presence of the fiscal authority if the government is less patient than the fiscal authority ($\beta_G < \beta_F$). Second, inflation

grows more slowly in the presence of the fiscal authority whenever $\bar{d}_t > 0$, as long as the fiscal authority dislikes debt ($\alpha_{dF} > 0$).

Scenario F: Delegation to a union-wide fiscal authority

Rather than delegating debt issuance to a fiscal authority F_j within each region, a possibly better alternative might be to delegate the issuance of each country's debt to a single authority F established for the union as a whole. Such an authority would have an incentive to take externalities across regions into account. In this case, the dynamics are given by

$$\bar{d}_t = R(\bar{d}_{t-1})\bar{d}_{t-1} - \breve{\kappa}(\bar{d}_{t-1})\breve{\pi}_t + \bar{\tilde{z}}_t, \tag{47}$$

$$\breve{\pi}_t = \frac{\alpha_{dF}}{\alpha_{\pi C}}\bar{d}_t + \beta_F E_t \left(R(\bar{d}_t) + R'(\bar{d}_t)\bar{d}_t + \left(\gamma + \chi\frac{\alpha_{\pi G}}{\alpha_{\pi C}}\right)\frac{\partial \pi_{t+1}}{\partial \bar{d}_t}\right)\breve{\pi}_{t+1}. \tag{48}$$

These equations are simplified using the parameter assumptions in Table 1; $\bar{d}_t$, $\tilde{\kappa}(d_{t-1})$, $\bar{\tilde{z}}_t$, and γ were defined earlier.

This system combines two properties we have seen before. Like a model with fiscal authorities at the regional level, debt slows down inflation growth, as long as the fiscal authority is debt averse ($\alpha_{dF} > 0$). But in addition, inflation growth is affected by the impact of debt on the interest rate (R') and on inflation ($\frac{\partial \pi_{t+1}}{\partial \bar{d}_t}$), because the union-wide fiscal authority knows it can alter aggregate debt, just as the government did in scenario I. Since inflation responds positively to a rise in debt, and the central bank is assumed to exhibits moderate inflation aversion (implying $\gamma > 0$), inflation growth is further reduced in this scenario, compared with scenario Fj.

3.3.2 Results

Parameters

The calculations reported in this version of our paper are based on a preliminary parameterization. Our numerical simulations serve to illustrate qualitatively the mechanisms at work in our model, but should not yet be compared quantitatively to macroeconomic data. Soon we intend to parameterize this reduced form model so that variables can be given a clear quantitative interpretation; in the future we also hope to study the same mechanisms in a DSGE model calibrated or estimated for consistency with a Eurozone periphery economy.

Our parameters are set to obey the restrictions stated in Section 3.1. In our simulations, the social welfare function is characterized by $\alpha_{gS} = 1$ and $\alpha_{\pi S} = 20$; the large value of the latter variable is necessary to avoid very large fluctuations of inflation in

equilibrium. The "natural" level of output, $\underline{x}$, is set to one. We explore two parameterizations for the bliss points: $\tilde{g} = \tilde{x} = 10$ and $\tilde{g} = \tilde{x} = 3$, in order to compare behavior when the economy is far from or near to the bliss point. Results are qualitatively similar in both cases; graphs shown assume the former calibration. The utility discount rate is $\beta_S = 0.98$, and the responsiveness of world interest rates to debt is $\delta = 0.03$ (the interest premium rises by three percentage points when debt equals 100% of GDP).

Other macroeconomic parameters include $\nu = 1$ (a one percent rise in taxes lowers output by one percent), $\kappa = 0.1$ (a one percentage point rise in inflation generates seignorage revenues equal to 0.1 percent of output), and $\chi = 0.5$ (half of debt is nominal). The price of public spending is $q^L = 1$ if allocated locally, and $q^H = 1.5$ if allocated by the central government.

Policy makers are characterized by the discount rates $\beta_G = 0.9$ (for the government), and $\beta_F = 0.95$ (for the fiscal authority). Inflation aversion is given by $\alpha_{\pi G} = \alpha_{\pi F} = \alpha_{\pi S}$, but $\alpha_{\pi C} = 3\alpha_{\pi S}$: the central bank dislikes inflation three times as much as society does. All policy makers value public spending equally: $\alpha_{gG} = \alpha_{gF} = \alpha_{gC} = \alpha_{gS}$. The fiscal authority is the only policy maker that explicitly dislikes debt; $\alpha_{dG} = \alpha_{dC} = \alpha_{dS} = 0$, but $\alpha_{dF} = 1$.

Policy functions

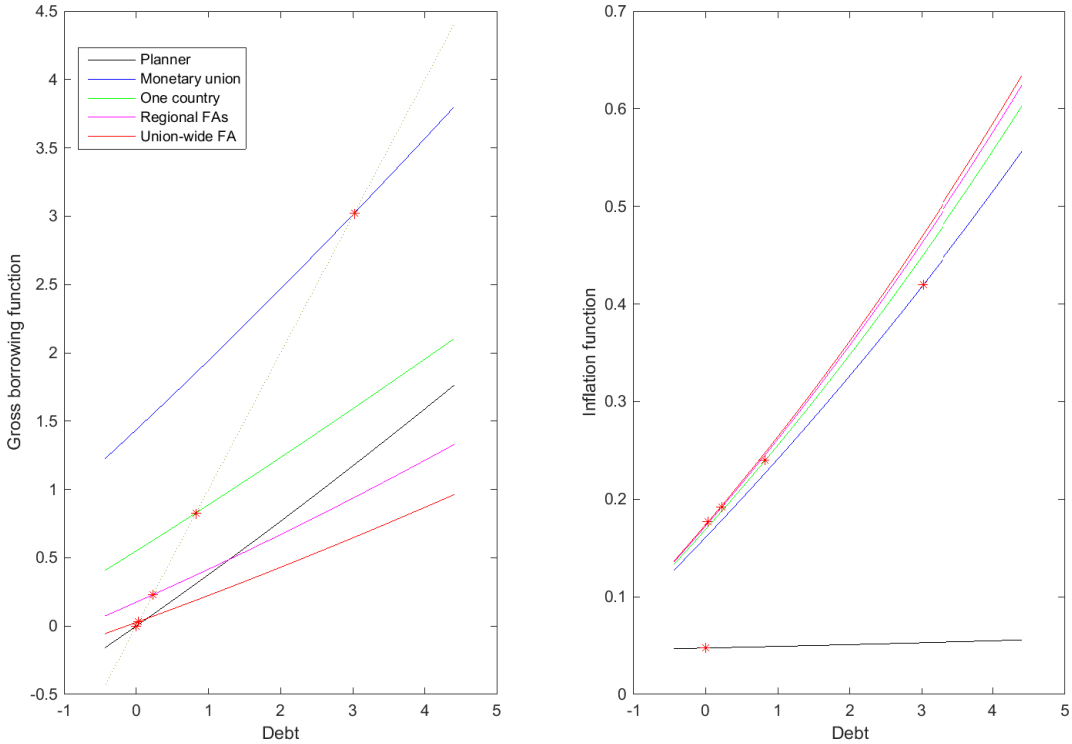
We characterize the behavior of each scenario $\mathcal{S}$ by calculating the nonlinear policy functions $d_t = B^{\mathcal{S}}(d_{t-1}, \epsilon_t)$ and $\pi_t = I^{\mathcal{S}}(d_{t-1}, \epsilon_t)$ consistent with the Euler equations derived from that scenario. In this subsection we report the results for two specifications: a nonstochastic version, and a stochastic version in which public spending demand varies according to

$$\tilde{g}_{jt} \;=\; \tilde{g}(1 + \epsilon_t). \tag{49}$$

Note that the public spending demand shock ϵ_t affects all regions j symmetrically; the shocks is assumed to have mean zero, standard deviation 0.02 and autocorrelation 0.7. The nonstochastic specification can be computed by assuming that ϵ_t has mean, variance, and autocorrelation zero, or by dropping ϵ_t entirely from the model so that the policy functions depend on debt only. We have run the calculations both ways, and obtained virtually identical results.

Figure 1 shows the policy functions under the nonstochastic specification, for scenarios P (black), MU (blue), I (green), Fj (magenta), and F (red). Since our planning scenario lacks any source of nondistortionary financing, the planner chooses nonzero inflation ($\pi^P_{ss} = 0.047$ at the planner's steady state $d^P_{ss} = 0$). This low level of inflation trades off marginal losses due to inflation against those due to distortionary taxes, as

Figure 1: *Borrowing and inflation policies. Comparing institutional scenarios*



Notes: Comparing policy functions across institutional scenarios, assuming debt is a control variable.
Left: Gross borrowing: debt d_t as a function of d_{t-1}.
Right: Inflation π_t as a function of d_{t-1}.
Black: planner. Blue: monetary union. Green: one country. Magenta: regional FAs. Red: Union-wide FA. Red stars: steady states.

well as the losses from failing to reach the bliss points in private and public consumption. The planner's inflation policy is extremely flat as a function of debt, with a barely perceptible rise in the graph. The borrowing function $d_t = B^P(d_{t-1})$ has a slope of roughly 0.4. That is, when the current debt level is one percentage point higher, 0.6 percentage points are paid off within one period, while 0.4 percentage points are carried over to the next period. Thus, the planner displays a moderate degree of smoothing of distortions over time.

Given the multiple forms of inflation bias and deficit bias present in the monetary union, scenario MU (blue) displays much higher borrowing and inflation than the planner's solution. Even at zero debt, the monetary union has higher inflation than the planner does ($I^{MU}(0) \approx 0.15$), since the central bank of the monetary union is tempted to achieve higher private and public spending, and lower debt, by creating surprise inflation (in equilibrium, of course, this surprise does not occur). The incentive to create surprise inflation increases strongly with the level of debt, so the inflation policy

function has a strong positive slope in the monetary union, unlike the flat policy seen for the planner. Also, the government of the monetary union prefers to delay distortions, compared with the planner; while the slope of the borrowing functions is similar in the two cases, the level of the monetary union borrowing function $B^{MU}(d)$ is much higher than the planner's borrowing function $B^P(d)$. Therefore steady state debt in the monetary union (where the borrowing function crosses the 45° line shown in the graph) is much higher: $d_{ss}^{MU} = 3.023$, compared with $d_{ss}^P = 0$, with correspondingly higher steady state inflation $\pi_{ss}^{MU} = 0.42$. (See the top panel of Table 2 for the numbers.)

The other institutional scenarios considered in Figure 1 reduce the policy biases that affect the monetary union, and thereby achieve lower inflation and lower debt. In scenario I, the single government prefers to accumulate less debt than the governments in scenario MU, because it recognizes that greater debt forces it to pay a higher interest rate, and worsens the central bank's temptation to create surprise inflation. Therefore curve $B^I(d)$ lies substantially below $B^{MU}(d)$, and steady state debt falls from 3.023 in the monetary union to $d_{ss}^I = 0.829$ in the single economy. Conditional on any given level of debt, equilibrium inflation is actually slightly higher in scenario I (apparently because the central bank recognizes that its inflation bias is slightly less damaging in this scenario than it is in the monetary union). Nonetheless, because steady state debt is so much lower, steady state inflation is also lower: $\pi_{ss}^I = 0.24$, down from 0.42 in the monetary union.

In scenario Fj, the regional fiscal authorities in the monetary union accumulate less debt than the governments do in scenario MU, because the fiscal authorities are more patient and because they dislike debt. Therefore again, $B^{Fj}(d)$ lies below $B^{MU}(d)$, implying much lower debt, $d_s^{Fj}s = 0.229$.[17] While the inflation policy $I^{Fj}(d)$ lies (slightly) above $I^I(d)$ and $I^{MU}(d)$, the lower steady state debt under regional fiscal authorities again lowers inflation, to $\pi_{ss}^I = 0.192$.

Finally, scenario F combines the debt-reducing incentives of scenarios I and F_j. Like the regional fiscal authorities, a union-wide fiscal authority is less impatient than national governments, and dislikes debt accumulation (the weights on *per capita* debt in the loss functions of the regional and union-wide fiscal authorities are assumed equal). Like a single government (but unlike the regional authorities), the union-wide fiscal authority internalizes the effect of its debt on the interest rate and on central bank behavior (the effects of *per capita* debt on the interest rate and on central bank preferences are assumed to be the same in scenario F that they are in scenario I). Therefore, the borrowing function in scenario F lies below $B^I(d)$ and $B^{Fj}(d)$, which

[17]The fact that $B^{Fj}(d)$ lies below $B^I(d)$ is calibration-specific; it is not a general result.

Table 2: *Debt, inflation, and welfare in scenarios $\mathcal{S}$ where debt is a control variable**

Debt $\bar{d}^{\mathcal{S}}_{ss}$	Inflation $\pi^{\mathcal{S}}_{ss}$	Welfare $W^{\mathcal{S}}_{ss}$	Crisis cost* $W^{\mathcal{S}}(d^{\mathcal{S}}_{ss}, \epsilon^g_0) - W^{\mathcal{S}}_{ss}$	Crisis cost* controlling for debt $W^{\mathcal{S}}(0, \epsilon^g_0) - W^{\mathcal{S}}(0, 0)$
Temporary shocks (autocorrelation 0)				
Scenario P: Planner				
0	0.047	−4511.4	-1.91	-1.91
Scenario I: single country with independent central bank				
0.829	0.240	−4547.7	-1.99	-1.93
Scenario MU: status quo monetary union				
3.023	0.420	−4741.3	-2.44	-2.14
Scenario Fj: Monetary union with regional fiscal authorities				
0.229	0.192	−4524.8	-1.93	-1.92
Scenario F: Monetary union with union-wide fiscal authority				
0.033	0.177	−4520.1	-1.92	-1.92
Correlated shocks (autocorrelation 0.7)				
Scenario P: Planner				
0	0.047	−4512.3	-6.05	-6.05
Scenario I: single country with independent central bank				
0.828	0.240	−4548.7	-6.17	-6.09
Scenario MU: status quo monetary union				
3.022	0.420	−4742.4	-6.88	-6.51
Scenario Fj: Monetary union with regional fiscal authorities				
0.229	0.192	−4525.8	-6.09	-6.07
Scenario F: Monetary union with union-wide fiscal authority				
0.033	0.177	−4521.0	-6.07	-6.07

* "Crisis" refers to a two-percent rise in public goods demand at time 0, $\epsilon^g_0 = 0.02$.

both lie below $B^{MU}(d)$. The resulting steady state debt level is $d^F_{ss} = 0.033$, almost as low as that in the social planner's problem.[18]

Besides debt and inflation, Table 2 also reports steady-state social welfare $W^{\mathcal{S}}_{ss}$ in each scenario $\mathcal{S}$. The planner's solution has the highest steady-state welfare $W^P_{ss} = -4511.4$, both because it has the lowest steady-state debt and because it represents the policy that optimizes social welfare, given debt. We have also seen that the scenarios with higher steady-state debt have higher steady-state inflation. In all the market-based scenarios (MU, I, Fj, and F), inflation is linked to public and private spending by (11) and (31); hence the scenarios with higher inflation also have larger gaps of public and private spending from their bliss points. Therefore the ranking of social welfare across the market-based scenarios is the opposite of their debt ranking: $W^{MU}_{ss} < W^I_{ss} < W^{Fj}_{ss} < W^F_{ss}$, reflecting higher inflation and lower public and private spending in the highest-debt scenarios.

Another notable difference in the policy functions across scenarios is that the borrowing function $B^{\mathcal{S}}(d)$ becomes much less steeply sloped in the presence of a fiscal authority. The slope of the borrowing function is roughly the same in the monetary union as it is in the planner's solution: when current debt rises by 1%, the next period's debt rises by roughly 0.4% both in the planner's solution and in the monetary union. In contrast, under a fiscal authority, there is substantially less intertemporal smoothing; the slope of the borrowing function is reduced to approximately 0.2. That is, of any marginal increase in debt, roughly 80% is paid off in one period. Hence, while steady-state welfare is greatly improved in the presence of a fiscal authority, compared with the *status quo* monetary union, the intertemporal welfare difference between scenarios MU, Fj, and F is much less obvious if we compare them starting from the same level of debt. In other words, starting from the steady state of the monetary union scenario, introducing a fiscal authority would imply a transition path with considerable "austerity". To better understand the dynamic welfare comparisons across various institutional scenarios, we next study impulse responses to public spending demand shocks, and transition paths starting from different levels of debt.

Impulse response functions

Figure 2 compares impulse responses to a temporary shock to the demand for public spending across scenarios P (black with squares), MU (blue with crosses), I (green

[18] As we discussed in Basso and Costain (2016), steady state debt in scenario Fj can be proved higher than steady state debt in the planner's solution, and steady state debt in scenario F is lower than that in scenario Fj. But the ranking of debt between scenarios P and F is ambiguous: a union-wide fiscal authority may actually choose a steady-state debt level that is inefficiently *low* compared with the social planner.

with "x"), Fj (magenta with diamonds), and F (red with dots). We think of an increase in the demand for public spending as a reasonable description of recent crises in Europe and other advanced economies, where large amounts of state funds were used to recapitalize banking systems, in an effort to avoid a major contraction of credit supply to the private sector.

Concretely, Figure 2 supposes a 2% increase in $\tilde{g}_{j,t}$ (from 10 to 10.2) at time 2 (the initial steady state of the model is shown at time 1, for reference).[19] The variance and autocorrelation of the shock are assumed to be zero (as in the upper panel of Table 2), so this represents an unanticipated, zero-probability event that is believed to be purely temporary. The impulse response functions are shown in levels (top four panels) and in differences from the steady state of each specification (bottom six panels).

Under the planner's solution (black), government spending rises from approximately 0.5 to 0.65 at the time of the shock; thus, the planner accomodates three-quarters of the rise in public spending demand. To finance this increase, debt rises from $d_1 = d_{ss} = 0$ to $d_2 = 0.07$, postponing roughly half of the cost of the increased spending to the future. Note that since debt levels vary greatly across specifications, the top, left panel is shown with a break in the vertical direction. To better see the magnitude of the change in debt, it is easier to view the impulse responses in deviations from steady state (third row, first panel). The inflation rate is virtually unchanged. Since tax distortions decrease output, and public spending falls further below its bliss point, compared to steady state, the flow of utility falls from -90.2 to -91.5 when the shock hits.

Turning to the monetary union scenario, we see again that most of the rise in public demand is accomodated. The rise in public spending is similar to that of the planner's problem, and the rise in debt is slightly larger, from 3.02 to 3.11. However, in this case there is less reliance on increased taxation, so the fall in output is slightly smaller (by 0.05) than it is in the planner's problem (where output falls by 0.06). Instead, there is a substantial increase in seignorage, with inflation rising by 0.002 on impact and by 0.009 thereafter in response to the rise in debt. Thus, as in the planner's problem, the monetary union succeeds in postponing much of the utility cost of the rise in public spending demand; the fall in utility on impact is similar. But although the costs are similar on impact, the medium-term impact of the shock is much more costly to the monetary union. Debt returns more slowly to its initial level in the monetary union (in spite of the rise in inflation), and thus we see a much more persistent loss in utility in the case of the monetary union than in the planner's solution. This can be seen

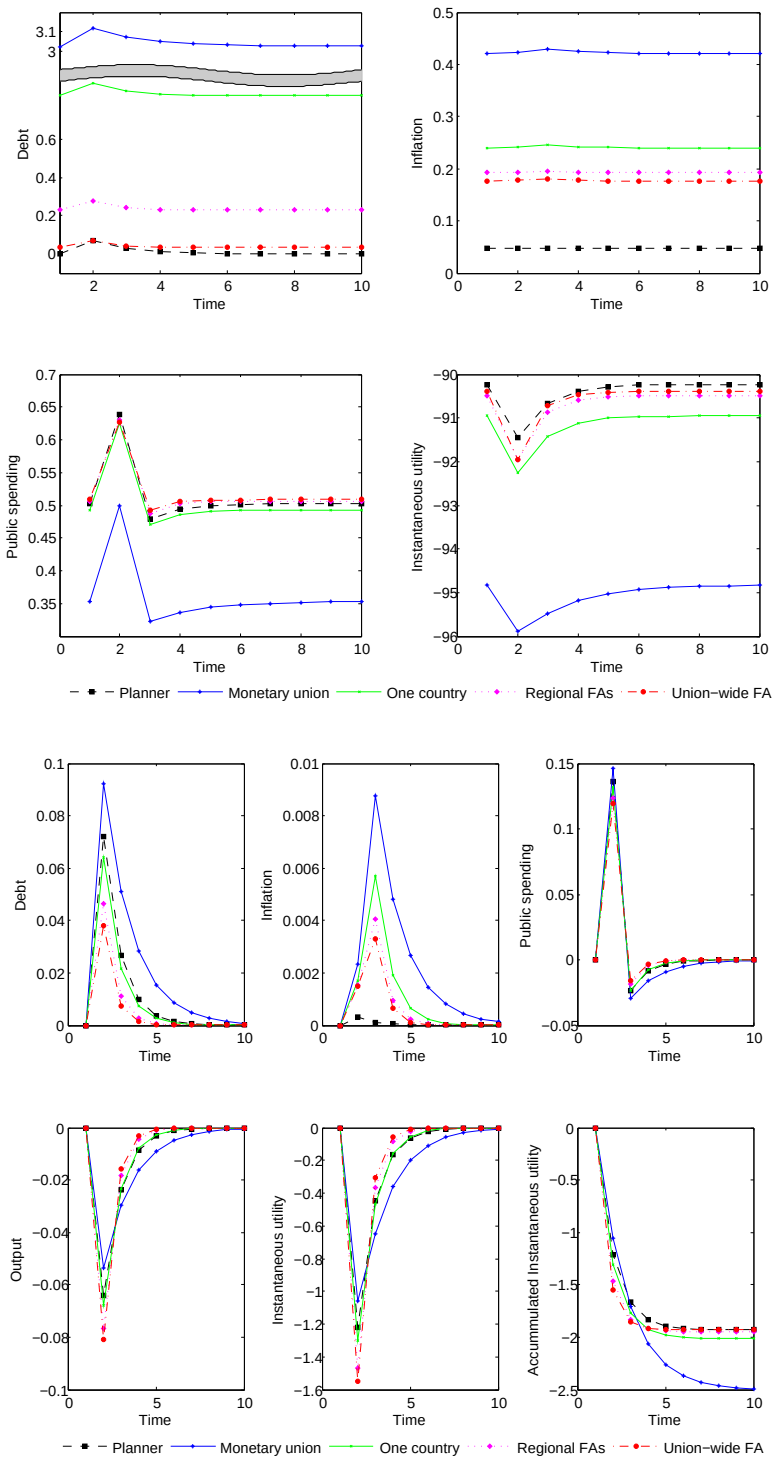
[19]This is a large shock. Since the bliss point $\tilde{g}$ is far above equilibrium public spending, fully accomodating this demand shock (raising spending by 0.2) would represent a large percentage increase in public spending.

especially clearly in the last two graphs of the fourth row– the first shows the deviation in utility from its steady state level, and the second cumulates this utility loss over time. While the utility loss in the monetary union is smaller on impact than it is in the planner's solution, the ranking is reversed in the following period; the persistent utility losses in the monetary union scenario eventually cumulate to a total utility loss of roughly 2.5, while in the planner's solution the cumulated losses are less than 2.

Thus, scenarios MU and P both accomodate a large part of the rise in public spending demand, and they both smooth out the financing over time. On the other hand, the impulse responses in scenario MU are also suggestive of inflation bias and deficit bias, since the increase in inflation is much larger than that chosen by the planner, and since the rise in debt is quite persistent over time. Therefore, it is interesting to compare these responses to those in the fiscal delegation scenarios (magenta and red lines). Under fiscal delegation, we see that public spending rises slightly less on impact than it does in scenario MU and in the planner's solution. The more notable difference, compared with scenario MU, is a much smaller increase in inflation and debt. Hence, in order to finance the increased spending, the fiscal delegation scenarios rely on a larger increase in taxes, implying that output falls more (it decreases by 0.08 under fiscal delegation, instead of only 0.05 in scenario MU). Thus, instantaneous utility falls more on impact under fiscal delegation than it does in the other scenarios considered. Nonetheless, by absorbing more of the cost on impact, instantaneous utility is already higher than that in scenarios MU and P in the period after the shock. And if we compare the cumulated utility cost associated with the demand shock, the overall loss under the fiscal delegation scenarios is virtually indistinguishable from that in the planner's solution, and is much less than the cumulated loss in scenario MU. In other words, while the austerity of the fiscal authorities is painful on impact, this is compensated by a rapid recovery of utility, and in intertemporal terms the fiscal authorities perform almost as well as the social planner.

These welfare conclusions are also reported in Table 2. The fourth column reports the welfare impact of a two percent rise in public spending demand, starting from steady state, in each scenario. That is, it reports $W^{\mathcal{S}}(d_{ss}^{\mathcal{S}}, \epsilon_0^g) - W^{\mathcal{S}}(d_{ss}^{\mathcal{S}}, 0)$ for each scenario $\mathcal{S}$, where $\epsilon_0^g = 0.02$. As expected, the intertemporal welfare loss is smallest in the social planner's solution. But strikingly, even though we have seen that output falls much more sharply on impact in the fiscal delegation scenarios than it does in the monetary union scenario, the intertemporal welfare cost of the shock is only slightly larger under fiscal delegation (1.92 or 1.93 in scenarios Fj and F, compared with 1.91 in the planner's solution). The smoother but more persistent fall in output that occurs

Figure 2: *Temporary public demand shock. Comparing institutional scenarios.*



Notes: Impulse responses of debt, inflation, government spending, and instantaneous utility to a temporary 2% increase in the public spending bliss point $\tilde{g}$, assuming debt is a control variable.
Top four panels: levels. (Note scale break in debt graph.)
Bottom six: deviations from steady state, showing also output and cumulated utility.

in scenario MU (together with a larger increase in inflation) turns out to be much more costly, representing a loss of 2.44.

A caveat here is that these calculations have all been performed at the steady states corresponding to each scenario. Steady state debt and inflation are much higher in scenario MU, and steady state public and private consumption is correspondingly lower. Therefore, the marginal cost of the same fluctuation in π, $\hat{g}$, or $\hat{x}$ is higher in the *status quo* monetary union than it is in the other scenarios. To control for this difference, the fifth column of Table 2 reports the cost of a public spending demand shock, starting all institutional scenarios from the same debt level. Concretely, we start all calculations from the planner's steady state debt level ($d^P_{ss} = 0$), so the welfare impact that we report is $W^{\mathcal{S}}(0, \epsilon^g_0) - W^{\mathcal{S}}(0, 0)$, with $\epsilon^g_0 = 0.02$. As expected, hitting the monetary union with the same shock, starting from a lower level of debt, implies a lower welfare cost (the welfare loss decreases from 2.44 to 2.14, since we are starting the perturbation at a point where the loss terms are less convex). Nonetheless, even in this case the welfare cost of the shock is largest in scenario MU, compared with the other scenarios. In other words, in intertemporal terms, the "austere" policies of the fiscal authority are not very costly. Even though the utility cost is smallest on impact in scenario MU, the fact that the fiscal authorities offset the inflation bias and deficit bias in the MU scenario is highly beneficial, bringing the welfare cost of demand shocks down almost as low as it is in the planner's solution.

Autocorrelated demand shocks

So far we have only considered temporary, zero-probability shocks to government spending. Next, we study a stochastic version of the model, in which ϵ^g has standard deviation 0.02 and autocorrelation 0.7.

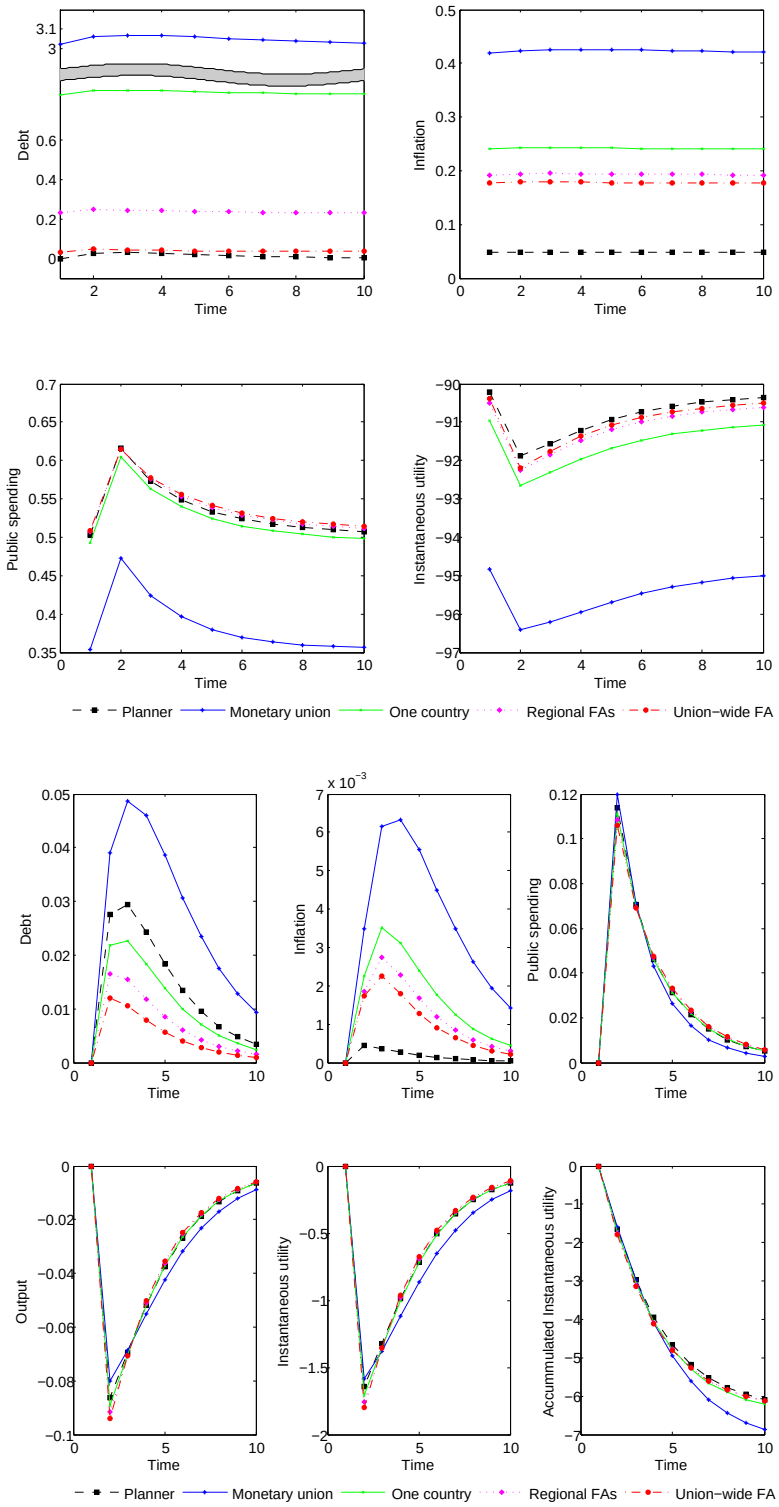
Results are reported in the lower panel of Table 2, with impulse responses shown in Figure 3. Our conclusions from the previous specification are qualitatively unchanged.

The difference in welfare $W^{\mathcal{S}}_{ss}$ between the top and bottom halves of Table 2 can be taken as a measure of the welfare cost of fluctuations, from an *ex ante* perspective. Notice that the welfare cost of fluctuations is largest in scenario MU, reduced in the fiscal delegation scenarios, and smallest in scenario P.

3.4 Games with debt as a residual

We now consider policy environments in which debt is the residual variable that ensures the budget constraint holds, while government expenditure, inflation and taxes are directly controlled by policy makers.

Figure 3: *Autocorrelated public demand shock. Comparing institutional scenarios.*



Notes: Impulse responses of debt, inflation, government spending, and instantaneous utility to a 2% increase in the public spending bliss point $\tilde{g}$ (autocorrelation 0.7), assuming debt is a control variable. Top four panels: levels. (Note scale break in debt graph.)
Bottom six: deviations from steady state, showing also output and cumulated utility.

3.4.1 Institutional scenarios

Scenario MUdr: Status quo model of a large monetary union, with debt as a residual

We start by looking at a large monetary union, with a single central bank that chooses inflation π_t for the whole union, while J regional governments G_j each choose regional taxes τ_{jt} and government expenditure g_{jt}. d_{jt} is then given by the budget constraint (3). Thus, the central bank's choice set is $\Theta_t^C \equiv \{\pi_t, \{d_{j,t}\}_{j=1}^J\}$, and government j's choice set is $\Theta_t^{G_j} \equiv \{\tau_{jt}, d_{jt}, g_{j,t}\}$. As before all policy makers act under discretion. So while policy makers take π_t^e as given, nonetheless in equilibrium $\pi_t = \pi_t^e$ at all times. As long as $\alpha_{gG} = \alpha_{gS}$, the government trades off output versus public spending according to (11), just as the OCCPP planner does. While before the central bank while being incapable of committing traded off inflation against public spending, possibly boosting output, it now faces the direct incentive to trade-off inflation to decrease the level of debt governments carry forward, influencing inflation and output in the future. The government maximization condition then is given by the following Euler equation

$$\begin{aligned}\alpha_{\pi C}\pi_t + \nu\bar{\hat{x}}_t &= \beta_S \frac{\chi\bar{d}_{t-1}+\kappa}{\chi\bar{d}_t+\kappa}\Bigg[(\alpha_{\pi C}\pi_{t+1}+\nu\bar{\hat{x}}_{t+1})(R(d_t)+R'(d_t)d_t) + \\ &\quad + \left(\frac{1}{\nu}+\frac{q_L^2\nu}{\alpha_{gC}}\right)(\alpha_{\pi C}\pi_{t+1}+(1+\chi\bar{d}_t+\kappa)\nu\bar{\hat{x}}_{t+1})\frac{\partial\bar{x}_{t+1}}{\partial d_t} + \\ &\quad +(\chi\bar{d}_t\alpha_{\pi C}\pi_{t+1}-\nu\bar{\hat{x}}_{t+1})\frac{\partial\pi_{t+1}}{\partial d_t}\Bigg] \qquad (50)\end{aligned}$$

Next, consider the Euler equation that governs fiscal policy over time. We continue focusing on the limit of a large monetary union ($J = \infty$) in which each individual country is infinitesimal. In this case, government j ignores all the spillovers from its decisions, and the region-j Euler equation simplifies to

$$\hat{x}_{j,t} = \beta_G R(\bar{d}_t) E_t \hat{x}_{j,t+1}. \qquad (51)$$

The symmetric solution of this scenario can be characterized by three policy functions: a gross borrowing function $\bar{d}_t = B^M(\bar{d}_{t-1}, \epsilon_t)$, an inflation function $\pi_t = I^M(\bar{d}_{t-1}, \epsilon_t)$, an output function $\bar{x}_t = X^M(\bar{d}_{t-1}, \epsilon_t)$, and their derivative with respect to the first term, denoted by $\frac{\partial I^M(\bar{d}_{t-1},\epsilon_t)}{\partial \bar{d}_{t-1}} = I'(\bar{d}_{t-1}, \epsilon_t)$, and $\frac{\partial X^M(\bar{d}_{t-1},\epsilon_t)}{\partial \bar{d}_{t-1}} = X^M(\bar{d}_{t-1}, \epsilon_t)$. Also define $\hat{X}^M(\bar{d}_{t-1}, \epsilon_t) \equiv \bar{x}_t - \bar{\tilde{x}}_t$. Using the fact that $R(d) + R'(d)d = \beta_S^{-1} + 2\delta d$, we can write the equilibrium conditions in terms of the policy functions as follows:

$$B^M(\bar{d}_{t-1},\epsilon_t) = (\beta_S^{-1}+\delta\bar{d}_{t-1})\bar{d}_{t-1} + \left(\frac{1}{\nu}+\frac{q_L^2\nu}{\alpha_{gC}}\right)\hat{X}^M(\bar{d}_{t-1},\epsilon_t) - \kappa I^M(\bar{d}_{t-1},\epsilon_t) + \bar{\tilde{z}}_t, \tag{52}$$

$$\hat{X}^M(\bar{d}_{t-1},\epsilon_t) = \beta_G\left(\beta_S^{-1}\right)E_t\hat{X}^M(B^P(\bar{d}_{t-1},\epsilon_t),\epsilon_{t+1}) \tag{53}$$

and

$$\begin{aligned}
&\alpha_{\pi C}I^M(\bar{d}_{t-1},\epsilon_t)+\nu\hat{X}^M(\bar{d}_{t-1},\epsilon_t) = \\
&=\beta_S\frac{\chi\bar{d}_{t-1}+\kappa}{\chi B^M(\bar{d}_{t-1},\epsilon_t)+\kappa}\Bigg[(\alpha_{\pi C}I^M(B^M(\bar{d}_{t-1},\epsilon_t),\epsilon_{t+1})+\nu\hat{X}^M(B^M(\bar{d}_{t-1},\epsilon_t),\epsilon_{t+1}))\left(\beta_S^{-1}+2\delta B^M(\bar{d}_{t-1},\epsilon_t)\right)+ \\
&\quad+\left(\frac{1}{\nu}+\frac{q_L^2\nu}{\alpha_{gC}}\right)(\alpha_{\pi C}I^M(B^M(\bar{d}_{t-1},\epsilon_t),\epsilon_{t+1})+(1+\chi B^M(\bar{d}_{t-1},\epsilon_t)+\kappa)\nu\hat{X}^M(B^M(\bar{d}_{t-1},\epsilon_t),\epsilon_{t+1}))X'(B^M(\bar{d}_{t-1},\epsilon_t),\epsilon_{t+1})+ \\
&\quad+(\chi\bar{d}_t\alpha_{\pi C}I^M(B^M(\bar{d}_{t-1},\epsilon_t),\epsilon_{t+1})-\nu\hat{X}^M(B^M(\bar{d}_{t-1},\epsilon_t),\epsilon_{t+1}))I'(B^M(\bar{d}_{t-1},\epsilon_t),\epsilon_{t+1})\Bigg]
\end{aligned} \tag{54}$$

We then solve the functional equations, approximating the policy functions and their respective derivative using Chebyshev polynomials and the expectation term employing a Gauss-Hermite quadrature.

Scenario Fjdr: Delegation of the tax rate to regional fiscal authorities, with debt as a residual

We now consider a policy game in which the central bank chooses inflation for the union, while regional governments choose public spending, but the decision of the level of taxes is decided by an independent regional fiscal authority F_j. Debt is treated as a residual by all policy makers, as such $\Theta_t^C \equiv \{\pi_t\{d_{j,t}\}_{j=1}^J\}$, $\Theta_t^{G_j} \equiv \{g_{j,t}, d_{j,t}\}$, and $\Theta_t^{F_j} \equiv \tau_{jt}, d_{jt}\}$. As in the previous policy game, we considering a symmetric equilibrium with many small countries.

The central bank decision problem is the same as the case of the monetary union without fiscal delegation but given that taxes and spending are set by different policy makers the trade off between output versus public spending used in all cases before (11) no longer holds, as such, the central bank Euler equation is given by

$$\begin{aligned}
\alpha_{\pi C}\pi_t+\nu\bar{\hat{x}}_t &= \beta_S\frac{\chi\bar{d}_{t-1}+\kappa}{\chi\bar{d}_t+\kappa}\Bigg[(\alpha_{\pi C}\pi_{t+1}+\nu\bar{\hat{x}}_{t+1})(R(d_t)+R'(d_t)d_t)+ \\
&\quad+(\alpha_{gC}\bar{\hat{g}}_{t+1}(1+\chi\bar{d}_t)+q_L(\alpha_{\pi C}\pi_{t+1}+\nu\bar{\hat{x}}_{t+1}))\frac{\partial\bar{\hat{g}}_{t+1}}{\partial d_t}+ \\
&\quad+\left(\frac{1}{\nu}\right)(\alpha_{\pi C}\pi_{t+1}+(1+\chi\bar{d}_t+\kappa)\nu\bar{\hat{x}}_{t+1})\frac{\partial\bar{\hat{x}}_{t+1}}{\partial d_t}+ \\
&\quad+(\chi\bar{d}_t\alpha_{\pi C}\pi_{t+1}-\nu\bar{\hat{x}}_{t+1})\frac{\partial\pi_{t+1}}{\partial d_t}\Bigg]
\end{aligned} \tag{55}$$

Next, consider the Euler equation that governs the region-j expenditure decision. The region-j govern Euler equation simplifies to

$$\hat{g}_{j,t} = \beta_G E_t \left[R(\bar{d}_t)\hat{g}_{j,t+1} - \left(\frac{q_L}{\alpha_{gG}} \hat{x}_{j,t+1} - \frac{1}{\nu} \hat{g}_{j,t+1} \right) \frac{\partial \bar{x}_{t+1}}{\partial d_t} \right]. \tag{56}$$

The regional fiscal authorities set taxes, or implicity output, such that

$$\nu \hat{x}_{j,t} + \alpha_{dF} d_{j,t} = \beta_F E_t \left[\nu \hat{x}_{j,t+1} R(\bar{d}_t) + (q_L \nu \hat{x}_{j,t+1} - \alpha_{gG} \hat{g}_{j,t+1}) \frac{\partial g_{j,t+1}}{\partial d_t} \right]. \tag{57}$$

The final equilibrium condition is given by the budget constraint. The solution now require us to also solve for the policy function that determines government expenditure, thus $\bar{g}_t = G^{FAjdr}(\bar{d}_{t-1}, \epsilon_t)$ (also note that $\hat{G}^{FAjdr}(\bar{d}_{t-1}, \epsilon_t) \equiv \bar{g}_t - (\bar{\tilde{g}}_t + \epsilon_t)$.

Scenario Fdr: Delegation of tax rates to a union-wide fiscal authority, with debt as a residual

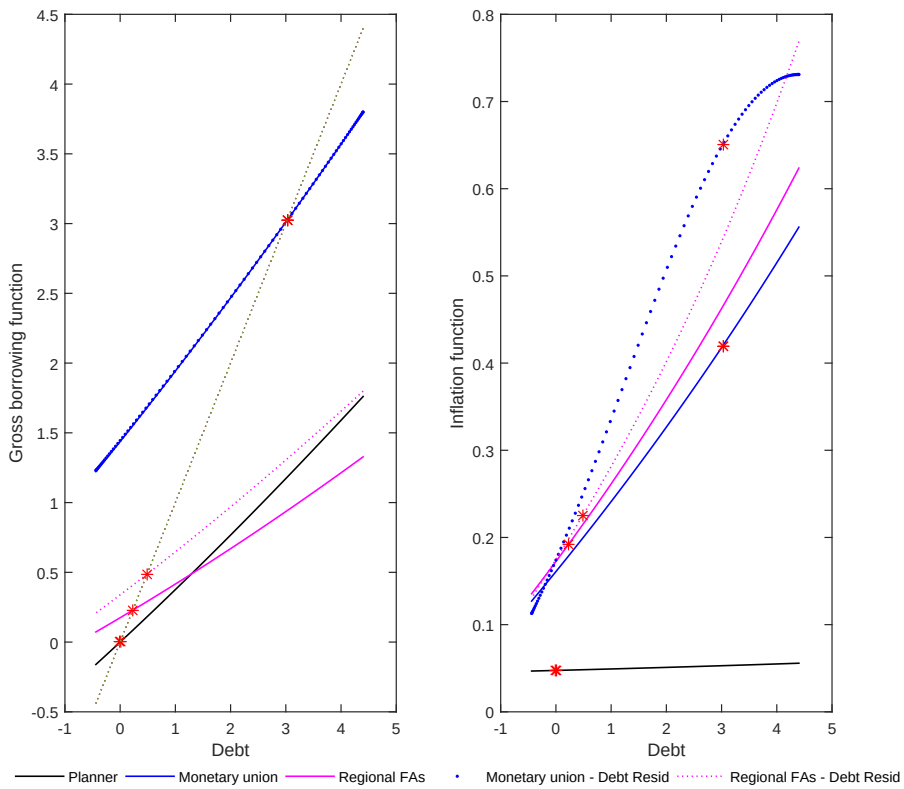
The equilibrium when delegation of taxation for all regions to a union-wide fiscal authority continue to be determined by conditions (55) for the central bank, (56) for the regional government, the budget constraint and finally, the conditions for the union-wide fiscal authority (replacing (57))

$$\begin{aligned} \nu \bar{\hat{x}}_t + \alpha_{dF} \bar{d}_t &= \beta_F E_t \Bigg[\nu \bar{\hat{x}}_{t+1} (R(\bar{d}_t) + R'(d_t) d_t) \\ &\quad + \left(q_L \nu \bar{\hat{x}}_{t+1} - \alpha_{gG} \bar{\hat{g}}_{t+1} \right) \frac{\partial \bar{g}_{t+1}}{\partial d_t} - (\alpha_{\pi F} \pi_{t+1} + \nu \bar{\hat{x}}_{t+1} \kappa) \frac{\partial \pi_{t+1}}{\partial d_t} \Bigg]. \end{aligned} \tag{58}$$

3.4.2 Results

The key messages from our analysis when debt is a control variable are (i) delegation of budget balance responsibilities to a national or union-wide fiscal authority achieves a large reduction in debt, inflation, and tax burdens in steady state, and thereby raises steady-state welfare and (ii) the fiscal authority imposes greater austerity on impact than the *status quo* scenario would imply, but the overall welfare cost of the shock is lower under the fiscal authority, because its presence makes lack of commitment less costly. In general those conclusions are not altered when the delegate instrument is level of taxes in region j instead of debt. Figure 6 depicts the policy functions; as before, fiscal authorities manage to achieve lower debt and inflation relative to the monetary union but permit less smoothing of shocks (the borrowing functions become flatter). As illustrated by figures 7-8, inflation and debt responses after a positive

Figure 4: *Borrowing and inflation. Comparing debt as a residual to debt as a control*



Notes: Comparing policy functions across institutional scenarios, under the assumption that debt is a residual, or that debt is a control variable.
Left: Gross borrowing: debt d_t as a function of d_{t-1}.
Right: Inflation π_t as a function of d_{t-1}.
Red stars: steady states.

public spending shock are subdued by fiscal delegation, but output falls more sharply. Despite that, welfare costs of shocks continue to be smaller under fiscal delegation (These 3 figures are shown in the Appendix).

Nonetheless we see important differences while comparing the policy regimes with debt as a residual or a control variable. In order to highlight them we compare the solutions under the *status quo* and under delegation to regional fiscal authorities displaying the models with debt as a residual and with debt as a control variable in the same graph (4 - 5). Firstly, we see that when debt is a residual (so that the central bank can directly affect the new quantity of debt) then the inflationary bias resulting from lack of commitment increases substantially. Given the amplification of this bias, a regional FA with the same aversion to debt is less effective in reducing the steady state inflation and debt, so these lie further away from their optimal levels (the planner's solution is again shown in black). Finally, with debt as a residual the fiscal authority's

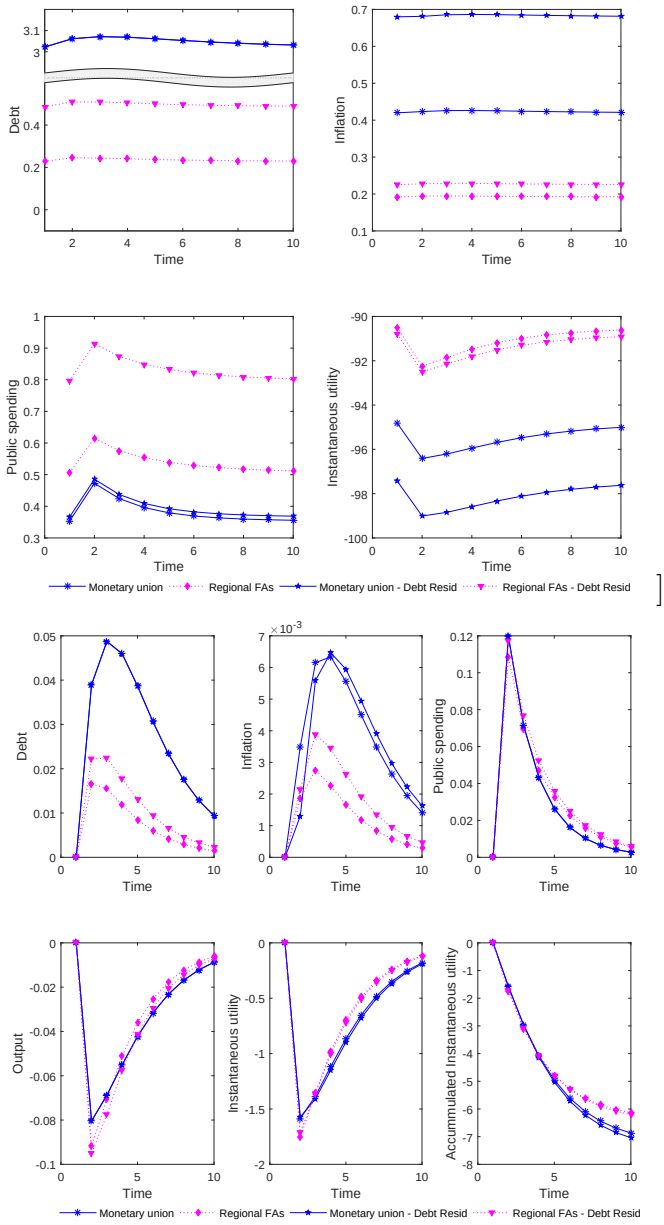
Table 3: *Debt, inflation, and welfare in scenarios $\mathcal{S}$ where debt is a residual**

Debt $\bar{d}^{\mathcal{S}}_{ss}$	Inflation $\pi^{\mathcal{S}}_{ss}$	Welfare $W^{\mathcal{S}}_{ss}$	Crisis cost* $W^{\mathcal{S}}(d^{\mathcal{S}}_{ss}, \epsilon^g_0) - W^{\mathcal{S}}_{ss}$	Crisis cost* controlling for debt $W^{\mathcal{S}}(0, \epsilon^g_0) - W^{\mathcal{S}}(0, 0)$
Temporary shocks (autocorrelation 0)				
Scenario P: Planner				
0	0.047	-4511.4	-1.91	-1.91
Scenario MUdr: status quo monetary union				
3.023	0.651	-4853.9	-2.46	-2.32
Scenario Fjdr: Monetary union with regional fiscal authorities				
0.487	0.225	-4539.6	-2.00	-1.95
Scenario Fdr: Monetary union with union-wide fiscal authority				
0.0001	0.181	-4525.0	-1.97	-1.95
Correlated shocks (autocorrelation 0.7)				
Scenario P: Planner				
0	0.047	-4512.3	-6.05	-6.05
Scenario MUdr: status quo monetary union				
3.023	0.680	-4872.8	-7.08	-6.80
Scenario Fjdr: Monetary union with regional fiscal authorities				
0.487	0.225	-4540.5	-6.18	-6.13
Scenario Fdr: Monetary union with union-wide fiscal authority				
0.0001	0.181	-4525.9	-6.12	-6.12

* "Crisis" refers to a two-percent rise in public goods demand at time 0, $\epsilon^g_0 = 0.02$.

response to a shock comes somewhat closer to that of the monetary union, so the welfare cost of a shock is somewhat increased. Nonetheless, fiscal delegation still delivers welfare gains, both in steady state and in response to shocks, relative to the *status quo* monetary union (See Table 3).

Figure 5: *Autocorrelated public demand shock. Comparing debt as a residual to debt as a control.*



Notes: Impulse responses to a temporary 2% increase in the public spending bliss point $\tilde{g}$, under the assumption that debt is a residual, or that debt is a control variable.
Top four panels: levels. (Note scale break in debt graph.)
Bottom six: deviations from steady state.

4 Policy implications

Fear of moral hazard continues to hold back agreements on possible mechanisms to prevent self-fulfilling attacks on Eurozone states' sovereign debt (such as Eurobonds) and cross-border panics in the European banking system (such as a Single Deposit Insurance Mechanism). The basic fear is that any mechanism capable of preventing crises opens the door to irresponsible fiscal policies that count on future bailouts instead of maintaining long-run national budget balance. Thus, designing an institutional framework capable of ensuring long-run fiscal discipline is a crucial counterpart to the establishment of a crisis prevention mechanisms, so an adequate fiscal framework could prove to be the key to the long-run stability of the Eurozone.

An independent fiscal authority for EMU

Our model points to one powerful framework for fiscal discipline: the establishment of a budgetary agency within the European Commission, mandated to ensure long-run budget balance, which for the sake of concreteness we will call the European Fiscal Authority (EFA). What exactly would the EFA do? First, it would necessarily take the form of a forecasting agency, monitoring and predicting fiscal trends in each member state. Second, it could provide advice to member governments about the likely fiscal impact of new policy proposals. In these ways it would resemble the national fiscal councils mandated under the "Fiscal Compact" treaty (European Council (2012)).

But our concept of the EFA would go beyond the monitoring and advisory role foreseen in the "Five Presidents' Report" (J. Juncker et al. (2015)), by exercising executive control over one or more national fiscal instruments. Importantly, these should be instruments with a sufficiently strong budgetary impact to give it effective control over the path of each member state's public debt. Our model suggests that this setup would decrease debt accumulation, and although fiscal shocks have a greater impact on output, this set-up, by correcting debt and inflation biases, delivers welfare results during stabilization closer to the optimal ones (planner).

In our model all policy decisions represent equilibrium outcomes of games between policy makers with different instruments and different preferences. Following Rogoff (1985), we assume that institutional design may affect institutional preferences. In particular, we assume that a budgetary agency with a mandate to maintain long-run budget balance, given control over a few instruments that make this mandate feasible, will act in a debt-averse manner. This is consistent with the apparent inflation aversion of central banks that are mandated to maintain low inflation and control instruments

that make low inflation feasible.[20] Thus, our analysis is founded on the assumption that no policy makers can commit to follow a rule, treating fiscal and monetary policies in a consistent way.[21]

Moreover, as with independent central banks, lowering long-run debt by means of fiscal delegation would not necessarily rule out short-run deviations needed to stabilize shocks, in contrast with the framework of uniform rules set in Maastricht Treaty of 1992. Under an EFA, important considerations such as each country's capacity to obtain revenues from taxes, their rate of growth and benefits and costs of default can be taken in consideration when the EFA sets the fiscal instrument under its control. Finally, an EFA would have an important advantage over establishing a federal government, since federations, by taking fiscal decisions at a more centralized level, would lose local information and thus would be likely to spend less efficiently and be more likely challenged for being undemocratic. In this sense, an unelected European body charged *only* with ensuring long-run budget balance might actually produce a more democratic outcome than would an elected European government with wider fiscal powers or uniformly set rules that do not allow for stabilization.

A credible quid pro quo

If we accept that this form of fiscal discipline is indeed beneficial, and compatible with democracy, several further questions arise. First, is it politically feasible? Second, can effective fiscal instruments be established, in practice? And finally, which fiscal instrument(s) would be most appropriate for delegation to a hypothetical European Fiscal Agency?

Although delegation of fiscal instruments is not standard practice today, it does seem politically feasible in the European context. Fiscally fragile countries in the Eurozone still need backing from the monetary authorities in order to avoid the risk of speculative attacks and banking panics, which the ECB is able to provide. However, fiscally strong European countries oppose monetary protection against speculative attacks, because they fear moral hazard: the weaker countries might fail to balance their budgets if they take ECB protection for granted.

[20] Blinder (1998) interprets the Rogoff (1985) model as an argument about the effects of delegating instruments to an independent central bank, instead of the simplistic interpretation that the bank should "hire a conservative" as its governor.

[21] In our model, there is no equilibrium role for rules. An interesting extension would be a stochastic model of "sustainable equilibria", which might allow us to incorporate rules and punishments as equilibrium outcomes, along the lines of Chari and Kehoe (1990). See Basso (2009) for an analysis of monetary delegation in a sustainable equilibrium model.

These considerations point to a politically feasible *quid pro quo*. Assuming that a European budget forecasting agency is established, as the "Five Presidents' Report" (J. Juncker et al. (2015)) proposes, then member states could be given the option to delegate one or more fiscal instruments to that agency, on a purely voluntary basis. The agency (EFA), would then evaluate whether the instruments proposed for delegation by a given member state are powerful enough and agile enough to give it effective control of that member state's debt. When the EFA judges that it has been granted effective control of the member state's debt level— including setting up the legal and administrative framework for control of the proposed instruments by the EFA— the member state would become immediately eligible for ECB protection against speculative attacks (by whatever mechanism the ECB judges appropriate).

Crucially, protection would remain contingent at all times on continuing approval from the EFA. If at any time the EFA judges that its delegated instruments are less powerful than expected, or if it judges that a member state has begun to "game the system" in some way that makes it unable to control that state's debt level, the EFA would publicly revoke its approval of the delegated instruments (probably, but not necessarily, after adequate advance warning to the member state). The ECB would then be obliged to cease backing that state's sovereign debt. One might question whether it is credible to threaten to eliminate a member state's protection against speculative attacks. There could be scope for moral hazard if eliminating protection of the bonds of one country caused contagion to others. But as long as the other fiscally fragile countries are themselves participating in the EFA system, scope for contagion would be greatly mitigated.

Which instruments to delegate?

Finally, we come to the question of which instrument(s), if any, would be appropriate for delegating control of long-term budget balance to the European Commission. Our paper has modeled instrument delegation in two ways. The simpler assumption is that the fiscal authority actually issues each member state's sovereign debt; the member government is then free to spend the cash proceeds.[22] We show that delegation of debt issuance is very effective in reducing biases generated in a monetary union, theoretically being the preferred option.

However, most forms of public spending involve long-term projects and long-term contracts that are costly and difficult to adjust rapidly; therefore, in practice, most

[22] When instead the authority is decreasing the debt stock in nominal terms, the implicit assumption is that the fiscal authority is the first claimant on all period t tax revenues of region j until it achieves its desired debt level $d_{j,t}$.

public spending decisions are planned long in advance, and sovereign debt issuance is typically a residual, chosen after spending and taxes to compensate any difference between the two. Indeed, formal control of debt issuance may not suffice for *de facto* control of the debt. The *de facto* debt level may be affected by hidden securitization of future public revenues, by off-balance sheet exposures (unfunded pensions, guarantees given to social security or other state entities), or even by more explicit measures such as the issuance of scrip, "platinum coins" (an instrument recently discussed in the US) or IOUs— or simply delaying payments. These measures have in fact have been used quite frequently by countries unable to formally issue more sovereign debt. As such we also consider the delegation of taxes or government expenditure, instead of debt issuance *per se*. While delegation is somewhat less effective in this case, it still significantly reduces debt biases without imposing further constraints on stabilization.

An EFA could be granted control over taxes or government expenditure in a wide variety of ways. In the case of taxes, probably the simplest idea is that of Gruen (1997), who proposed defining a multiplicative shift factor in the Australian tax code. He proposed applying this shift factor to income taxes, VAT taxes, and all other types of taxes. Tax rates would take whatever complicated functional form the Australian government chose, but would subsequently by multiplied by a factor X_t, which would initially be set to one but would thereafter be adjusted by an independent fiscal authority to ensure control of the debt level.

As for controlling government expenditure, the analysis of Gomes (2011) indicates a possible mechanism. He shows that public sector wages should optimally be state-contingent, rising in times of fiscal plenty and falling when the budget is tight. Across-the-board shifts in public labor compensation would have a powerful budgetary impact, and could in principle be performed very quickly, particularly if a shift factor were spelled out explicitly *ex ante* in public contracts, instead of being an *ad hoc* crisis response, as was the case in Spain and Portugal during the crisis.[23] Additional adjustment factors related to long-term budget trends offer another potentially powerful lever that could be delegated to an independent fiscal authority.[24]

Whether or not to participate in the EFA mechanism, and if so, which instrument(s) to delegate to the fiscal authority, is ultimately a political decision that should be

[23]See also, Costain and de Blas (2012a,b), who go a step further and point out that *all public sector prices* could be made effectively state-contingent by budgeting them in an alternative unit of account, the value of which would be determined by the fiscal authority.

[24]In a recent pension reform, the Spanish government established a "Factor de Revalorización Anual" that will be applied annually to automatically adjust pensions in response to any persistent deficits or surpluses in the pension system; see Sánchez (2014).

taken democratically in each member state. But from the point of view of the political *quid pro quo* between member states, the only essential question is whether a given instrument has a sufficient budgetary impact to enable the EFA to adequately control long-run debt. The only decision in the hands of the fiscal authority itself would be the technical and quantitative question of what setting of its delegated instrument is consistent with long-run budget balance under its forecasts, given the policies of the member government.[25] All other fiscal instruments would remain under the control of the member government, consistent with the European principal of "subsidiarity".

5 Conclusions

Motivated by the failure of fiscal rules to avoid deficit bias in Europe, this paper has analyzed an alternative policy regime in which each member state government delegates at least one fiscal instrument to an independent authority with a mandate to avoid excessive debt. Other fiscal decisions remain in the hands of member governments, including the allocation of spending across different public goods, and the composition of taxation.

We have compared long run debt accumulation and the response to public spending shocks in dynamic games representing several different institutional configurations, including a *status quo* monetary union scenario with many local governments, a monetary union with a single federal government, and various fiscal delegation scenarios, as well as a social planner's solution. We made two simple assumptions to discipline our treatment of different types of institutions: first, that elected institutions are relatively impatient, and second, that an institution mandated to achieve a simple, feasible, quantitative goal will value that goal more strongly than the rest of the society does.

In our numerical simulations, delegation of budget balance responsibilities to a national or union-wide fiscal authority achieves a large reduction in debt, inflation, and tax burdens in steady state, and thereby raises steady-state welfare, compared with the *status quo* scenario. This is true both when the fiscal authority chooses debt directly, and when the fiscal authority instead chooses the tax rate, implying that debt is determined as a budget residual.

In response to a public spending shock, the fiscal authority imposes greater austerity on impact than the *status quo* scenario would imply. Nonetheless, the overall

[25] Since debt rather than deficits *per se* is the relevant issue for intertemporal budget balance, deficits may fluctuate substantially even when they are controlled by the EFA. There may even be circumstances when a short-run deficit favors long-run budget balance, for example if a temporary deficit enables productive investments, or if the economy appears to be temporarily beyond the maximum of its Laffer curve.

welfare cost of the shock is lower under the fiscal authority, because its presence makes lack of commitment less costly, so that paying back the initial debt increase is much less distortionary. Similarly, the transition path when a fiscal authority is established imposes substantial austerity as the high initial debt is paid down. Nonetheless, the long-run welfare gains are so large that establishing a fiscal authority is preferred, from an *ex ante* social welfare perspective, even when the economy starts at the high steady-state debt level of the monetary union.

Going beyond the model, Section 4 discussed the role that fiscal delegation might play in Eurozone reform, where a disciplined fiscal regime is a crucial counterpart (both economically and politically) to most of the monetary and financial mechanisms currently under consideration to stabilize European economies and financial markets. A European Fiscal Authority controlling at least one sufficiently powerful fiscal instrument in a member state could guarantee that state's long-run budget balance. The member state itself would decide which instrument to delegate, while the EFA would evaluate whether it is "sufficiently powerful". Delegation to the EFA would be attractive if it made member states eligible for ECB protection against speculative attacks; but even without such a guarantee it could be attractive as a way of improving fiscal credibility and lowering risk premia. Therefore we have stressed that these institutions could be constructed in a voluntary, step-by-step fashion. As long as fears of moral hazard persist, peripheral countries can do little to achieve a union-wide agreement that would protect them against any future shocks to the Eurozone. Reforming their fiscal institutions— possibly unilaterally— is one way peripheral countries could jumpstart the negotiations for such an agreement.

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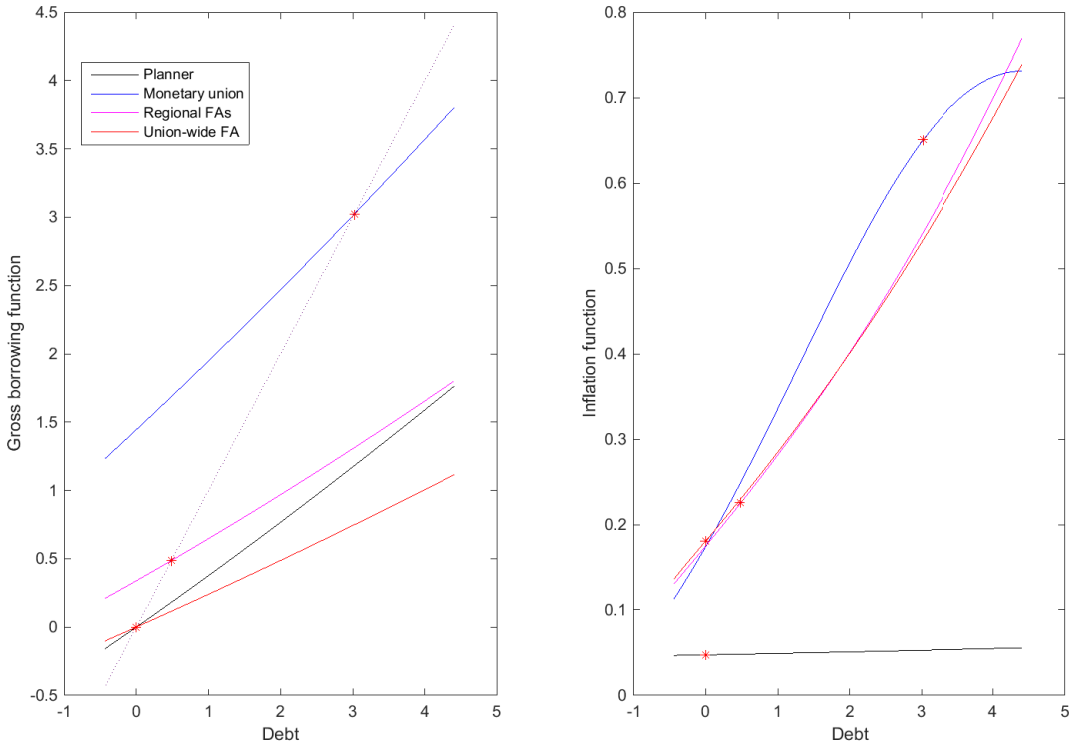
A Appendix: Comparing institutional scenarios when debt is a residual.

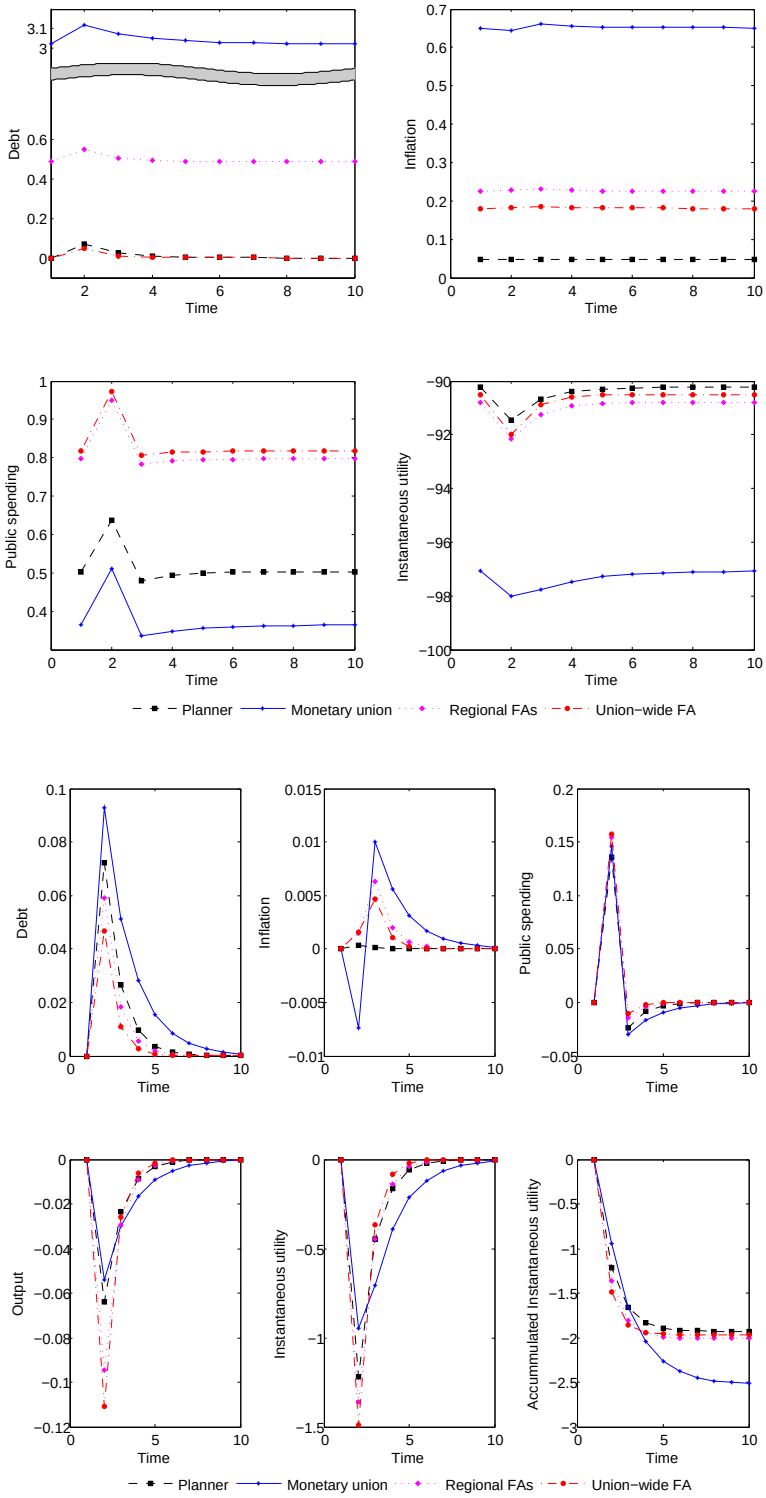
This appendix displays policy functions and impulse response functions, under the assumption that debt is a residual. The graphs shown here are the analogues of our earlier Figures 1-3.

Figure 6: *Borrowing and inflation. Comparing institutional scenarios when debt is a residual*



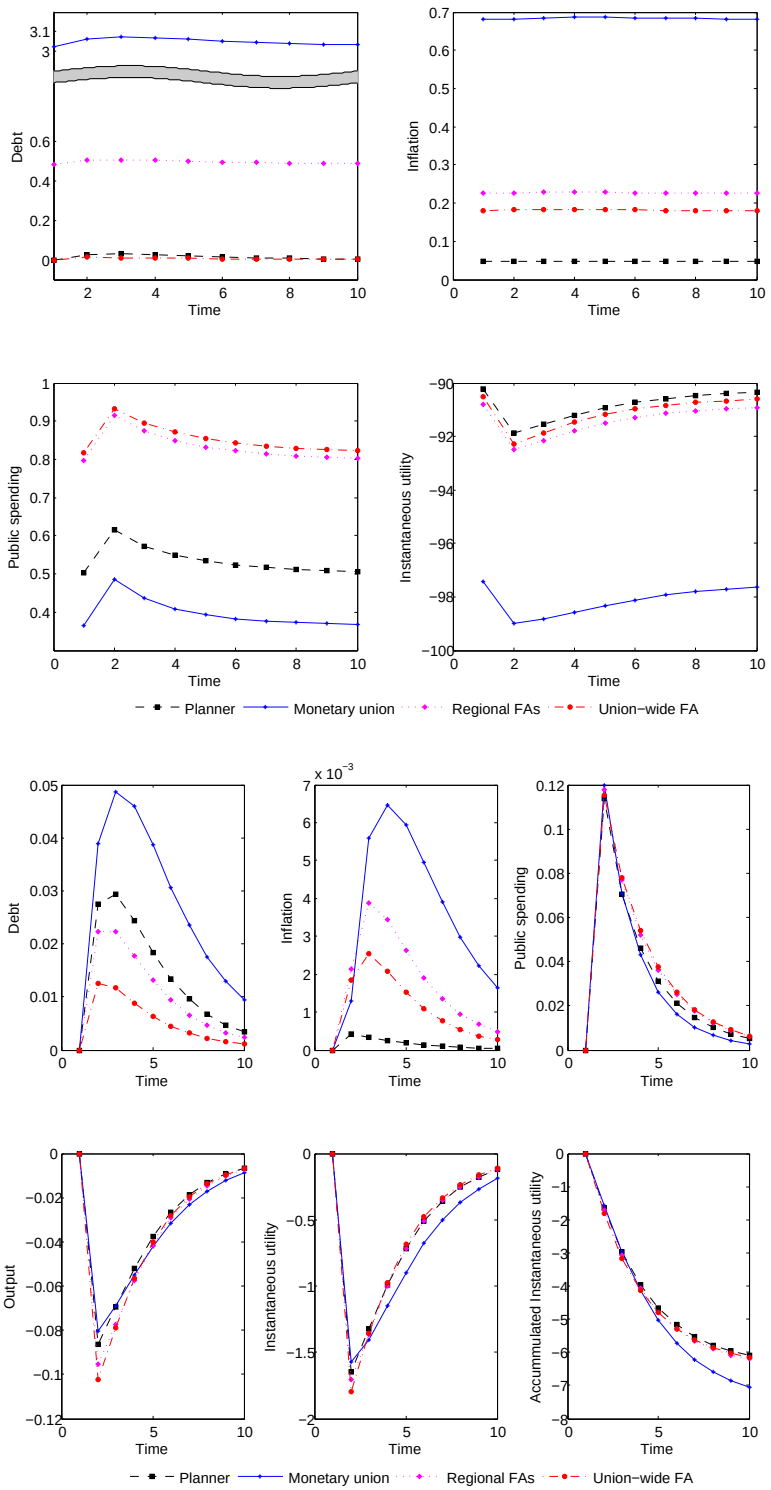
Notes: Comparing policy functions across institutional scenarios, assuming debt is a residual.
Left: Gross borrowing: debt d_t as a function of d_{t-1}.
Right: Inflation π_t as a function of d_{t-1}.
Black: planner. Blue: monetary union. Magenta: regional FAs. Red: Union-wide FA. Red stars: steady states.

Figure 7: *Temporary public demand shock. Comparing scenarios when debt is a residual.*



Notes: Impulse responses of debt, inflation, government spending, and instantaneous utility to a temporary 2% increase in the public spending bliss point $\tilde{g}$, assuming debt is a residual.
Top four panels: levels. (Note scale break in debt graph.)
Bottom six: deviations from steady state, showing also output and cumulated utility.

Figure 8: *Autocorrelated public demand shock. Comparing scenarios when debt is a residual.*



Notes: Impulse responses of debt, inflation, government spending, and instantaneous utility to a 2% increase in the public spending bliss point $\tilde{g}$ (autocorrelation 0.7), assuming debt is a residual.
Top four panels: levels. (Note scale break in debt graph.)
Bottom six: deviations from steady state, showing also output and cumulated utility.