Institution Design for Macroeconomic Policy

by Alexander Mihailov and Katrin Ullrich
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Abstract

This paper explores the normative aspects of the institution design for macroeconomic policymaking when a society legislates specific objectives and sequencing of decisions for the involved authorities. We develop a general theoretical framework that adds fiscal policy to the flexibility-credibility trade-off well-established in monetary policy. We find that delegation of both monetary and fiscal policy to autonomous institutions of appointed experts improves macroeconomic outcomes by delivering lower average inflation and lower average public-sector deficit-to-output ratio over alternative policies conducted with interference by elected politicians. Simulated expected social losses across 24 considered institution-design regimes demonstrate the long-run welfare dominance of delegation.

JEL Classification: E02, E61, E63

Key Words: delegation, independence, expert committees, monetary-fiscal interactions, policy games, institution design

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1 Introduction

The purpose of the present paper is to explore the normative aspects of the design of institutions for macroeconomic policymaking. Since the early 1990s, inflation has been low and stable in the OECD countries and the euro area. At the same time, persistent deficits have characterized even the cyclically-adjusted general government budget balances in most of these countries. Monetary policy has been operating under considerable autonomy, yet mostly within credible monetary regimes imposing some degree of commitment in the form of constrained discretion, as Bernanke and Mishkin (1997) characterized the inflation-forecast targeting (IFT) framework. By contrast, fiscal policy has been implemented by elected governments. Fiscal policy councils in a narrower sense, that is, by analogy to monetary policy committees, have been set up only recently in few countries (e.g., Sweden in 2007). But these agencies, as well as some older and broader ones in the area of macroeconomic policy (e.g., the Central Planning Bureau in the Netherlands since 1945 and the Economic Council in Denmark since 1962), have mostly been mandated to provide independent consultancy and assistance to authorities – and not to make decisions – including on issues related to public deficits and debt.¹

No matter the introduction of prescribed fiscal rules, in some countries at a national level² and for the European Union at a supranational level, namely, the Stability and Growth Pact (SGP),³ there is broad agreement among researchers that fiscal policy has remained mostly unconstrained by such rules, basically because they have been easily breached without sanctions. While the economic environment has been the same for monetary and fiscal policy, there has been a monetary-fiscal divide with respect to the institutions and mechanisms implementing each of these policies. This institution-design aspect may explain to a large extent why monetary policy has been more coherent, and perhaps more successful, than fiscal policy throughout the pre-crisis period in anchoring inflation expectations virtually worldwide.

Our interest is to understand how the choice of a particular institution-design regime, implying delegation under differing degrees of policy interactions of expert committees for monetary as well as fiscal policy with the Government, affects their prescribed strategies and credibility, thereby private-sector expectations, macroeconomic outcomes as well as social welfare. We study both simultaneous-move and sequential-move pure-strategy equilibria arising in a static policy game. With this, we derive analytically the equilibrium outcomes and compute numerically expected social loss criteria for each

¹Wyplosz (2008), pp. 183-184, notes that the establishment of the High Council of Finance in Belgium in 1989, under the pressures of fiscal sustainability, appears to have contributed to the reversal of the trend toward increasing gross public debt in terms of GDP since 1994. For a recent survey with more institutional background on independent fiscal agencies and their future, see Debrun et al. (2009).
²HM Treasury specified two key fiscal rules: the so-called “golden rule”, according to which the government can borrow over the economic cycle only to invest and not to fund current spending; and the “sustainable investment rule”: public-sector net debt as percentage of GDP should be kept at a stable and prudent level, below 40%. Similar fiscal rules, such as formal budget deficit ceilings or targets, have recently been introduced in other countries too, e.g., Chile and Brazil: see Krogstrup and Wyplosz (2010), p. 269.
³The SGP was signed in 1997 to strengthen the legislative basis for the two fiscal convergence criteria of the Maastricht Treaty of 1992.
institution-design regime defining various degrees of policymakers’ autonomy and interactions – ranging from full independence, through partial coordination, and to full dependence. Differently from most of the literature, our theoretical framework requires optimal instrument setting in response not only to macroeconomic shocks and/or key endogenous macrovariables, but also to the targets and instruments of the remaining policymakers. The latter feature makes the optimal instrument rules more complex than in most of the related literature (e.g., in New Keynesian models). In addition to these institution-design regimes predefining unconditional commitment under alternative degrees of policy independence or coordination, we further consider regimes with a preannounced escape clause, which we term regimes under conditional commitment in the spirit of Lohmann (1992). The escape clause is triggered by an extreme negative shock realization. We model conditional commitment by additively weighting the unconditional commitment optimal policy outcomes in the context of each institution-design regime, with the eventual activation of the escape clause preannounced in a probabilistic sense.

Our main contribution consists in the systematic analysis of alternative institution-design regimes that legislate various degrees of policy autonomy or coordination to a fiscal policy committee in addition to a monetary policy committee with respect to the government, formalizing ideas set out in Wyplosz (2005). Our key results can be summarized as follows. If elected officials target an overambitious level of output as in the classic articles, thus generating both inflation and deficit biases, delegation of macroeconomic policy to independent expert agencies mandated to pursue unbiased targets delivers lower expected social loss. The delegation can be done simultaneously for monetary and fiscal policy, but certain compromises in reaching the respective objectives while dealing with macroeconomics shocks are in order. By design, delegation does not solve the problem of output variability, but it also does not exacerbate this problem compared to monetary delegation alone. However, the division of labour between the committees requires a clear mandate for the expert committees. We interpret the institution-design regimes we analyze as the options available to an ultimate and common principal to the three policymakers – society (via parliament) – in choosing to legislate the delegation and implementation of its preferred macroeconomic policy strategy. Combining analytical propositions and model simulation results that embody a few alternative plausible parameterizations allows us to infer a robust ranking of the examined institution-design regimes, which include 15 regimes with unconditional commitment and 9 regimes with conditional commitment.

The paper is organized as follows. The next section gives an overview of the literature we rely on, followed by the section that specifies the model, defining the economic environment and the legislated mandates of the institutions responsible for macroeconomic policy. Section 4 presents our main results by institution-design regime, with ranking of the regimes according to a few criteria of interest, including a social welfare metric. Concluding remarks are offered in the last section.
2 Related Literature

This paper addresses the issue of institution design for macroeconomic policymaking in a game-theoretic model allowing for different degrees of autonomy *vis-à-vis* the Government of expert committees to which society may opt to delegate both monetary and fiscal policy. This general theoretical framework extends to fiscal implications a long tradition in the study of the flexibility-credibility trade-off in monetary policy going back to Kydland and Prescott (1977), Barro and Gordon (1983 a, b), Rogoff (1985), Lohmann (1992), Walsh (1995) and Svensson (1997). With view to the more recent academic literature and policymaking practices, focusing on the design of institutions and their interactions, the policymakers in our framework are considered to operate within legislated mandates. These mandates are the result of formal agreement via representation in parliament (which we do not model) and assign to the policymakers respective objective functions, with targets and related target weights, as well as respective instruments to be adjusted optimally in response to aggregate demand (AD) and aggregate supply (AS) shocks and the anticipated strategies of the other involved policymakers.

By analogy with – and to expand upon – the papers that propose solutions to the inflation bias of discretionary (monetary) policy, our analysis of alternative institution-design regimes proceeds by examining versions of a static stochastic linear-quadratic policy game that derives the optimal instrument rules for each player. This has been the dominant methodological approach over decades. Yet, we extend it to encompass a rich set of strategic interactions among *three* major macroeconomic authorities, which we would refer to as the government, a monetary policy committee (MPC), and a fiscal policy committee (FPC). The subset of legislated assignments within such “division of policymaking labor” (Blinder 1997, 124) to which we restrict our attention comprises a representative “menu” of delegation options on institution-design regimes available to society that pose meaningful macroeconomic policy trade-offs in the sense of Tinbergen (1952). That is, it involves overall *three* socially desirable and appropriately assigned (by regime) policy targets, stabilization of output, inflation and the structural public-sector deficit-to-GDP ratio around their target values, but only *two* available and appropriately assigned (by regime) policy instruments, the nominal interest rate and the structural deficit share in GDP, to attempt to achieve the targets.

Our model structure is designed to be quite general, and in fact it nests most of the set-ups in the Kydland-Prescott-Barro-Gordon tradition. Notably, our framework is richer in policymaker interactions, insofar as we allow for a third, fiscal policy authority involved in macroeconomic decisions. Similarly to Rogoff (1985) but in a more general sense, we assume conservative expert committees, as their respective target weights on the stabilization of their primary objectives are more ambitious (i.e., higher with regard to inflation and the structural deficit-to-GDP ratio, respectively) relative to those of the Government. As in Svensson (1997), and beyond Rogoff’s assumption, we also assume conservative expert committees in the sense that their respective primary targets are more ambitious too (lower inflation and structural deficit share in GDP) than those of the Government, while the output targets of the MPC and the FPC are identical.
(implying certain coordination, which is realistic), set at the level of normal output. Our modeling of monetary-fiscal-government interactions via delegation implying a higher or a lower degree of cooperation follows the linear weighting approach to combining the objectives of the policymakers introduced by Canzoneri and Henderson (1991). As in Lohmann (1992), we allow for an escape clause for the government in cases of extreme shock realizations, a variation which we denote as conditional commitment regimes, in addition to the corresponding unconditional commitment regimes considered earlier. Differently from Lohmann (1992), our environment studies various versions of a richer interactions set, comprising three social objectives to achieve by two instruments at disposal to three potential policymakers with different responsibilities and powers across the considered institution-design regimes. Finally, to deal with issues at the heart of fiscal stabilization, we focus on the central role of the structural deficit-to-GDP ratio as both a target and an instrument of fiscal policy, in addition to influencing AD, and hence equilibrium, together with the automatic stabilizers. In effect, we use the same macroeconomic environment as that in Buti et al. (2001), but the objective functions that allow for various degrees of independence and cooperation with or without an envisaged escape clause which we study across 24 (seemingly most relevant) institution-design regimes go much beyond Buti et al. (2001). Thus, our model is a generalization of the literature. The key assumption from this literature that we retain throughout all our institution-design regimes, to keep simplicity and comparability of the analysis, is the Barro-Gordon (1983a) assumption that the government has an overambitious output target, \( y^{*G} > y^N \), which we rationalize alternatively by the “re-election motive” of elected politicians or by the “stimulus bias” of even the private sector (or society it is embedded in) over the immediate short run and after extreme negative shock realizations.

Independent committees ruling over monetary policy have been frequent in central banking practice and in the academic literature since at least the early 1990s. By contrast, expert committees to decide on fiscal policy have only began emerging in theory as well as in practice just before the advent of the global financial crisis. The lack of earlier interest to delegate fiscal policy can be explained mostly by its distributive effects, as these call for ex-ante democratic control. Wyplosz (2005) and Krogstrup and Wyplosz (2010) were among the early proponents of fiscal councils. Notably, Wyplosz (2005) argues that the determination of the fiscal deficit can also be delegated to an independent agency, since its distributive effects do not differ much from the effects of interest rate decisions in monetary policy. The literature has not considered, however, the normative implications of the interactions of monetary and fiscal policy committees under alternative legislated mandates in addition to a government within a society, which is the main purpose of the present paper.

Figure 1 situates our present work within the context of the key related literature. As is clear from the figure, one could broadly distinguish two approaches in this literature. More precisely, \( u^* < u^N \) as \( u^* = ku^N \) with \( 0 < k < 1 \) in Barro-Gordon (1983), p. 593, fn. 4.
been searching for solutions to the inflation bias problem of discretionary policymaking. We would denote the earlier approach as institution-design regimes implying unconditional commitment or unconditional constrained discretion – unconditional regimes or "regimes A", for short – as this type of regimes is designed and perceived without envisaging an escape clause. Rogo¤ (1985) and Svensson (1997) are two classic examples of this type of unconditional institution-design regimes. Both authors propose modifying an aspect of the objective of the monetary authority in order to solve the inflation bias. Rogo¤'s (1985) solution suggests delegation to a central banker who has “more conservative” preferences for inflation stabilization than the average individual in the society (or the median voter), that is, technically, a higher weight on inflation stabilization in the policymaker’s objective function under discretion. Svensson’s (1997) solution, in turn, proposes delegation of monetary policy to a central bank which implements explicit inflation(-forecast) targeting (IFT), that is, technically, a lower (we may by analogy say “conservative”) target on inflation stabilization in the policymaker’s objective function under (thereby) constrained discretion. The second, later approach to solving the inflation bias in the classic literature relies on adding an escape clause (overriding) for the government in case of an extreme negative (AS) shock under discretion of the monetary authority, which is Lohmann’s (1992) solution. For this reason, we would denote a similar type of institution-design regimes we shall also discuss as regimes implying conditional commitment or conditional constrained discretion – conditional regimes or “regimes B”, for short. Lohmann (1992) is the first and most well-known illustration of such conditional institution-design regimes.

3 Model

We set up a model that allows for the explicit interactions among three macroeconomic authorities: an elected Government (denoted henceforth in the formulas by superscript G); and two appointed committees of experts, an MPC (superscript M) and an FPC (superscript F). These policymakers face an implicit private sector, whose behavior is embodied in the economic environment. Their mandates, in terms of target and instrument variables and relative target weights over the targets in the objective functions, are legislated by the society as a whole.

3.1 Macroeconomy

We assume a standard macroeconomy, borrowing the rational expectations environment in Buti et al. (2001), itself similar to that in the traditional Kydland-Prescott (1977) and Barro-Gordon (1983 a) framework for the analysis of the flexibility-credibility trade-off in monetary policy, but with an added fiscal policy dimension. In any period t this macroeconomy is described by a log-linear AD function, $y^D_t (\cdot) \equiv \ln Y^D_t (\cdot)$, and a log-linear AS function (also sometimes termed Phillips curve), $y^S_t (\cdot) \equiv \ln Y^S_t (\cdot)$, both

$^5$Building upon earlier RE models that generate “surprise inflation” under assumptions of partial information, as in Lucas (1972, 1973), or sticky prices and wages, as in Phelps and Taylor (1977).
expressed in % deviations from “normal” output, $y^N \equiv \ln Y^N = \text{const}$, that is, in output gap terms: $^6$

$$y^D_t - y^N = a \left[ d_t - \chi (y_t - y^N) \right] - b (i_t - \pi^e) + \varepsilon^D_t,$$

$$y^S_t - y^N = c (\pi_t - \pi^e) + \varepsilon^S_t,$$

$$y_t - y^N \equiv y^D_t - y^N = y^S_t - y^N. \tag{1}$$

The equilibrium condition, (1), captures the private-sector (or market) constraint on policymakers when each of them chooses optimally the adjustment of the available instrument(s) in stabilizing the model economy following stochastic disturbances. The AS gap, $y^S_t - y^N$, depends on “inflation surprises”, i.e., a mismatch between inflation, $\pi_t$ (in % per annum), and inflation expectations, $\pi^e \equiv E_{t-1} [\pi_t]$, as well as on an AS shock, $\varepsilon^S_t$, with $\varepsilon^S_t \sim i.i.d. (0, \sigma^2_S)$. As is common in the literature, this AS disturbance process is assumed to be independently and identically distributed (i.i.d.) with mean zero and constant variance.$^7$ The AD gap, $y^D_t - y^N$, depends on the (ex ante) real interest rate, $r_t \equiv i_t - \pi^e$, itself influenced by the (short-run or policy) nominal interest rate, $i_t$ (in % per annum), the instrument of monetary policy, and on the actual budget deficit, $\delta_t \equiv d_t - \chi (y_t - y^N)$, itself influenced by the structural (or cyclically-adjusted) general government budget deficit-to-GDP, $d_t \equiv D_t / Y^N$ (expressed as the structural deficit $D_t$ in % of $Y^N$), the instrument of fiscal policy, so that $\delta_t$ is measured in % of $Y^N$ too. The AD gap also depends on an AD shock, $\varepsilon^D_t$. Again, the expected value of this i.i.d. AD disturbance process is zero and its variance is constant, $\varepsilon^D_t \sim i.i.d. (0, \sigma^2_D)$. $^8$ As in Buti et al. (2001), $\chi > 0$ is the cyclical sensitivity of the government budget, also known as “automatic fiscal stabilizers”. $^9$ Observe that the actual deficit, $\delta_t$, is reduced in booms, when the output gap is positive, the more so the higher is $\chi$; by symmetry, the actual deficit rises in recessions, when the output gap is negative, the more so the higher is $\chi$. The choice of the structural deficit-to-GDP ratio as the relevant instrument of fiscal policy, as well as the presence of the actual deficit-to-GDP term in the AD equation but not in the AS equation (too), as in Buti et al. (2001), is motivated by

$^6$For simplicity, and to focus on institution design rather than macroeconomic dynamics, we here assume a static framework with implicitly sticky prices where $t$-subscripts denote ex-post equilibrium values of the variables and where “normal” output $y^N = \text{const}$ is some proxy for (an observed) long-run average capacity utilization. In a dynamic extension of the model, $y^N_t$ may instead evolve deterministically, e.g., $y^N_t = \rho_1 y^N_{t-1}$, or stochastically, e.g., $y^N_t = \rho_1 y^N_{t-1} + \xi_t$, with $\xi_t$ drawn from $i.i.d. (0, \sigma^2_N)$, from one period to another. This is inconsequential with regard to the essence of our key results on the welfare ranking of the institution-design regimes we shall compare.

$^7$A positive realization of the supply shock can be interpreted as an efficiency shock, e.g., better technology or knowledge spillover, and a negative realization as a cost-push shock, e.g., higher wages or an oil-price jump.

$^8$A positive realization of the demand shock can be interpreted as a wave of consumption and/or investment optimism, while a negative realization as a wave of private-sector spending pessimism.

$^9$Buti et al. (2001), p. 807, fn 4 cite studies that quantify $\chi$ over a broad range, with a lower empirical bound of the order of 0.1 and a higher empirical bound of about 0.9 (for the Nordic countries, with the Mediterranean countries falling roughly in the middle of this range).
our focus on delegating the stabilization role of fiscal policy.\textsuperscript{10} The constants $a > 0$, \(b > 0\), \(c > 0\) measure key sensitivities: \(a\) reflects the sensitivity of AD to the fiscal policy instrument,\textsuperscript{11} \(d_t\) (as well as to the actual deficit, \(\delta_t\)); similarly, \(b\) is the slope of the AD curve and reflects the sensitivity of AD to the monetary policy instrument, \(i_t\) (as well as to the real interest rate, \(r_t\)); \(c\), being the slope of the AS (or Phillips) curve, captures the sensitivity of AS to surprise inflation, \(\pi_t - \pi^e\).

Our model economy is, thus, a usual two-equation macroeconomic system which determines the endogenous variables, equilibrium output, inflation and, residually, the actual budget deficit share in GDP, \(y_t\), \(\pi_t\) and \(\delta_t\), as a function of the shock realizations, \(\varepsilon_t^D\) and \(\varepsilon_t^S\), the respective institution-design predetermined inflation expectations, \(\pi^e\), and the respective institution-design predetermined optimal macroeconomic stabilization policies to be implemented via adjustment of the instruments, \(i_t\) and \(d_t\):

\[
y_t - y^N = \frac{b}{1+\alpha} \pi^e - \frac{b}{1+\alpha} i_t + \frac{a}{1+\alpha} d_t + \frac{1}{1+\alpha} \varepsilon_t^D,
\]

\[
\pi_t = \left[ 1 + \frac{b}{(1+\alpha)c} \right] \pi^e - \frac{b}{(1+\alpha)c} i_t + \frac{a}{(1+\alpha)c} d_t + \frac{1}{(1+\alpha)c} \varepsilon_t^D - \frac{1}{c} \varepsilon_t^S. \tag{2}
\]

As becomes obvious from the solution (2) to system (1), both instruments, to be set optimally, affect AD and AS directly. Moreover, taking expectations from both sides of the inflation (AS) equation in the system, agents solve for \(\pi^e\), and one can see that – via \(\pi^e\), indirectly – both instruments affect AD and AS as well. The optimal setting of \(i_t\) and \(d_t\) will, in turn, depend on the particular institution-design regime in operation, and the implied expectations on which policymaker is assigned to set each of the instruments in it with a corresponding degree of freedom. Hence, policy will be correctly anticipated and will influence both AS and AD, as discussed next.

### 3.2 Institution Design

Since our interest is to compare alternative institution-design arrangements for macroeconomic policy, the objective functions of the expert committees and the Government reflect independence and coordination issues assigned to them by a common ultimate principal, society. This assignment is binding and enforced via the parliament, the constitution and the appropriate legislation and regulations, implicit but not modeled here. Various degrees of autonomy and interactions can be considered where each of the monetary and fiscal authorities can pursue its own chosen or prescribed targets, adjust the policy instrument available at its disposal, and follow its own chosen or prescribed preferences in implementing the optimal policy implied within the respective institution-design regime.

\textsuperscript{10}Such an approach is also consistent with analogous modeling shortcuts in Beetsma and Bovenberg (1997, 1998), von Hagen and Mundschenk (2003), and Castellani and Debrun (2005), among others.  
\textsuperscript{11}It is to be stressed here, as Buti et al. (2001) do, that in such a macroeconomy Ricardian equivalence does not hold fully, unless \(a = 0\). This assumption does not seem very restrictive or unrealistic, insofar as it would be supported empirically to the extent that government deficits tend to exert a positive influence on AD.
We focus on delegated targets and target weights in the objective functions of the expert policymakers and the Government. That is, we analyze constrained discretion under varying degrees of instrument (or operational) independence and policy coordination, although the framework is general enough to accommodate as well goal independence and full discretion without coordination. Alternative institution-design regimes between the extremes of complete freedom of action and full dependence of both policy committees with respect to the Government are, therefore, explored in our model context. In it, constrained discretion will equivalently imply commitment to the optimal policy rules for the monetary and fiscal instruments that emerge from each considered institution-design regime, and can therefore be interpreted as commitment to these optimal rules, unconditional if there is no pre-announced escape clause or conditional if there is. This latter terminology is what we shall mostly employ hereafter, although an equivalent interpretation as constrained discretion, unconditional or conditional, could be synonymously used.

3.2.1 Parliament, Government and Expert Agencies

We assume additive separability of a quadratic loss function for each policymaker, rational expectations and perfect information. Our point of departure is the objective function of society, or of the representative agent implicitly populating our (private-sector) economy. This social objective is legislated by the Parliament. A reasonable assumption about the long-run objective (i.e., ex-ante at some initial time \( t = 0 \)) the society wishes to get attained in the context of the model we introduced is to minimize the following expected loss function:

\[
E_0 \sum_{t=1}^{\infty} \beta^t \left[ L_t^S (j_t; j^*, \gamma_j) \right] = E_0 \sum_{t=1}^{\infty} \beta^t \left[ \frac{\gamma_y}{2} (y_t - y^*)^2 + \frac{\gamma_\pi}{2} (\pi_t - \pi^*)^2 + \frac{\gamma_d}{2} (d_t - d^*)^2 \right].
\]

The macroeconomic variables that are targeted in any period \( t \) are \( j_t = \{y_t, \pi_t, d_t\} \), an asterisk denotes their respective (constant) target levels, \( j^* \), with \( y^* = y^N \), and \( \gamma_j \) are the respective target weights. Note that, on grounds of intertemporal social justice, a relevant discount factor in our set-up is \( \beta = 1 \), which we assume hereafter. In addition, for all constants pre-announced in accordance with any particular legislated institution-design regime, the above infinite-time objective could more realistically be pursued – i.e., thus becoming feasible – if “decomposed” on a period-by-period basis. Then, for any period \( t \) (say, one calendar year) and given credible commitment to the assigned objective, which we assume hereafter, it reduces to

\[
L_t^S (j_t; j^*, \gamma_j) = \frac{\gamma_y}{2} (y_t - y^*)^2 + \frac{\gamma_\pi}{2} (\pi_t - \pi^*)^2 + \frac{\gamma_d}{2} (d_t - d^*)^2.
\] (3)

We refer to (3) as the (intertemporally decomposed) long-run policy objective of society under commitment. However, in the short run (i.e., ex-post, after observing the shock realizations in each year \( t \)) and especially under negative disturbances, society
(or the representative agent) tends to be tempted to give more priority to employment and, hence, output stabilization, at the cost of allowing higher inflation and/or deficit variability. That is, the period $t$ social objective function keeps its form the same as in (3) but changes the target and weight values, as follows:

$$I_t^G (j_t; j_t^G, \gamma_j^G) = \frac{\gamma_y^G}{2} (y_t - y_t^G)^2 + \frac{\gamma_{\pi}^G}{2} (\pi_t - \pi_t^G)^2 + \frac{\gamma_d^G}{2} (d_t - d_t^G)^2,$$

where $j_t^G > j_t^*$ for $j_t = \{y_t, \pi_t, d_t\}$ with $\gamma_y^G > \gamma_y^*, \gamma_{\pi}^G < \gamma_{\pi}^*$, $\gamma_d^G < \gamma_d^*$. We have now used superscript $G$ as we assume that it is exactly the short-run (annual) social loss (4) that an elected Government would naturally minimize (year-by-year over the length of its mandate): (i) either because of its own choice to please the electorate/society, consistent with the political economy literature and the Barro-Gordon tradition, reflecting what we would call “re-election concern”; (ii) or because of legal assignment by the electorate/society, consistent with its short-term temptation to prioritize employment stabilization rather than inflation or deficit stabilization under (exceptionally) difficult circumstances, i.e., what we would call “stimulus bias”. For short, and stressing the first interpretation that has been much more exploited, we refer to (4) as the short-run policy objective of the Government under commitment. In line with this literature and our model economy, we assume that the overambitious output target, $y_t^G > y_N$, translates into corresponding higher inflation and deficit target levels too, $\pi_t^G > \pi^*$ and $d_t^G > d^*$. The (decomposed) long-run objective function that a society legislates via Parliament, (3), provides our benchmark for institution-design comparisons.

Note as well that there are three targets, but only two instruments, $i_t$ and $d_t$, which introduces the trade-offs that make the optimization problem of interest realistic and meaningful, in the sense of Tinbergen (1952).

With view to achieving fiscal sustainability, Wyplosz (2005) has recommended delegating to an FPC decisions on the (primary) budget balance(-to-GDP) only, and not on its structure, a proposal we adopt and formalize. In writing our social loss function(s) with a deficit-to-output stabilization term, we essentially view our deficit target as imposed by the requirement for fiscal sustainability. Because we focus on delegating the

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12 Reminiscent of the realities during the Great Depression in the 1930s as well as the recent Great Recession and global financial crisis.

13 Conventional macroeconomic models studying monetary and fiscal policy interactions, such as Beetsma and Bovenberg (1997, 1998), von Hagen and Mundschenk (2003) or Castellani and Debrun (2005), have worked with the same three quadratic terms in the objective function of the policymaker, where government spending has usually been included instead of the deficit. Benigno and Woodford (2003) have microfounded a similar multiperiod loss function where the third term above is absent. In their optimization problem, however, the real primary budget surplus enters via the intertemporal budget constraint of the government.

14 The rationale is that the government intertemporal budget constraint can be written in two equivalent ways, as a transversality condition and as present value of expected future primary budget balances. Government spending, ([lump-sum] government transfers, and some (distortionary) tax rate have commonly been modeled as instruments of fiscal policy. Usually such modeling has assumed only one of the mentioned fiscal instruments to be chosen endogenously by the government under discretion or commitment, with all the remaining – alternative or simultaneous – potential fiscal instruments taken as exogenously given, e.g., in the neoclassical literature on optimal fiscal policy as well as in its modern microfounded extensions, such as Benigno and Woodford (2003, 2007) or Benigno and De Paoli (2010).
stabilization role of fiscal policy only, the relevant deficit should be the structural one, as in Buti et al. (2001). More importantly, as already stressed, we distinguish between the social loss function in the long run, but annually decomposed for implementation, which captures the (educated) preferences or interests of society (or parliament), and the social loss function in the short run, which coincides with the (spontaneous) employment stabilization bias of societies and the corresponding (electoral) preferences or interests of governments. Insofar this re-election concern of the Government or stimulus bias of the electorate relative to the long-run goals of society generates both an inflation bias and a deficit bias, as the analysis of our model will show in the next section, there is a justification for appropriate institution design in a democratic society. By legislating a particular institution-design regime, the Parliament can “tie the hands” of the Government and, thus, as well suppress its own electorate’s likely short-run employment stabilization temptations in our framework, eradicating or mitigating the re-election concern and the stimulus bias. One way to do away with these “perverse incentives”, on which our model focuses, is by delegating the monetary and fiscal instruments to appointed expert agencies with long terms in office (longer than the electoral cycle) in accordance with a chosen institution-design regime. The latter would imply a degree of autonomy and corresponding policy interactions of the MPC and the FPC with respect to the Government that is desirable for a particular society. This is the basic intuition behind the willingness of society in our set-up to delegate monetary and fiscal policies, and our purpose here is to study analytically and from a normative perspective the macroeconomic effects and corresponding social loss rankings of alternative institution-design regimes.

Formalizing ideas of Blinder (1997) and Wyplosz (2005), we assume that our intertemporally decomposed long-run social objective function (3) can further be decomposed within each period (or year) \( t \) and its parts delegated to the MPC and the FPC. This second, intratemporal decomposition of the long-run social objective function involves some “division of policymaking labor” (Blinder 1997, 124) between these institutions with respect to the primary target of each, inflation stabilization and structural deficit-to-GDP stabilization, respectively, but also complementarity with respect to the secondary (and shared) target of output stabilization. Under such separation of powers our expert committees are assigned different prerogatives and minimize institution-specific loss functions. The resulting quadratic loss function for the MPC is standard:

\[
L^M_t (j^M_t; j^{*,M}_t, \gamma^M_j) = \frac{\gamma^M}{2} (\pi_t - \pi^*)^2 + \frac{\gamma^M y}{4} (y_t - y^N)^2, \tag{5}
\]

where \( j^M_t = \{y_t, \pi_t\} \subset j_t \) and \( j^{*,M}_t = \{y^N, \pi^*\} \subset j^* \).

For the FPC, we have in a symmetric fashion:

\[
L^F_s (j^F_s; j^{*,F}_s, \gamma^F_j) = \frac{\gamma^F}{2} (d_t - d^*)^2 + \frac{\gamma^F y}{4} (y_t - y^N)^2, \tag{6}
\]

where \( j^F_s = \{y_t, d_t\} \subset j_t \) and \( j^{*,F}_s = \{y^N, d^*\} \subset j^* \).
We further assume that the primary goal for the MPC is to keep inflation on target. Output stabilization also plays some role but receives a lower weight in the loss function, $2 > \gamma^M_\pi > \gamma^M_y > 0$. The Government budget deficit is not a concern for monetary policy. In a similar way, the FPC is mostly concerned with having the structural deficit share in GDP on target; it also cares about output, $2 > \gamma^F_d > \gamma^F_y > 0$, but not about inflation. A final analogy for the Government requires us to posit $2 > \gamma^G_y > \gamma^G_M > 0$ and $2 > \gamma^G_d > \gamma^G_y > 0$ (without being specific as to whether $\gamma^G_y < \gamma^G_d$).

In accordance with the related literature, we endow our expert committees with conservative preferences in the sense of Rogo¤ (1985); i.e., each of them attaches a higher absolute and relative weight to its primary goal compared to the Government:

$$\begin{align*}
\gamma^M_\pi > \gamma^G_\pi, & \quad \gamma^M_y > \gamma^G_y \quad \frac{\gamma^M_y}{\gamma^G_y} > 1 > \frac{\gamma^G_y}{\gamma^M_y} \quad \text{and} \quad \gamma^F_d > \gamma^G_d, & \quad \frac{\gamma^F_d}{\gamma^G_d} > 1 > \frac{\gamma^G_d}{\gamma^F_d}.
\end{align*}$$

The interpretation of conservatism in our model is, however, more general than Rogo¤’s (1985). First, it is rather the specialized knowledge embodied in the (assigned) preferences of the MPC – and the FPC (in our case) – that explains it, not the mere preferences. Second, being non-elected policy institutions consisting of experts, the committees are further assumed (or assigned) not to have an overambitious output target; they pursue instead only “output gap stabilization”, a policy that brings output to its normal level, $y^* = y^{*F} = y^{N} < y^{*G}$. Hence, $\pi^{*,M} = \pi^{*,F} < \pi^{*,G}$, which is essentially equivalent to the IFT solution to the inflation bias in Svensson (1997), whereby a lower inflation target than that of the Government (and, possibly, the median voter) is delegated to the central bank. Similarly, the structural deficit target assigned to the FPC is $d^{*,F} = d^{*} < d^{*,G}$.

In the context of our model, (3) cannot be implemented directly – even by joint optimization of monetary and fiscal policies by the Government, for it then transforms into (4) most of the time, due to the re-election concern, the stimulus bias or both. In this sense, we would refer to (3) as ideal or desirable period social loss function. However, in our set-up (3) can be implemented via appropriate delegation – in fact, decomposition – to our MPC and FPC, i.e., by the sum of (5) and (6). Note that under our assumptions on the targets and weights, the long-run loss function of society, (3), coincides exactly with the sum of the loss functions of the policy committees when they are fully independent from the Government, as it would be under an institution-design regime implementing (5) and (6) but not (4). In this sense, we would refer to the latter sum as contractible or implementable period social loss function.

In essence, our modeling strategy is thus consistent with the key trade-off characterizing most of the academic literature and social practice: while the long-run goals of society should anchor inflation and deficit expectations, ensuring policy credibility, the short-run pressures on the Government (or even society itself) may well impose the temporary priority to deal with severe macroeconomic shocks, stabilizing employment and output and ensuring some policy flexibility. This crucial policy trade-off between
long-run credibility and short-run flexibility is operationalized next by our modeling of the degrees of coordination of monetary and fiscal policies with the Government.

3.2.2 Delegation and Coordination under Unconditional Commitment

We study delegation and coordination under unconditional as well as conditional commitment. Figure 2 provides an overview over all regimes we study.

The unconditional institution-design regimes in the left-hand-side half of Figure 2, 15 in total, are distinguished among each other by the varying degree \( 0 \leq \theta^M \leq 1 \) of monetary policy autonomy and coordination. In these regimes, the MPC optimizes with respect to the interest rate, but is required to also coordinate with the Government, to the extent captured by the value of \( \theta^M \). Thus, the MPC is forced to take the targets and target weights of the Government into account, to a degree measuring its (in)dependence. Following Canzoneri and Henderson (1991), this is modeled by a weighting, \( 0 \leq \theta^M \leq 1 \), applied to the objective functions of the MPC and the Government,

\[
Z_t^M \left( L_t^G \left( j_t; j^{*G}, \gamma_t^G \right), L_t^M \left( j_t^M; j^{*M}, \gamma_t^M \right) \mid \theta^M \right) = \theta^M L_t^G + (1 - \theta^M) L_t^M. \tag{7}
\]

Such an approach, and in particular the parameter \( \theta^M \), captures the degree of operational independence and corresponding cooperation in monetary policy with the Government imposed by the legislated institution-design regime under analysis. If \( \theta^M = 0 \), the MPC is granted complete instrument independence, because it can determine the interest rate according to its own objective function without taking the targets and target weights of the Government into consideration; if, furthermore, \( \pi^{*M} \) is chosen by the MPC rather than being mandated to it by society, our model captures also goal independence. If \( \theta^M = 1 \), the MPC is instrument- as well as goal-dependent, i.e., operating with no discretion at all and, effectively, is suppressed as an institution. Any intermediate degrees of policy autonomy with cooperation are, then, captured by \( 0 < \theta^M < 1 \).

By analogy, the objective function of the FPC under the unconditional institution-design regimes implies a degree of operational independence and corresponding cooperation in fiscal policy with the Government captured by \( 0 \leq \theta^F \leq 1 \),

\[
Z_t^F \left( L_t^G \left( j_t; j^{*G}, \gamma_t^G \right), L_t^F \left( j_t^F; j^{*F}, \gamma_t^F \right) \mid \theta^F \right) = \theta^F L_t^G + (1 - \theta^F) L_t^F, \tag{8}
\]

where analogous interpretations of instrument and goal (in)dependence of the FPC apply.

3.2.3 Delegation and Coordination under Conditional Commitment

We also model conditional institution-design regimes in the spirit of Lohmann (1992) and in accordance with the views of Blinder (1997) concerning delegation (see the right-hand-side of Figure 2). We focus on 9 such regimes which allow both or one of the expert policy committees to be independent from the Government (\( \theta^M = 0 \) and/or \( \theta^F = 0 \)). The conditional regimes pre-announce, by legislation, an escape clause to be activated
ex post, provided an extreme negative AS or AD shock hits the economy, whereby the Government is allowed to step in and re-optimize alone, without any intervention from the MPC and FPC, both policy instruments according to its own objective function. In these conditional regimes the elected Government minimizes (4) again, but ex post, and the difference now is a constant cost term that enters into consideration, capturing the losses due to policy uncertainty. The latter constitutes a second source of uncertainty in the conditional regimes, with regard to which authority will ultimately set the policy instruments, that adds onto the intrinsic (AS and AD) shock uncertainty embedded in the macroeconomy and typical for the unconditional regimes too. The activation of the escape clause comes at a price to society because (i) the adaptation of expectations ex post as to which policymaker ultimately sets the instruments may imply irreversible (sunk) costs and because (ii) delegation of economic policy to an independent agency has been made in the first place.

We model expectations regarding the macrovariables in the conditional regimes as a weighted sum of the macro-outcomes when the Government optimizes alone (regime A11) and the macro-outcomes implied by a particular corresponding unconditional regime (e.g., A00 for B00, etc.). \( \alpha \) denotes any probability for a preannounced flexibility mechanism via an escape clause to be activated. As in Lohmann (1992) and Mihov and Sibert (2006), \( \alpha \) would ultimately reflect some (known) down-sided “tail risk” in the probability density function of the relevant AS and/or AD shock processes to which macroeconomic stabilization policy optimally responds. In other words, the probability of activating the escape clause in the conditional regimes will be low and naturally linked to a threshold value of the size of the relevant shock(s) realization beyond which the Government has a mandate to step in and override committee decisions. One could think of such threshold as being, e.g., a shock causing a drop of 20% of normal output. If the MPC is overridden by the Government, society would incur a sunk cost \( C^M \); if the FPC is overridden by the Government, society would incur a sunk cost \( C^F \); if both the MPC and the FPC are overridden by the Government, society incurs a cost of \( C^M + C^F \). In our unconditional institution-design regimes \( \alpha = 0 \); in our conditional institution-design regimes \( 0 < \alpha < 1 \). Yet it remains low, say, of the order of \( \alpha = 0.05 \), and is preannounced – for the purpose of the credibility of the conditional regimes, which we assume as unquestionable and enforceable in our present normative analysis.

Private agents will take this credible and enforceable institution-design regimes with conditional commitment into account, understanding that the level of macroeconomic variables such as inflation and output can be determined ex post either by the MPC and the FPC or by the Government, and will form inflation expectations accordingly. Inflation expectations in the conditional regimes are, consequently, a weighted average of the inflation rate resulting in the unconditional regime where the Government sets jointly monetary and fiscal policies, A11, (weighted with probability \( \alpha \)) and the inflation rate in the unconditional regime corresponding to the conditional one considered, e.g., A00 for B00 (weighted with probability \( 1 - \alpha \)). With such expectation formation weighted by the preannounced and quantified policy uncertainty embodied in the parameter \( \alpha \), we
need to solve for optimal instrument setting and the ensuing macroeconomic equilibrium only for the unconditional institution-design regimes. The corresponding solution for the respective conditional institution-design regimes then follows immediately.

3.3 Timing of Events and Expectations Formation

The sequencing of events in any period $t$ is assumed to be as follows.

1. The preferences of society regarding (long-run) macroeconomic policy are first exogenously entrusted, via legislation in Parliament in $t-1$ (or earlier), by selecting a particular institution-design regime within the set we study illustrated in Figure 2. The choice of regime preannounces in effect the degrees of independence from the Government assigned to the MPC ($0 \leq \theta^M \leq 1$ in $Z^M$) and the FPC ($0 \leq \theta^F \leq 1$ in $Z^F$) and whether there is an escape clause for the Government, in the regimes where at least one of the expert committees enjoys independence in instrument setting, to re-optimize alone monetary and fiscal policies jointly ex-post ($0 < \alpha < 1$) or not ($\alpha = 0$). That is, each institution-design regime in our model context is uniquely pinned down by this triplet of parameters, $(\theta^M, \theta^F; \alpha)$, and the private-sector as well as the policymakers all fully understand the macroeconomic implications of such legislation.

2. Then, still in (or near the end of) $t-1$, the private sector forms rational expectations about the equilibrium inflation rate, assuming a linear form of an optimal feedback rule for each policymaker that responds to own and other policymakers’ targets and instruments and to AD and AS shocks to be materialized ex post.

3. At the beginning of $t$, the AS and AD shocks materialize and are observed by everybody (perfect information with common knowledge).

4. In the conditional regimes we denoted as regimes B, the Government re-optimizes ex post in case of an extreme negative shock realization. In these regimes B, $0 < \alpha < 1$ embodied in the regime preannounces probabilistically such an escape clause and, for the sake of clear communication to both the private sector and the policymakers, links it explicitly, in a precise quantitative way, to a threshold value in terms of % drop of normal output (in any period $t$, or cumulatively over several subsequent periods).

5. The equilibrium macroeconomic outcomes in any $t$ are finally determined, as a function of the shock realizations and the corresponding and preannounced (by each particular institution-design regime) optimal instrument setting.

In the next section, we discuss the model solution and compare the optimally set instruments, expectations formation, the macroeconomic outcomes and expected social losses across the unconditional and conditional institution-design regimes we defined (see Figure 2).
4 Key Results

To optimally set the instrument levels, the interest rate and the structural deficit-to-GDP ratio, the loss function of the relevant policymaker by regime is minimized with respect to the instrument at hand. We analyze the case of simultaneous-move (Nash) equilibria and the corresponding alternative sequential-move (von Stackelberg) equilibria given the institution-design regime in force. In many aspects simultaneous and leadership game equilibrium outcomes are not dramatically different, due to the clearly assigned responsibilities in terms of objective functions, targets and weights by regime for each policymaker involved, which also helps guiding expectations of the private sector. Essentially, the very purpose of explicit mandating of objectives and fixing the degree of policy independence and coordination according to a society’s preferences in regimes without a overriding clause (Regimes A) consists in resolving completely policy uncertainty and anchoring private-sector expectations; regimes with an overriding clause (Regimes B), by contrast, introduce a precisely quantified and preannounced policy uncertainty to allow to a society to mitigate the variability of output and employment following extreme negative AS and/or AD shocks.

The results show, overall, that the optimal instrument setting and the macroeconomic outcomes in the different regimes have a similar structure, depending on a weighted average of target values, gaps between the corresponding inflation, deficit-to-GDP and output targets of the involved decision makers, the normal output level and the exogenous shocks. These key terms in the solutions are weighted by composite parameters consisting of structural parameters of the economy (a, b, c) and the policymakers’ objectives (γ’s). Such weights play an important role, as they characterize the different possibilities for combining the influences of the Government, the MPC and the FPC according to the degree of independence (0 ≤ θ^M ≤ 1 and 0 ≤ θ^F ≤ 1) of the committees without (α = 0) or with (0 < α < 1) an escape clause for the Government.

In the following paragraphs after presenting general outcomes, institution-design regimes are first ranked according to two important properties of any macroeconomic stabilization policy: (i) to what extent it ensures anchoring of expectations ex ante; and (ii) to what extent it stabilizes target macrovariables ex post, offsetting completely or partly the effects of AD and/or AS shocks. The ranking of the regimes is then discussed from the perspective of expected social loss that is computed via simulations for alternative plausible parameterizations, as we shall report further down. The details of the equilibrium solutions are provided in Appendix A and summarized in tables 1 (general analytical summary), 3 (simulation under unitary symmetric calibration of AD and AS slopes), 4 (simulation under inelastic symmetric calibration of AD and AS slopes) and 5 (simulation under elastic symmetric calibration of AD and AS slopes). Proofs of the propositions and corollaries follow immediately from the solutions: see the Appendix for mathematical details and the corresponding analytical summary in Table 15.

15Our Maple 13 programs with the optimization codes and expected loss computations are available upon request.
1. Proofs of the propositions and corollaries follow immediately from the solutions: see the Appendix for details and the analytical summary in Table 1.

4.1 Optimal Policy: Instrument Setting and Resulting Outcomes

4.1.1 Unconditional Commitment: Regimes A

Under unconditional commitment, i.e., in our regimes A (where $\alpha = 0$), and beginning with simultaneous moves, the relevant monetary and fiscal policymakers minimize their respective loss functions, each taking as given the strategy of the other policymakers(s).

In the general case of regime A where the MPC and the FPC loss functions feature an intermediate degree of operational independence from the Government – that is, $0 < \theta^M < 1$, $0 < \theta^F < 1$ – inflation and inflation expectations differ only because of the supply shock. The demand shock is completely offset by monetary policy. Because the committees and the Government have different target values of inflation, output and the structural deficit-to-GDP, and monetary and fiscal policy are not independent, Government preference parameters in the objective function matter and the gaps between the respective targets influence the different variables.

There are four interesting limiting solution cases that arise in our set-up with unconditional commitment. These are a completely (in)dependent monetary and fiscal policy as well as a completely independent monetary (fiscal) and completely dependent fiscal (monetary) policy.

Regime A11 constitutes joint optimization of both policies by the Government alone because monetary and fiscal policy are completely dependent ($\theta^M = 1$ and $\theta^F = 1$). The results show that, whereas the structural deficit ratio is on target, inflation expectations and, depending on the shock realization, the inflation rate end up above target. The reason is the inflation bias that originates in targeting output above its normal level as in the seminal literature. Actual inflation and inflation expectations differ because of the supply shock that is not completely offset by policymakers. This yields an output level that deviates from its normal level. The deviation is upwards if a positive supply shock has materialized, and downwards in case of a negative supply shock.

In regime A00 monetary and fiscal policies are completely independent from the Government ($\theta^M = 0$ and $\theta^F = 0$) to determine the respective instrument level. In this case, the deficit instrument reacts to the supply shock and differs from target value. Inflation expectations are on target and differ from inflation because of a not fully dampened supply shock. This leads to an output level that deviates from the normal one in the direction of the supply shock.

In regime A01 monetary policy is assumed to be completely independent, whereas the FPC is completely dependent ($\theta^M = 0$ and $\theta^F = 1$). Because fiscal policy is conducted with regard to Government targets and target weights, the structural deficit instrument explicitly depends on the gaps between the output and inflation targets, where the basic level of the deficit is given by the Government target. Inflation expectations are anchored at target value and differ from the inflation rate because of the supply shock as in regime
A00. This leads to an output level different from the normal level, depending on the sign and size of the supply shock.

In regime A10 monetary policy is completely dependent on the Government but fiscal policy is completely independent ($\theta^M = 1$ and $\theta^F = 0$). Again, there is the influence of the difference between the output and inflation targets, as the interest rate is now determined optimally by the Government. The supply shock, not completely offset, leads to deviations of output from target.

The A regimes with monetary leadership deliver broadly similar equilibrium outcomes. The essential difference is that in all these regimes actual (ex-post) inflation is fixed exactly at its regime-dependent expected value, on target, as the monetary authority benefits from a first-mover advantage.

The equilibrium outcomes in the A regimes with fiscal leadership are even more similar and often identical to the corresponding ones in the simultaneous-move case. The main difference is that in the two regimes where fiscal policy is set by an independent expert committee, the latter benefits analogously from its first-mover advantage to fix the ex-post structural deficit-to-GDP ratio exactly at its regime-dependent expected value, on target.

4.1.2 Conditional Commitment: Regimes B

In the Regimes B with conditional commitment (where $0 < \alpha < 1$), the actual macro-outcomes consist of two possible levels for each variable depending on whether the escape clause is activated ex post or not. If not, each respective policymaker in the particular institution-design regime B sets its instrument optimally, exactly as in the corresponding A regime. If the preannounced escape clause is activated, the Government steps in and re-optimizes jointly monetary and fiscal policies as a sole policymaker, exactly as in regime A11. Expectations are, therefore, allowed to re-adjust ex post accordingly, to arrive at an equilibrium, but there are irreversible costs arising from the policy uncertainty ex ante resulting in a loss to society. Expectations for each macrovariable are weighted averages of the two alternative outcomes, since the probability of activation of the escape clause is pre-announced and linked to a threshold value of a negative AS and/or AD shock realization. Thus, our B regimes reproduce ex-post the equilibrium macro-outcomes of regime A11 if the escape clause is activated, and those of the corresponding A regime if it is not.

We could generalize the escape clause, of course, beyond this special case analogous to a Government override as in Lohmann (1992). For example, it is possible to design and implement regimes where each policymaker will have the obligation or option to re-set its targets and/or weights as pre-envisaged by legislation, after observing rare and adverse developments in the economy. The parallels with the Great Depression of the 1930s and the global financial crisis of late are of immediate relevance here. It is ultimately a choice to each (democratic) society to select a particular institution-design regime appropriate to its own needs and featuring conditional commitment that is potentially interpreted in a broader sense than the focus on escape clause for the Government on which we limit attention in the present study.
4.2 Ranking of Regimes by Expectations Anchoring

We present the ranking of institution-design regimes by our results on expectation formation: see the respective expressions in Appendix A for detailed solutions and the dense analytical comparison of expectations across all unconditional regimes in Table 1. For compactness and clarity, we state these key results as propositions and corollaries.

4.2.1 Expected Inflation

Ranking the regimes according to inflation expectations, we come to the following conclusions:

**Proposition 1 (Anchoring Inflation Expectations):** Among the 15 unconditional institution-design regimes considered, those 6 featuring an independent MPC implement optimal macroeconomic policies with the lowest anchor for inflation expectations, irrespective of the simultaneous (regimes A00 and A01) or sequential (regimes A0l0f and A0l1f with monetary leadership or A0f0l and A0f1l with fiscal leadership) nature of the policy moves. These same 6 regimes, therefore, eliminate the inflation bias arising in the regimes where the Government operates monetary policy.

**Corollary 1.1 (Anchoring Inflation Expectations and Fiscal Policy):** Provided that monetary policy is delegated to an independent MPC, delegation or not of fiscal policy to a similarly independent FPC does not matter for inflation expectations.

**Corollary 1.2 (Anchoring Inflation Expectations and the Escape Clause):** Each of all 9 conditional institution-design regimes (regimes B00, B01 and B10 with simultaneous moves, regimes B0l0f, B0l1f and B1l0f with monetary leadership, and regimes B0f0l, B0f1l and B1f0l with fiscal leadership) is dominated by the corresponding unconditional regime (regimes A00, A01 and A10; A0l0f, A0l1f and A1l0f; A0f0l, A0f1l and A1f0l; respectively) along the dimension of anchoring inflation expectations.

4.2.2 Expected Deficit

Ranking the regimes according to both structural \((d)\) and actual \((\delta)\) deficit-to-GDP share expectations, we arrive at the following conclusions:

**Proposition 2 (Anchoring Deficit Expectations):** Among the 15 unconditional institution-design regimes considered, those 6 featuring an independent FPC implement optimal macroeconomic policies with the lowest anchor for deficit expectations, irrespective of the simultaneous or sequential nature of the policy moves. These same 6 regimes, therefore, eliminate the deficit bias arising in the regimes where the Government operates fiscal policy.

**Corollary 2.1 (Anchoring Deficit Expectations and Monetary Policy):** Provided that fiscal policy is delegated to an independent FPC, delegation or not of monetary policy to a similarly independent MPC does not matter for deficit expectations.
Corollary 2.2 (Anchoring Deficit Expectations and the Escape Clause):) Each of all 9 conditional institution-design regimes is dominated by the corresponding unconditional regime along the dimension of anchoring deficit expectations.

The structural deficit-to-(normal) output ratio \(d_t\) is the sole instrument as well as one target \(d^*\) of fiscal policy, and is set optimally in each regime by the relevant fiscal authority. The actual deficit-to-(normal) output ratio \(\delta_t\) then results from the effects of AS and/or AD shocks and of the automatic fiscal stabilizers, \(\chi\).

4.2.3 Expected Interest Rate

With regard to the ranking of regimes according to interest rate expectations, we conclude the following:

Proposition 3 (Anchoring Interest Rate Expectations): Among the 15 unconditional institution-design regimes considered, those 3 featuring an independent MPC coupled by an independent FPC implement optimal macroeconomic policies with the lowest anchor for interest rate expectations. These same 3 regimes, therefore, eliminate both the inflation and deficit biases arising in the regimes where the Government operates monetary and/or fiscal policy.

Corollary 3.1 (Anchoring Interest Rate Expectations and Fiscal Policy): To anchor interest rate expectations at the lowest possible level implied by our model, independence of both committees is required while simultaneity of policy moves is not.

Corollary 3.2 (Anchoring Interest Rate Expectations and the Escape Clause): Each of all 9 conditional institution-design regimes is dominated by the corresponding unconditional regime along the dimension of anchoring interest rate expectations.

The interest rate instrument is optimally set in each regime as a function of the respective inflation and deficit targets of the involved policymakers. Therefore, its expected value by regime is also a function of the targets for inflation and the structural deficit-to-GDP ratio, with a relative weight attached to the latter of a magnitude \(\frac{a}{b}\).

4.2.4 Expected Output

Proposition 4 (Output Expectations Always Anchored): Given the rational expectations set-up of our model and its remaining structure, output expectations are always anchored at the normal output level.

4.3 Ranking of Regimes by Shock Stabilization

Ranking according to the smallest deviation in absolute value is based on differences between actual and expected values of the macrovariables across the considered regimes. Actual equilibrium values differ from their respective expected values by terms containing the ex post AS and/or AD shock realizations, multiplied by a composite parameter
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which is a combination of structural model parameters. The smallest composite parameter by regime is not always identifiable analytically as comparisons sometimes depend on the assumed combinations of parameter values. Yet, our simulation results for three plausible parameterizations reported in tables 3, 4 and 5 provide a numerical magnitude of the stabilization and, therefore, a realistic approximation to the regime rankings.

In the context of our model, shocks are mitigated or completely stabilized by the use of the two available policy instruments. However, since the structural deficit share in GDP is not only the sole fiscal instrument but also one of the two fiscal targets, it is optimally set at its target level to minimize the respective fiscal term in the objective function delegated by society. It is, therefore, the remaining interest rate instrument, which is optimally set to achieve the inflation target in the objective function, anticipating correctly the optimal deficit adjustment by the fiscal authority, that basically enjoys more freedom of movement and, hence, serves as a buffer to absorb shocks. This results in a higher interest instrument variability relative to the deficit instrument variability most of the time.

4.3.1 Inflation Stabilization

Concerning inflation stabilization, we reach the following conclusions:

**Proposition 5 (Inflation Stabilization):** Among the 15 unconditional institution-design regimes considered, those 5 featuring monetary policy leadership achieve complete stabilization of inflation at the respective target, lowest in the case of an independent MPC (regimes A0l0f and A0l1f). Among the remaining 10 unconditional regimes without monetary policy leadership, those with independent MPC ensure the smallest deviation of inflation for any given AS shock from the lowest possible inflation target, and those with monetary policy operated by the Government lead to the largest deviation of inflation from the now higher inflation target.

**Corollary 5.1 (Inflation Stabilization and Fiscal Policy):** Provided that monetary policy is delegated to an independent MPC, delegation or not of fiscal policy to a similarly independent FPC matters for inflation stabilization too.

**Corollary 5.2 (Inflation Stabilization and the Escape Clause):** Each of all 9 conditional institution-design regimes is dominated by the corresponding unconditional regime along the dimension of stabilizing actual inflation around its target.

4.3.2 Optimal Interest Rate Response to AS and AD Shocks

In our model, stabilization of the interest rate is not a goal of macroeconomic policy. The interest rate is the instrument of monetary policy, which is set optimally to minimize inflation variability around the assigned inflation target by responding to AS and AD shocks. In this sense, the interest rate serves as a buffer that mitigates the effect of shocks on the remaining macrovariables in the system, by taking these shocks upon
itself. Therefore, the interest rate is the main shock absorber, which naturally leads to the highest volatility it exhibits among the macrovariables we consider.

Concerning the optimal interest rate responses to AD and AS shocks with the aim to stabilize inflation close to its target, we arrive at the following conclusions:

**Proposition 6 (Optimal Interest Rate Response to Shocks):** The optimal response to AS shocks is equal to the magnitude of the inverse of the AS slope and positive in the simultaneous-move regimes and under fiscal leadership, but negative and of the same absolute magnitude in the regimes with monetary leadership; the above responses are accompanied by simultaneous responses with the opposite sign and a (slightly) lower absolute magnitude to the alternative AD shock. On balance, the net response of the interest rate to both AS and AD shocks is not quite high in magnitude, except in regime A11.

**Corollary 6.1 (Interest Rate Levels and Volatility and Fiscal Policy):** Provided that monetary policy is delegated to an independent MPC, delegation or not of fiscal policy to a similarly independent FPC matters for the optimal interest rate response to shocks under simultaneous moves and fiscal leadership, resulting in higher levels and volatility of the optimally set interest rates, but not (much) under monetary leadership.

**Corollary 6.2 (Interest Rate Levels and Volatility and the Escape Clause):** All policy regimes with conditional commitment are dominated by the corresponding regimes with unconditional commitment in terms of resulting in lower levels and volatility of the optimally set interest rates.

### 4.3.3 Structural and Actual Deficit-to-GDP Stabilization

Concerning stabilization of the structural deficit share in GDP, we come to the following conclusions.

**Proposition 7 (Structural Deficit-to-GDP Stabilization):** The two unconditional regimes with independent fiscal policy leadership (regimes A0f0l and A1f0l) as well as joint simultaneous optimization by the Government (regime A11) achieve complete stabilization of the structural deficit-to-GDP ratio at the respective target, lowest in the former case. However, all other unconditional regimes come very close to complete structural deficit-to-GDP stabilization.

**Proposition 8 (Actual Deficit-to-GDP Stabilization):** The unconditional regime with independent fiscal policy leadership (A1f0l), followed by joint optimization by the Government with fiscal policy leadership (regime A1f1l) achieve the highest stabilization of the actual deficit-to-GDP ratio at the respective target. Generally, the lowest actual deficit-to-GDP stabilization is implemented by the unconditional regimes with monetary policy leadership, with the respective simultaneous-move regimes falling in-between these two extremes.
Corollary 8.1 (Actual Deficit-to-GDP Stabilization and Monetary Policy): Provided that fiscal policy is delegated to an independent FPC, delegation or not of monetary policy to a similarly independent MPC matters for actual deficit-to-GDP stabilization too: it results in higher variability of the latter relative to regimes where monetary policy is operated by the Government.

Corollary 8.2 (Structural and Actual Deficit-to-GDP Stabilization and the Escape Clause): All policy regimes with conditional commitment are dominated by the corresponding regimes with unconditional commitment in terms of resulting in lower deviation of the structural and the actual from the expected deficit-to-GDP ratio.

4.3.4 Output Stabilization

Output is the only macrovariable in our model that plays the role of a target in the objective functions of all three policymakers. The output levels that arise in the unconditional regimes are all based on the normal output level and show different deviations from this benchmark. In the regimes with simultaneous moves or fiscal leadership, these deviations arise solely because of the AS shock, whose effect on output depends on the targets and weights of the involved policymakers; in case of a positive (negative) AS shock, output is higher (lower) than normal. In the regimes with monetary leadership, the deviations of output from its normal level arise solely because of the AD shock; they are in the same direction but of a higher magnitude, as in these regimes the AD shock translates into output fluctuations almost – yet not exactly – one-to-one.

Proposition 9 (Output Stabilization): Among the 15 unconditional institution-design regimes considered, those 2 featuring optimization of fiscal policy by the Government under simultaneous moves (A11, A10) and the regime of independent fiscal leadership (A1f0l) implement the highest stabilization of output, while independent monetary policy leads to the lowest output stabilization within this class of regimes. All remaining 5 regimes with monetary policy leadership result in the highest and identical output variability.

Corollary 9.1 (Output Stabilization and Fiscal Policy): Provided that fiscal policy is operated by the Government under simultaneous policy moves (A11), output variability is the lowest. Delegation or not of fiscal policy to an independent FPC matters for output stabilization too only under fiscal leadership. Under monetary leadership, whoever implements fiscal policy is irrelevant for output stabilization.

Corollary 9.2 (Output Stabilization and the Escape Clause): Each of all 9 conditional institution-design regimes dominates the corresponding unconditional regime along the dimension of stabilizing output.

Our conclusions with regard to output stabilization, and the implied ranking of regimes, are thus reversed, when comparing them with those concerning inflation stabilization. For output, the deviation from normal level is highest if monetary policy is
independent, and even more so if monetary policy enjoys a first-mover advantage. If the Government dominates macroeconomic policymaking, output stabilization is strong, according to its relative target weights. Because the MPC gives a higher priority to bringing inflation back to target rather than output compared to the Government, it is not surprising that shocks influence the output level more if the MPC is independent and/or enjoys policy leadership so as to stabilize the economy according to its own relative target weights. In the general case of regime A, shock stabilization is a weighted average of the target weights of the Government and the MPC, where the weights by regime correspond to the degree of independence of the MPC. In this case, an intermediate level of shock stabilization arises.

4.4 Ranking of Regimes by Expected Social Loss

In this subsection, we present simulation results that quantify the expected social loss by institution-design regime for alternative baseline parameterizations. These simulation results are illustrated in four figures assuming different slope combinations of the AD and AS schedules: identical AD-AS slopes in Figure 3; lower AD and higher AS slopes in Figure 4; higher AD and lower AS slopes in Figure 5; and inelastic AD but AS elastic or vice versa in Figure 6.

We here briefly justify our choices of the parameter values employed, as listed in Table 2 (see also the notes under the simulation figures). Normal output in the model, the secondary and shared target of the expert committees, is calibrated to correspond exactly to the nominal value of US GDP in current 2013 US dollars, of $1.68 \times 10^{13}$ USD according to the World Bank online data. Yet the rest of our parameter choices, covering four essential dimensions of the model (policy targets; policy weights; sensitivity parameters in the macroeconomy; and regime-specific degrees of monetary and fiscal independence or interactions) would generally fit any modern advanced economy, in the following sense. To the expert committees, we assign an inflation target of 2% per annum, as is the case of the Bank of England and many other central banks, and a deficit target of 3% of GDP, as envisaged by the Maastricht Treaty and implemented in many countries. With the purpose to obtain sharper conclusions from the simulations, we assume that the Government has an output target 10% higher than normal output, and twice higher inflation and deficit targets than the committees, 4% p.a. and 6% of GDP, respectively. The primary target of each committee gets a weight of 1.5 in the objective function, while the secondary target gets a weight of 0.5. For the Government, as it has three targets, the primary target, output stabilization, gets a weight of 1, whereas both secondary targets, inflation and deficit stabilization, share a weight of 0.5. The macroeconomy is characterized by typical (or median) values for two of the four sensitivity parameters that appear less diverse (hence, controversial): based on related research, the automatic fiscal stabilizers embodied in $\chi$ are set to a value of 0.3 – see footnote 9; and the relatively low value of the sensitivity of AD to the fiscal instrument, $a$, set at 0.1, captures a high (yet not full, if $a = 0$) degree of Ricardian equivalence – see footnote 11. The other two parameters that are likely to display higher diversity across
real-world economies, the slopes of AD and AS, have each been calibrated alternatively to five values, capturing the inelastic, unit-elastic and elastic case in various combinations. As our simulations have shown, the social loss rankings remain quite robust to these five alternative parameterizations of the slopes of AD and AS. Finally, the parameters that characterize institution-design choices have been allowed to vary between the extremes of independence and full dependence, with the mid-point case of equally shared division of labor in stabilization policy \((\theta^M = \theta^F = 0.5)\) considered too.

Similar to the macro-outcomes, the relative magnitude of expected social losses differ somewhat, depending on leadership. Yet again an overall conclusion is that the socially optimal institution-design regimes, in terms of minimizing the expected social loss, are those regimes assigning complete independence of the committees. In this case it does not matter much which policymaker leads or whether both act simultaneously.

\subsection{Symmetric and Identical AD and AS Slopes}

Let us begin the interpretation of our graphical illustration of the expected social losses with identical slopes of AD and AS. Using the simultaneous-move policymaking depicted in the first column of panels as a benchmark, we can rank the five unconditional institution-design regimes according to the lowest magnitude of the expected social loss.

The minimum is attained by regime A00, with independent committees each in charge of monetary and fiscal policy and no Government interference: as the variance of the AS shock (the AD shock is completely stabilized) increases from 0% to 10% of normal output, expected social loss increases monotonically and with a concave profile to about 1% of normal output. Whether the identical AD and AS slopes are unit-elastic, inelastic or elastic does not matter that much. To be precise, however, the minimal expected social loss obtains – for any variance of the AS shock different from zero – when both AD and AS are identically inelastic; whereas the maximal expected social loss for the same panel A00 obtains when both AD and AS are identically elastic; the unit-elastic case of AD and AS lies in-between, but much closer to the inelastic case. The intuition behind this result is that when each of the two expert committees implements monetary and fiscal policy, respectively, there are no inflation and deficit target differences between the experts and the Government that would lead to social losses due to an overambitious output goal of the Government, neither will there be a separate output target above normal output as the Government is kept aside of macropolicy implementation, by the assignment of this particular institution-design regime.

Second-best comes regime A01, with independent monetary policy and fiscal policy dictated by the Government, where the expected social loss ranges from about 2.5% of normal output with zero variance of the AS shock to about 3% of normal output with variance of 10% of normal output. Third-best, and very close to A01, even dominating it slightly at the higher end of the AS shock variance, is the regime of “shared macropolicy responsibilities” of the committees and the Government, i.e., where \(\theta^M = \theta^F = 0.5\) (regime A0505). Fourth in rank comes regime A10, where monetary policy is dictated by the Government but fiscal policy is delegated to an expert committee (which is histor-
ically or empirically an irrelevant case, and socially undesirable too, as our simulations indicate). Fifth is regime A11, where the Government operates both monetary and fiscal policy. Our simulation quantifies this highest expected loss from a little bit below 5% of normal output for zero AS shock variance to about just below 10% of normal output for variance of the AS shock of 10% of normal output. Note that in the last three compared regimes the combination of AD and AS slopes does matter, because the symmetric elastic case yields the worst case scenario in terms of expected social loss.

If monetary policy is granted the first-mover advantage, an interesting result is that the combination of AD and AS slopes does not matter at all. This is because in these regimes inflation is completely stabilized at its respective target, with optimal policy neutralizing both the effects of AS and AD shocks on it. The ranking of the five regimes is the same as in the previous case of simultaneously moving monetary and fiscal policy. Yet, it should be noted that the simultaneous-move A00 regime performs a bit better in minimizing expected social loss for higher variance of the relevant shocks than the corresponding monetary-leadership A010f regime, except for the case of identical and inelastic AS and AD slopes, where differences in the social loss profiles are hardly distinguishable. We would ascribe this result to the fact that the structural deficit instrument is stabilized at its target completely in A00, but not in A010f, where fiscal policy is a follower and for this reason cannot stabilize the deficit instrument while the monetary leader does stabilize completely inflation on target, exploiting its first-mover advantage.

If fiscal policy is granted a first-mover advantage, expected social loss profiles in all regimes behave in exactly the same fashion as in the simultaneous moves of monetary and fiscal policymakers; the ranking of the five regimes is exactly replicated. As discussed in relation to analogous simulation results, our interpretation of this finding is as follows. The particular assignment of the fiscal instrument as also a target in the objective function leads to the optimal policy outcome that, in our model, fiscal policy always stabilizes the structural deficit share in GDP, at its target $d^*$ when the fiscal policymaker is independent. The structure of our model, in which the fiscal instrument is also a target variable but the monetary instrument, the interest rate, is not and is used to achieve an inflation target, in effect produces this equivalence result in terms of expected social loss. Monetary policy stabilizes completely the AD shock in the simultaneous-move regimes and when it follows fiscal policy, but the AS shock is not stabilized completely and results in social losses, the higher the variance of the AS shock. When monetary policy leads, it now stabilizes the AS shock too virtually in full, and has the chance to move first and stabilize inflation at target completely, in essence superseding the optimal deficit setting at target in the other two columns of panels. When monetary policy leads, fiscal policy stabilizes that AD shock, via the optimal setting of its deficit instrument, but only partly.

4.4.2 Asymmetric AD and AS Slopes

We now point to the main similarities and differences when looking at asymmetric AS and AD slopes compared to the previously analyzed symmetric cases. We stick with
the same baseline cases where the identical AD and AS slopes are unit-elastic, elastic or inelastic, yet allow for a difference in the slopes.

If the AD slope is relatively lower than the AS slope, the introduction of those asymmetries does not matter that much. The differences are very few and quite minor, and can be summarized as follows. The range with lower shock variance as well as, and especially, with higher shock variance between the minimal and maximal expected social loss across slope parameterizations narrows down a bit relative to the same range in the corresponding panels of the symmetric cases. The main similarity concerns all the other details of our analysis above, such as the preserved rankings, curve profiles and relative positions of the inelastic, unit-elastic and elastic curves.

If the AD slope is relatively steeper than the AS slope, with both being in the same elastic or inelastic general category, this again does not matter that much. With lower shock variance as well as, and especially, with higher shock variance, the range between the minimal and maximal expected social losses narrows down even further compared to the case of a lower AD slope relative to the AS slope. As was in the preceding section, the main similarity concerns all the other details of our analysis thus far, namely, the preserved rankings, curve profiles and relative positions (here somewhat intersecting near the high-variance end of the panels for the top row of “shared responsibilities” of the committees and the Government) of the inelastic, unit-elastic and elastic curves.

If AD is inelastic while AS is elastic, or vice versa, the overall impression is still not much different from the main findings of our simulation of expected social losses we already discussed in the other three cases thus far. The similarity is closest to the case of a lower AD slope relative to the higher AS slope, however when comparing the corresponding panels the slope often reverses from increasing to decreasing as one moves from the inelastic via the unit-elastic and to the elastic cases. The dominant similarity across all simulation figures is preserved, once again: the rankings of the regimes are the same, and so are the curve profiles, but their relative positions sometimes minimally change.

4.4.3 Conditional Regimes Inferior to Respective Unconditional Regimes

Recalling our solutions that apply to the conditional regimes, it is now clear why the corresponding unconditional regimes always welfare-dominate – in terms of the expected social losses we computed – the respective conditional regimes. In a nutshell, the conditional regimes reproduce the macro-outcomes of either regime A11 if the escape clause is activated or the respective A regime if it is not. Being, in effect, probability weighted averages of the outcomes in regime A11 and a corresponding A regime, the expected losses in the conditional regimes will be always higher, due to the influence of the expected losses in regime A11, relative to that in the corresponding unconditional regimes. For this obvious reason, we do not present graphical illustrations for the conditional regimes.
5 Concluding Remarks

Institution design for macroeconomic policymaking is an important practical issue. We analyze it in a game-theoretic model allowing for different degrees of autonomy of expert committees vis-à-vis the Government to which society may opt to delegate both monetary and fiscal policy. The model structure nests most of the set-ups in the Kydland-Prescott-Barro-Gordon tradition and is, therefore, quite general. Notably, our framework is richer in policymaker interactions, as we allow for fiscal policy authority involved in macroeconomic decisions. We assume conservative expert committees, as their respective target weights on the stabilization of their primary objectives are more ambitious relative to those of the Government. In addition, expert committees are more ambitious in targeting lower objective values of inflation and deficit-to-GDP ratio than the Government, while their output targets are identical and set at the level of normal output. Our modeling of monetary-fiscal-government interactions via delegation implying a higher or a lower degree of cooperation follows the linear weighting approach to combining the objectives of the policymakers. We allow for an escape clause for the Government in cases of extreme shock realizations, a variation which we denote as conditional commitment regimes. All in all, our environment comprises three social objectives to achieve by two instruments at disposal to three potential policymakers with different responsibilities and powers. Our study across 24 institution-design regimes thus extends the seminal game-theoretic macro-framework in the monetary policy literature to fiscal dimensions and interactions.

Even in this rich setting delegation to autonomous institutions of appointed experts improves the outcomes in terms of average inflation and deficit performance over policies conducted by self-interested politicians in line with the previous literature. Independent monetary and fiscal authorities operating within clear mandates solve the problem of inflation and deficit biases by anchoring inflation and deficit expectations at their conservative targets. Moreover, such institutional arrangements also achieve the strongest stabilization of inflation and of the deficit-to-GDP ratio ex post. Yet greater independence of monetary and fiscal policymakers from the government results in increased output variability around normal output. Insofar output stabilization ex post may matter as a key criterion, this implies a certain trade-off. However, it is minor in magnitude, and the simulated expected social losses by all considered institution-design regimes show convincingly the long-run welfare-dominance of delegation of both monetary and fiscal policy to independent expert committees. The gains in welfare we compare are quite substantial, reducing social losses from about 5-10% of normal output when the Government operates macropolicies alone and targets output 10% higher than normal to less than 1% of normal output when independent monetary and fiscal policy committees are in charge instead, both targeting normal output. The conditional regimes preannouncing an escape clause to be activated following extreme negative shocks may help mitigate short-run output and employment fluctuations, but at the cost of expected social losses that rise considerably from their lower levels attained under the corresponding unconditional regimes.
The model can readily be extended to incorporate dynamics, by repeating the policy game, without or with occasional changes of the legislated institution-design regime, and incorporating economic growth. This remains an avenue for future research as well as an extended modeling of non-policy related features. E.g., the current set-up limits the constraint of the macroeconomy to the necessary minimum implicitly embodying equilibrium private-sector behavior by assuming full information and rational expectations. Alternative macroeconomic models that constrain optimal policy, as well as alternative assumptions regarding the information structure and expectations formation, are left for further work.
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**Ranking of regimes for each variable**

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**Ex post value = expected value of the variable**

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Note: The expected value of a variable is a sum of (target) difference term(s) denoted by $\Delta$ respectively.

**Table 1**: Analytical Results on Expectation Formation by Unconditional Regime
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<tr>
<td>(\gamma^M)</td>
<td>1.5</td>
<td>fixed</td>
</tr>
<tr>
<td>(\gamma^G)</td>
<td>0.5</td>
<td>fixed</td>
</tr>
<tr>
<td>(\gamma^F)</td>
<td>1.5</td>
<td>fixed</td>
</tr>
<tr>
<td>(\gamma^d)</td>
<td>0.5</td>
<td>fixed</td>
</tr>
<tr>
<td>(\chi)</td>
<td>0.3</td>
<td>fixed</td>
</tr>
<tr>
<td>(a)</td>
<td>0.05</td>
<td>fixed</td>
</tr>
<tr>
<td>(b)</td>
<td>0.33; 0.67; 1.0; 1.33; 1.67</td>
<td>alternating by simulation case</td>
</tr>
<tr>
<td>(c)</td>
<td>0.33; 0.67; 1.0; 1.33; 1.67</td>
<td>alternating by simulation case</td>
</tr>
<tr>
<td>(\theta^M)</td>
<td>0.0; 0.5; 1.0</td>
<td>alternating by regime</td>
</tr>
<tr>
<td>(\theta^F)</td>
<td>0.0; 0.5; 1.0</td>
<td>alternating by regime</td>
</tr>
<tr>
<td>(C^M)</td>
<td>0</td>
<td>fixed</td>
</tr>
<tr>
<td>(C^F)</td>
<td>0</td>
<td>fixed</td>
</tr>
</tbody>
</table>

**Table 2:** Parameter Values in the Simulations
### Panel 1: Simulated Expectation Formation, in % (per annum)

<table>
<thead>
<tr>
<th>Regime</th>
<th>A0505</th>
<th>A11</th>
<th>A00</th>
<th>A01</th>
<th>A10</th>
<th>A0f05f</th>
<th>A11lf</th>
<th>A0lf0f</th>
<th>A0lf1f</th>
<th>A1lf0f</th>
<th>A0lf05f</th>
<th>A11lf</th>
<th>A0lf0l</th>
<th>A0lf1l</th>
<th>A1lf0l</th>
<th>A1lf0l</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{t-1}^i$</td>
<td>4.21</td>
<td>10.4</td>
<td>2.15</td>
<td>2.32</td>
<td>10.2</td>
<td>2.69</td>
<td>4.32</td>
<td>2.15</td>
<td>2.32</td>
<td>4.15</td>
<td>4.21</td>
<td>10.4</td>
<td>2.15</td>
<td>2.29</td>
<td>4.15</td>
<td>10.2</td>
</tr>
<tr>
<td>$E_{t-1}^d$</td>
<td>3.82</td>
<td><strong>6.00</strong></td>
<td>3.00</td>
<td>6.40</td>
<td>3.00</td>
<td>3.84</td>
<td>6.30</td>
<td>3.00</td>
<td>6.40</td>
<td>3.00</td>
<td>3.75</td>
<td>6.30</td>
<td><strong>3.00</strong></td>
<td>5.90</td>
<td><strong>3.00</strong></td>
<td></td>
</tr>
<tr>
<td>$E_{t-1}^\delta$</td>
<td>3.82</td>
<td>6.00</td>
<td>3.00</td>
<td>6.40</td>
<td>3.00</td>
<td>3.84</td>
<td>6.30</td>
<td>3.00</td>
<td>6.40</td>
<td>3.00</td>
<td>3.75</td>
<td>6.30</td>
<td>3.00</td>
<td>5.90</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>$E_{t-1}^{\pi t}$</td>
<td>4.02</td>
<td>10.1</td>
<td>2.00</td>
<td>2.00</td>
<td>10.1</td>
<td><strong>2.50</strong></td>
<td><strong>4.00</strong></td>
<td><strong>2.00</strong></td>
<td><strong>2.00</strong></td>
<td><strong>4.00</strong></td>
<td>4.02</td>
<td>10.1</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>10.1</td>
</tr>
</tbody>
</table>

### Panel 2: Simulated Stabilization, in % (per annum), in Response to AD and AS Shocks of 1% of $Y^N$

<table>
<thead>
<tr>
<th></th>
<th>$i_t$ ($c_t^i$)</th>
<th>$i_t$ ($c_t^S$)</th>
<th>$d_t$ ($c_t^d$)</th>
<th>$d_t$ ($c_t^S$)</th>
<th>$\delta_t$ ($c_t^\delta$)</th>
<th>$\delta_t$ ($c_t^S$)</th>
<th>$\pi_t$ ($c_t^\pi$)</th>
<th>$\pi_t$ ($c_t^S$)</th>
<th>$y_t$ ($c_t^y$)</th>
<th>$y_t$ ($c_t^S$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{t-1}^i$</td>
<td>+1.00</td>
<td>+1.00</td>
<td>+1.00</td>
<td>+1.00</td>
<td>+1.00</td>
<td>+1.00</td>
<td>+1.00</td>
<td>+1.00</td>
<td>+1.00</td>
<td>+1.00</td>
</tr>
<tr>
<td>$E_{t-1}^d$</td>
<td>-0.01</td>
<td>0</td>
<td>-0.01</td>
<td>-0.08</td>
<td>-0.003</td>
<td>-0.01</td>
<td>-0.07</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$E_{t-1}^\delta$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$E_{t-1}^{\pi t}$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Note: Bold entries indicate that expected values are also indeed obtained ex post with certainty. For shocks of the size of 1% of $E_{t-1}^i [Y_t] = Y^N$, numbers in the columns of panels 1 and 2 for each macroeconomic variable add up directly to yield the actual (ex post) optimal level of the respective policy instrument variable and the resulting level of the respective variable by each institution design regime. For example, the optimal interest rate instrument in the second (0505) column is: 4.21 + 1.0 - 0.63 = 4.58 % p.a.

**Table 3:** Simulation Results on Expectations and Stabilization by Unconditional Regime under Symmetric Unit-Elastic Slopes of AD and AS (b=c=1)
<table>
<thead>
<tr>
<th>&quot;ISUS&quot;</th>
<th>Simultaneous Moves</th>
<th>Monetary Leader</th>
<th>Fiscal Leader</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regime</td>
<td>A0505</td>
<td>A11</td>
<td>A00</td>
</tr>
<tr>
<td>(E_{t-1}[i_t])</td>
<td>3.65</td>
<td>7.65</td>
<td>2.30</td>
</tr>
<tr>
<td>(E_{t-1}[d_t])</td>
<td>3.84</td>
<td>6.00</td>
<td>3.00</td>
</tr>
<tr>
<td>(E_{t-1}[\delta_t])</td>
<td>3.84</td>
<td>6.00</td>
<td>3.00</td>
</tr>
<tr>
<td>(E_{t-1}[\pi_t])</td>
<td>3.26</td>
<td>7.05</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Panel 1: Simulated Expectation Formation, in % (per annum)

| Panel 2: Simulated Stabilization, in % (per annum), in Response to AD and AS Shocks of 1% of \(Y^N\) |
|-------|-----------------|-----------------|-----------------|-----------------|
| \(i_t (\varepsilon_t^M)\) | +2.00 | +2.00 | +2.00 | +2.00 | +2.00 | -1.97 | -1.96 | -1.97 | -1.96 | -1.97 | +2.00 | +2.00 | +2.00 | +2.00 | +2.00 | +2.00 |
| \(i_t (\varepsilon_t^S)\) | -1.76 | -1.35 | -1.95 | -1.96 | -1.35 | +2.00 | +2.00 | +2.00 | +2.00 | +2.00 | -1.76 | -1.35 | -1.95 | -1.95 | -1.95 | -1.35 |
| \(d_t (\varepsilon_t^M)\) | 0 | 0 | 0 | 0 | 0 | -0.03 | -0.10 | -0.01 | -0.10 | -0.01 | 0 | 0 | 0 | 0 | 0 | 0 |
| \(d_t (\varepsilon_t^S)\) | -0.02 | 0 | -0.01 | -0.09 | -0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| \(\delta_t (\varepsilon_t^M)\) | 0 | 0 | 0 | 0 | 0 | -0.33 | -0.39 | -0.39 | -0.39 | -0.30 | 0 | 0 | 0 | 0 | 0 | 0 |
| \(\delta_t (\varepsilon_t^S)\) | -0.28 | -0.20 | -0.30 | -0.37 | -0.30 | 0 | 0 | 0 | 0 | 0 | -0.27 | -0.27 | -0.29 | -0.30 | -0.20 |
| \(\pi_t (\varepsilon_t^M)\) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| \(\pi_t (\varepsilon_t^S)\) | -0.27 | -0.67 | -0.08 | -0.08 | -0.67 | 0 | 0 | 0 | 0 | 0 | -0.27 | -0.67 | -0.08 | -0.08 | -0.67 |
| \(y_t (\varepsilon_t^M)\) | 0 | 0 | 0 | 0 | 0 | +0.98 | +0.98 | +0.98 | +0.98 | +0.98 | 0 | 0 | 0 | 0 | 0 | 0 |
| \(y_t (\varepsilon_t^S)\) | +0.86 | +0.67 | +0.96 | +0.96 | +0.67 | 0 | 0 | 0 | 0 | 0 | +0.86 | +0.67 | +0.96 | +0.96 | +0.67 |

Note: Bold entries indicate that expected values are also indeed obtained ex post with certainty. For shocks of the size of 1% of \(E_{t-1}[Y_t] = Y^N\), numbers in the columns of panels 1 and 2 for each macroeconomic variable add up directly to yield the actual (ex post) optimal level of the respective policy instrument variable and the resulting level of the respective variable by each institution design regime. For example, the optimal interest rate instrument in the second (A0505) column is: 3.65 + 2.0 – 1.76 = 3.89 % p.a.

**Table 4:** Simulation Results on Expectations and Stabilization by Unconditional Regime under Symmetric Inelastic Slopes of AD and AS (b=c=0.5)
<table>
<thead>
<tr>
<th>“ESUS”</th>
<th>Simultaneous Moves</th>
<th>Monetary Leader</th>
<th>Fiscal Leader</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regime</td>
<td>A0505</td>
<td>A11</td>
<td>A00</td>
</tr>
<tr>
<td>$E_{t-1}[e]$</td>
<td>5.64</td>
<td>16.33</td>
<td>2.08</td>
</tr>
<tr>
<td>$E_{t-1}[d]$</td>
<td>3.82</td>
<td><strong>6.00</strong></td>
<td>3.00</td>
</tr>
<tr>
<td>$E_{t-1}[\delta]$</td>
<td>5.55</td>
<td>16.18</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Panel 1: Simulated Expectation Formation, in % (per annum)

| Panel 2: Simulated Stabilization, in % (per annum), in Response to AD and AS Shocks of 1% of $Y^N$ |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| $i_t \left(e_t^P\right)$ | +0.50 | +0.50 | +0.50 | +0.50 | +0.50 | -0.49 | -0.49 | -0.49 | -0.49 | -0.49 | +0.50 | +0.50 | +0.50 | +0.50 | +0.50 | +0.50 |
| $i_t \left(e_t^S\right)$ | -0.15 | -0.06 | -0.30 | -0.31 | -0.06 | +0.50 | +0.50 | +0.50 | +0.50 | +0.50 | -0.62 | -0.34 | -0.87 | -0.87 | -0.87 | -0.34 |
| $d_t \left(e_t^P\right)$ | 0 | 0 | 0 | 0 | 0 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | 0 | 0 | 0 | 0 | 0 |
| $d_t \left(e_t^S\right)$ | -0.01 | 0 | -0.01 | -0.05 | -0.0009 | 0 | 0 | 0 | 0 | 0 | -0.005 | -0.03 | 0 | -0.007 | 0 | 0 |
| $\delta_t \left(e_t^P\right)$ | 0 | 0 | 0 | 0 | 0 | -0.33 | -0.39 | -0.30 | -0.39 | -0.30 | 0 | 0 | 0 | 0 | 0 | 0 |
| $\delta_t \left(e_t^S\right)$ | -0.09 | -0.03 | -0.18 | -0.23 | -0.18 | 0 | 0 | 0 | 0 | 0 | -0.19 | -0.13 | -0.26 | -0.26 | -0.26 | -0.1 |
| $\pi_t \left(\pi_t^P\right)$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $\pi_t \left(\pi_t^S\right)$ | -0.36 | -0.44 | -0.20 | -0.20 | -0.44 | 0 | 0 | 0 | 0 | 0 | -0.38 | -0.67 | -0.14 | -0.14 | -0.14 | -0.67 |
| $y_t \left(\pi_t^P\right)$ | 0 | 0 | 0 | 0 | 0 | +0.98 | +0.98 | +0.98 | +0.98 | +0.98 | 0 | 0 | 0 | 0 | 0 | 0 |
| $y_t \left(\pi_t^S\right)$ | +0.29 | +0.11 | +0.60 | +0.60 | +0.11 | 0 | 0 | 0 | 0 | 0 | +0.62 | +0.33 | +0.86 | +0.86 | +0.86 | +0.33 |

Note: Bold entries indicate that expected values are also indeed obtained ex post with certainty. For shocks of the size of 1% of $E_{t-1}[Y] = Y^N$, numbers in the columns of panels 1 and 2 for each macroeconomic variable add up directly to yield the actual (ex post) optimal level of the respective policy instrument variable and the resulting level of the respective variable by each institution design regime. For example, the optimal interest rate instrument in the second (A0505) column is: $5.64 + 0.5 - 0.15 = 5.99\%$ p.a.

Table 5: Simulation Results on Expectations and Stabilization by Unconditional Regime under Symmetric Elastic Slopes of AD and AS (b=c=2)
Figure 1: Solutions to the Inflation Bias in the Classic Literature
Our Model Nests
Figure 2: Classification and Coding of the Institution-Design Regimes We Study
Figure 3: Summary of Simulated Expected Social Loss under Unconditional Commitment and Symmetric Slopes of AD and AS \( (b = c) \), \( Y^N = 1.68 \times 10^{13} \) (which is US GDP in current USD in 2013, World Bank online data, and is used in the figures and tables containing simulation results that follow), \( Y^*G = 1.1 \times Y^N \). Black solid lines indicate the unit-elastic case \( (b = c = 1) \), used as a benchmark too in the figures that follow), red lines with a cross indicate the elastic case \( (b = c = 2) \), and blue lines with a circle indicate the inelastic case \( (b = c = 0.5) \). The LHS column shows the simultaneous-move institution-design regimes, the middle column shows the regimes where monetary policy is the leader \( (lf) \), and the RHS column shows the regimes where fiscal policy is the leader \( (fl) \). The first row shows the general case under \( \theta^M = \theta^F = 0.5 \); the second row shows the special case of Government joint optimization of monetary and fiscal policies \( (\theta^M = \theta^F = 1) \); the third row shows the special case of independent monetary and fiscal policy expert committees \( (\theta^M = \theta^F = 0) \); the fourth row shows the special case of independent monetary policy but dependent fiscal policy decided by the Government \( (\theta^M = 0, \theta^F = 1) \); the fifth row shows the special case of independent fiscal policy but dependent monetary policy decided by the Government \( (\theta^M = 1, \theta^F = 0) \).
Figure 4: Summary of Simulated Expected Social Loss under Unconditional Commitment and Asymmetric Slopes of AD (Lower) and AS (Higher) \((b < c)\), \(Y^N = 1.68 \times 10^{13}\), \(Y^*G = 1.1 \times Y^N\). Black solid lines indicate the unit-elastic symmetric benchmark \((b = c = 1)\), red lines with a cross indicate the elastic case \((1.33 = b < c = 1.67)\), and blue lines with a circle indicate the inelastic case \((0.33 = b < c = 0.67)\). The LHS column shows the simultaneous-move institution-design regimes, the middle column shows the regimes where monetary policy is the leader \((lf)\), and the RHS column shows the regimes where fiscal policy is the leader \((fl)\). The first row shows the general case under \(\theta^M = \theta^F = 0.5\); the second row shows the special case of Government joint optimization of monetary and fiscal policies \((\theta^M = \theta^F = 1)\); the third row shows the special case of independent monetary and fiscal policy expert committees \((\theta^M = \theta^F = 0)\); the fourth row shows the special case of independent monetary policy but dependent fiscal policy decided by the Government \((\theta^M = 0, \theta^F = 1)\); the fifth row shows the special case of independent fiscal policy but dependent monetary policy decided by the Government \((\theta^M = 1, \theta^F = 0)\).
Figure 5: Summary of Simulated Expected Social Loss under Unconditional Commitment and Asymmetric Slopes of AD (Higher) and AS (Lower) \((b > c)\), \(Y^N = 1.68 \times 10^{13}\), \(Y^{*,G} = 1.1 \times Y^N\). Black solid lines indicate the unit-elastic symmetric benchmark \((b = c = 1)\), red lines with a cross indicate the elastic case \((1.67 = b > c = 1.33)\), and blue lines with a circle indicate the inelastic case \((0.67 = b > c = 0.33)\). The LHS column shows the simultaneous-move institution-design regimes, the middle column shows the regimes where monetary policy is the leader \((lf)\), and the RHS column shows the regimes where fiscal policy is the leader \((fl)\). The first row shows the general case under \(\theta^M = \theta^F = 0.5\); the second row shows the special case of Government joint optimization of monetary and fiscal policies \((\theta^M = \theta^F = 1)\); the third row shows the special case of independent monetary and fiscal policy expert committees \((\theta^M = \theta^F = 0)\); the fourth row shows the special case of independent monetary policy but dependent fiscal policy decided by the Government \((\theta^M = 0, \theta^F = 1)\); the fifth row shows the special case of independent fiscal policy but dependent monetary policy decided by the Government \((\theta^M = 1, \theta^F = 0)\).
Figure 6: Summary of Simulated Expected Social Loss under Unconditional Commitment and Strongly Asymmetric Slopes of AD and AS, whereby one is inelastic and the other one elastic, $Y^N = 1.68 \times 10^{13}$, $Y*G = 1.1 \times Y^N$. Black solid lines indicate again – as a benchmark for comparisons – the unit-elastic symmetric case ($b = c = 1$), magenta lines with a cross indicate the asymmetric case with elastic (hence, higher) AD and inelastic (lower) AS ($1.67 = b > c = 0.33$), and green lines with a circle indicate the asymmetric case with inelastic (hence, lower) AD and elastic (higher) AS ($0.33 = b < c = 1.67$). The LHS column shows the simultaneous-move institution-design regimes, the middle column shows the regimes where monetary policy is the leader ($lf$), and the RHS column shows the regimes where fiscal policy is the leader ($fl$). The first row shows the general case under $\theta^M = \theta^F = 0.5$; the second row shows the special case of Government joint optimization of monetary and fiscal policies ($\theta^M = \theta^F = 1$); the third row shows the special case of independent monetary and fiscal policy expert committees ($\theta^M = \theta^F = 0$); the fourth row shows the special case of independent monetary policy but dependent fiscal policy decided by the Government ($\theta^M = 0$, $\theta^F = 1$); the fifth row shows the special case of independent fiscal policy but dependent monetary policy decided by the Government ($\theta^M = 1$, $\theta^F = 0$).
A Model Solution

Throughout, we use the following notation:

- Composite parameters involving institution-design choice (functions of $\theta^M$ and/or $\theta^F$) given our ‘baseline’ assumptions for the policy weights:

\[
\begin{align*}
\Theta^M_n &= \theta^M\gamma^G_n + (1 - \theta^M) \gamma^M_n > 0 \\
\Theta^M_y &= 2\theta^M\gamma^G_y + (1 - \theta^M) \gamma^M_y > 0, \\
\Theta^F_d &= \theta^F\gamma^G_d + (1 - \theta^F) \gamma^F_d > 0 \\
\Theta^F_y &= 2\theta^F\gamma^G_y + (1 - \theta^F) \gamma^F_y > 0, \\
\Theta^{FM}_{n,i} &= (1 - \theta^M) \left( \Theta^F_y \gamma^M_n + \theta^F \gamma^G_n \gamma^M_n \right) + \theta^M (1 - \theta^F) \gamma^G_n \gamma^F_y > 0, \\
\Theta^{FM}_{n,d} &= (1 - \theta^M) \left( \Theta^F_y \gamma^M_n - \theta^F \gamma^G_n \gamma^M_n \right) + \theta^M (1 - \theta^F) \gamma^G_n \gamma^F_y > 0.
\end{align*}
\]

- Composite parameters involving model economy properties (functions of $a$ or $c$):

\[
\begin{align*}
\Gamma^{aG}_{\pi y} &= \gamma^G_{\pi y} + c^2 \gamma^G_y > 0, \\
\Gamma^{cG}_{\pi y} &= 2\gamma^M_{\pi y} + c^2 \gamma^M_y > 0, \\
\Gamma^{aF}_{dy} &= v2\gamma^F_d + a^2 \gamma^F_y > 0, \\
\end{align*}
\]

- Composite parameters involving only policy weights ($\gamma$’s) given our ‘baseline’ assumptions for the policy weights:

\[
\Gamma^{GM}_{\pi y} \equiv 2\gamma^G_{\pi y} - \gamma^G_{\pi y} > 0
\]

A.1 Nash Equilibrium

A.1.1 General Case – Regime A: Intermediate Degrees of Independence

In a simultaneous-move game Nash equilibrium, we derive the following expressions for the optimized policy instruments, the nominal interest rate and the structural budget deficit, and the resulting equilibrium macroeconomic outcomes, in terms of (ex post) inflation, output and budget deficit:

\[
\begin{align*}
\iota_i &= \frac{\theta^M \gamma^G_{\pi y} \pi^* + (1 - \theta^M) \gamma^M_{\pi y} \pi^*}{\Theta^M_n} + \frac{a \left[ \theta^F \gamma^G_{\pi y} \pi^* + (1 - \theta^F) \gamma^F_{\pi y} \pi^* \right]}{b \Theta^M_d} \\
&+ \frac{(1 - \theta^M) \theta^F \gamma^G_{\pi y} \gamma^G_{\pi y} a^2}{\Theta^M_n} \left( \pi^*G - \pi^* \right) \\
&+ \left( \frac{\theta^M}{\Theta^M_n} + \frac{(1 - \theta^M) \theta^F a^2}{b (1 + a\chi) \Theta^F_d \Theta^M_n} \right) \gamma^G_{\pi y} \left( \gamma^G_{\pi y} - y^N \right) \\
&+ \frac{1}{b} \left( \frac{2\theta^M \Theta^F_d (1 + a\chi)^2 + a^2 \Theta^{FM}_{n,i} \gamma^G_{i,y}}{b \Theta^F_d (1 + a\chi) \left( 2\Theta^M_n + c^2 \Theta^M_d \right)^2} \right).
\end{align*}
\]
\[ d_t = \frac{\theta^F \gamma^G d^t \gamma^F d^t}{\Theta^F_d} + \frac{(1 - \theta^F) \gamma^F d^t}{(1 + \alpha \chi) \Theta^F_d \Theta^M_d} \left[ \frac{2a}{c} \left( \pi^G - \pi^* \right) + \gamma^G \left( y^*G - y^N \right) \right] - \frac{a \Theta^F_{y,d}}{(1 + \alpha \chi) \Theta^F_d \left( 2\Theta^M_d + c^2 \Theta^M_y \right) \epsilon_t}, \]  
(A-2)

\[ \pi_t = \frac{\theta^M \gamma^G \pi^G + (1 - \theta^M) \gamma^G \pi^*}{\Theta^M_d} + \frac{\theta^M \gamma^C \gamma^G_c}{\Theta^M_y} \left( y^*G - y^N \right) - \frac{c \Theta^M_y}{2\Theta^M_d + c^2 \Theta^M_y} \epsilon_t^S, \]  
(A-3)

\[ \delta_t = d_t - \frac{2 \Theta^M_y}{2 \Theta^M_d + c^2 \Theta^M_y} \epsilon_t^S, \]  
(A-4)

\[ y_t = y^N + \frac{2 \Theta^M_y}{2 \Theta^M_d + c^2 \Theta^M_y} \epsilon_t^S. \]  
(A-5)

**A.1.2 Special Cases: Corner Degrees of Independence**

**Institution-Design Regime A00: Simultaneous-Move Independent Monetary and Fiscal Policymakers Each with a Single Instrument and Two Targets**

In a simultaneous-move Nash game equilibrium, this institution-design regime implements the “Svensson solution” not only for monetary policy but also for fiscal policy. In it, there is a shared secondary output target by assignment, \( y^*M = y^*F = y^N < y^*G \), but different weights, \( \gamma^M \neq \gamma^F \), for the monetary and fiscal policymakers, and own respective primary targets and weights.

\[ r_t^0 = \pi^* + \frac{a}{b} \rho^* + \frac{1}{b} \epsilon_t^D - \frac{\gamma^M \gamma^M a}{b \gamma^D \gamma^M (1 + \alpha \chi) \epsilon_t^S}, \]  
(A-7)

\[ d_t^0 = d^* - \frac{\gamma^F \gamma^M a}{\gamma^D \gamma^M (1 + \alpha \chi) \epsilon_t^S}, \]  
(A-8)

\[ \pi_t^0 = \pi^* - \frac{\gamma^F c}{\gamma^M \gamma^M \epsilon_t^S}, \]  
(A-9)

\[ \delta_t^0 = d_t^0 - \frac{2 \gamma^M \epsilon_t^S}{\gamma^M \epsilon_t^S}, \]  
(A-10)

\[ y_t^0 = y^N + \frac{2 \gamma^M \epsilon_t^S}{\gamma^M \epsilon_t^S}. \]  
(A-11)

**Institution-Design Regime A01: Simultaneous-Move Independent Monetary and Dependent Fiscal Policymakers Each with a Single Instrument and Two Targets**

In a simultaneous-move Nash game equilibrium, this institution-design regime implements the “Svensson solution” for monetary policy but not for fiscal policy, which is decided by the Government. It is, in the latter sense, the standard case considered in the monetary policy literature on the inflationary bias.
$$\psi_i^0 = \pi^* + \frac{a}{b} d^rG + \frac{a^2}{b} \left[ \frac{\gamma_G}{G} \left( \pi^{rg} - \pi^* \right) + \gamma_y \left( y^{rg} - y^N \right) \right]$$
$$+ \frac{1}{b} \varepsilon^D_i - \frac{2 \gamma_M^G}{\gamma_M^G + a \chi} \left( \frac{G^{yM} + \alpha}{\gamma_M^G + \alpha} \right) \frac{\gamma^{yM}}{\gamma_M^G + \alpha} \varepsilon_i^S,$$  \quad (A-12)$$
$$d_i^0 = d^rG + \frac{a}{\gamma_M^G + a \chi} \left[ \frac{\gamma_G}{G} \left( \pi^{rg} - \pi^* \right) + \gamma_y \left( y^{rg} - y^N \right) \right] - \frac{a \gamma_y}{\gamma_M^G + a \chi} \varepsilon_i^S,$$  \quad (A-13)
$$d_i^0 = d_i^0 \gamma^G M \varepsilon_i^S.$$  \quad (A-14)

The equilibrium inflation and output – ex ante and, for an identical AS shock having materialized, also ex post – are the same as in Regime 00: \( \psi_i^0 = \psi_i^0 \) and \( y_i^0 = y_i^0 \) (for any given \( \varepsilon_i^S \)).

**Institution-Design Regime A10: Simultaneous-Move Dependent Monetary and Independent Fiscal Policymakers Each with a Single Instrument and Two Targets** In a simultaneous-move Nash game equilibrium, this institution-design regime implements the “Svensson solution” for fiscal policy but not for monetary policy, which is decided by the Government. It is, in the latter sense, the reverse case to the standard one considered in the monetary policy literature on the inflationary bias (just above).

$$\psi_i^{10} = \pi^* G + \frac{a}{b} d^rG + \frac{\gamma_G}{e} \left( y^{rg} - y^N \right)$$
$$+ \frac{1}{b} \varepsilon^D_i - \frac{\gamma_G}{e} \frac{2 \gamma^{yF}}{\gamma^{yF} + a \alpha} \varepsilon_i^S,$$  \quad (A-15)
$$d_i^{10} = d^rG - \frac{\gamma^{yF} \gamma^{yG}}{2 \gamma^{yF} \gamma^{yG} + (1 + a \alpha)} \varepsilon_i^S,$$  \quad (A-16)
$$d_i^{10} = d_i^{10} \gamma^G M \varepsilon_i^S.$$  \quad (A-17)

The equilibrium inflation and output – ex ante and, for an identical AS shock having materialized, also ex post – are the same as in Regime 11: \( \psi_i^{10} = \psi_i^{11} \) and \( y_i^{10} = y_i^{11} \) (for any given \( \varepsilon_i^S \)).

**Institution-Design Regime A11: The Government as a Single Simultaneous-Move Policymaker with Two Instruments and Three Targets**

$$\psi_i^{11} = \pi^* G + \frac{a}{b} d^rG + \frac{\theta^M}{\theta^M} \frac{C^G}{\Theta^M} \left( y^{rg} - y^N \right) + \frac{1}{b} \varepsilon^D_i - \frac{\gamma^G}{b \gamma^G + \alpha} \varepsilon_i^S,$$  \quad (A-18)
$$d_i^{11} = d^rG = \text{const},$$  \quad (A-19)
$$y_i^{11} = y^N + \gamma^G \varepsilon_i^S.$$

(A-21)
A.2 von Stackelberg Equilibrium with Monetary Policy Leadership

A.2.1 General Case – Regime Alf: Intermediate Degrees of Independence

In a sequential-move von Stackelberg game equilibrium where the monetary authority is the leader, we derive the following expressions for the optimized policy instruments, the nominal interest rate and the structural budget deficit, and the resulting equilibrium macroeconomic outcomes, in terms of (ex post) inflation, output and budget deficit:

\[
i^I_t = \frac{\theta^M \gamma^*_G \pi^*_G + (1 - \theta^M) \gamma^*_w \pi^*_w}{\Theta^I_t} + \frac{a \left[ \theta^F \gamma^*_G d^*_G + (1 - \theta^F) \gamma^*_d d^*_d \right]}{b \Theta^F_t} \quad \text{[same terms as in Nash]} \\
+ \frac{1 - \theta^M}{\Theta^F_t \Theta^I_t c (1 + a \chi)} \left( \pi^*_G - \pi^* \right) \quad \text{[same term as in Nash]} \\
+ \frac{\theta^F \gamma^*_G a^2}{b (1 + a \chi) \Theta^F_t} \left( y^*_G - y^* \right) \\
- \frac{2 (1 + a \chi) \Theta^F_t}{c \left[ 2 \Theta^F_t (1 + a \chi)^2 + a^2 \Theta^F_y \right]} \varepsilon^I_t + \frac{1}{c} \varepsilon^S_t, \quad (A-23)
\]

\[
d^I_t = \frac{\theta^F \gamma^*_G d^*_G + (1 - \theta^F) \gamma^*_d d^*_d}{\Theta^I_t} \quad \text{[same term as in Nash]} \\
- \frac{\theta^F a}{(1 + a \chi) \Theta^I_t} \left[ \frac{(1 - \theta^M) \gamma^*_w \gamma^*_G}{\Theta^I_t c} \left( \pi^*_G - \pi^* \right) + \gamma^*_y \left( y^*_G - y^* \right) \right] \\
- \frac{a \Theta^F_y}{2 \Theta^F_t (1 + a \chi)^2 + a^2 \Theta^F_y} \varepsilon^I_t, \quad (A-25)
\]

\[
\pi^I_t = \frac{\theta^M \gamma^*_G \pi^*_G + (1 - \theta^M) \gamma^*_w \pi^*_w}{\Theta^I_t}, \quad (A-27)
\]

\[
\delta^I_t = d^I_t - \frac{2 \Theta^F_t (1 + a \chi)}{2 \Theta^F_t + c^2 \Theta^F_y} \varepsilon^I_t, \quad \text{(A-28)}
\]

\[
y^I_t = y^* + \frac{2 \Theta^F_t (1 + a \chi)}{2 \Theta^F_t + c^2 \Theta^F_y} \varepsilon^I_t. \quad \text{(A-29)}
\]
A.2.2 Special Cases: Corner Degrees of Independence

Institution-Design Regime A1l1f: The Government as a Single Sequential-Move Policymaker with Two Instruments, Three Targets and Monetary Leadership

\[ i^{11f} = \pi^*_G + \frac{a}{b} d^*_G + \frac{\gamma_G a^2}{\gamma_d b (1 + a \chi)} (y^*_G - y^N) - \frac{\gamma_G (1 + a \chi)}{c \gamma_d^2 (1 + a \chi)^2 + \gamma_G a^2} \varepsilon^D + \frac{1}{c} \varepsilon^S, \]  
(A-30)

\[ d^{11f} = d^*_G + \frac{\gamma_G a}{\gamma_d^2 (1 + a \chi)^2 + \gamma_G a^2} \varepsilon^D, \]  
(A-31)

\[ \pi^{11f} = \pi^*_G = \text{const}, \]  
(A-32)

\[ \delta^{11f} = d^{11f} - \frac{\gamma_G (1 + a \chi)}{\gamma_d^2 (1 + a \chi)^2 + \gamma_G a^2} \varepsilon^D, \]  
(A-33)

\[ y^{11f} = y^N + \frac{\gamma_G (1 + a \chi)}{\gamma_d^2 (1 + a \chi)^2 + \gamma_G a^2} \varepsilon^D. \]  
(A-34)

Institution-Design Regime A0l0f: Independent Monetary Leader and Independent Fiscal Follower Each with a Single Instrument

In a sequential-move von Stackelberg game equilibrium where the monetary authority is the leader, this institution-design regime implements the “Svensson solution” not only for monetary policy but also for fiscal policy. In it, there is a shared secondary/output target by assignment, \( y^M = y^F = y^N < y^G \), but different weights, \( \gamma_M^* \neq \gamma_F^* \), for the monetary and fiscal policymakers, and own respective primary targets and weights.

\[ i^{00f} = \pi^* + \frac{a}{b} d^* - \frac{2 \gamma_F (1 + a \chi)}{c \gamma_d (1 + a \chi)^2 + \gamma_F a^2} \varepsilon^D + \frac{1}{c} \varepsilon^S, \]  
(A-35)

\[ d^{00f} = d^* - \frac{\gamma_F a}{2 \gamma_d^2 (1 + a \chi)^2 + \gamma_F a^2} \varepsilon^D, \]  
(A-36)

\[ \pi^{00f} = \pi^* = \text{const}, \]  
(A-37)

\[ \delta^{00f} = \delta^{00f} - \frac{2 \gamma_F (1 + a \chi)}{2 \gamma_d^2 (1 + a \chi)^2 + \gamma_F a^2} \varepsilon^D, \]  
(A-38)

\[ y^{00f} = y^N + \frac{2 \gamma_F (1 + a \chi)}{2 \gamma_d^2 (1 + a \chi)^2 + \gamma_F a^2} \varepsilon^D. \]  
(A-39)

Institution-Design Regime A0l1f: Independent Monetary Leader and Dependent Fiscal Follower Each with a Single Instrument

In a sequential-move von Stackelberg game equilibrium where the monetary authority is the leader, this institution-design regime implements the “Svensson solution” for monetary policy but not for fiscal policy, which is decided by the Government. It is, in the latter sense, the standard case considered in the monetary policy literature on the inflationary bias.
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\[ \pi_t^{01f} = \pi^* + \frac{a}{b} d^{*,G} \]
\[ + \frac{a^2}{\gamma_d^1 (1 + a \chi)} \left[ \frac{\gamma^G}{c} \left( \pi^{*,G} - \pi^* \right) + \gamma_y^G \left( y^{*,G} - y^N \right) \right] \]
\[ - \frac{\gamma^G (1 + a \chi)^2 + \gamma_y^G a^2}{\gamma_y^G (1 + a \chi)^2 + \gamma_y^G a^2} \varepsilon_t^D + \frac{1}{c} \varepsilon_t^S, \]  \hspace{1cm} (A-40)

\[ d_t^{01f} = d^{*,G} + \frac{a}{\gamma_d^1 (1 + a \chi)} \left[ \frac{\gamma^G}{c} \left( \pi^{*,G} - \pi^* \right) + \gamma_y^G \left( y^{*,G} - y^N \right) \right] \]
\[ - \frac{\gamma^G (1 + a \chi)^2 + \gamma_y^G a^2}{\gamma_y^G (1 + a \chi)^2 + \gamma_y^G a^2} \varepsilon_t^D, \]  \hspace{1cm} (A-41)

\[ \delta_t^{01f} = d_t^{01f} - \frac{\gamma^G (1 + a \chi) \chi}{\gamma_d^1 (1 + a \chi)^2 + \gamma_y^G a^2} \varepsilon_t^D, \]  \hspace{1cm} (A-42)

\[ y_t^{01f} = y^N + \frac{\gamma^G (1 + a \chi) \chi}{\gamma_d^1 (1 + a \chi)^2 + \gamma_y^G a^2} \varepsilon_t^D. \]  \hspace{1cm} (A-43)

The equilibrium (ex post) inflation is the same as in Regime 0L0f: \( \pi_t^{01f} = \pi_t^{00f} \).

Institution-Design Regime A1l0f: Dependent Monetary Leader and Independent Fiscal Follower Each with a Single Instrument

In a sequential-move von Stackelberg game equilibrium where the monetary authority is the leader, this institution-design regime implements the “Svensson solution” for fiscal policy but not for monetary policy, which is decided by the Government. It is, in the latter sense, the reverse case to the standard one considered in the monetary policy literature on the inflationary bias (just above).

\[ \pi_t^{10f} = \pi^* + \frac{a}{b} d^{*,G} - \frac{2 \gamma^G (1 + a \chi)}{c \left[ 2 \gamma_d^1 (1 + a \chi)^2 + \gamma_y^G a^2 \right]} \varepsilon_t^D + \frac{1}{c} \varepsilon_t^S, \]  \hspace{1cm} (A-44)

\[ d_t^{10f} = d^{*,G} - \frac{\gamma_d^1 a}{2 \gamma_d^1 (1 + a \chi)^2 + \gamma_y^G a^2} \varepsilon_t^D, \]  \hspace{1cm} (A-45)

\[ \delta_t^{10f} = d_t^{10f} - \frac{2 \gamma^G (1 + a \chi) \chi}{2 \gamma_d^1 (1 + a \chi)^2 + \gamma_y^G a^2} \varepsilon_t^D. \]  \hspace{1cm} (A-46)

The equilibrium (ex post) inflation is the same as in Regime 1l1f: \( \pi_t^{10f} = \pi_t^{11f} \); the equilibrium (ex post) output is the same as in Regime 0l0f: \( y_t^{10f} = y_t^{00f} \).

A.3 von Stackelberg Equilibrium with Fiscal Policy Leadership

A.3.1 General Case – Regime A1f: Intermediate Degrees of Independence

In a sequential-move von Stackelberg game equilibrium where the fiscal authority is the leader, we derive the following expressions for the optimized policy instruments, the nominal interest rate and the structural budget deficit, and the resulting equilibrium macroeconomic outcomes, in terms of (ex post) inflation, output and budget deficit:
\[
\begin{align*}
i_t^* &= \beta M^d z_\gamma \pi^* + (1 - \theta M) \gamma M^d \pi^* + a \left[ \beta M^d d*^G + (1 - \theta^F) \gamma d^* \right] \quad [\text{same terms as in Nash and in MP leader}] \\
&\quad + \left( 1 - \theta M \right) \beta M^d \gamma M^d a^2 \left( \gamma^* - \pi^* \right) \quad [\text{same terms as in Nash and in MP leader}] \\
&\quad + \left( \frac{\gamma^*_a}{\beta M^d} + \frac{(1 - \theta M)}{b (1 + \alpha \chi)} \theta F^d \gamma M^d \right) \gamma y^y \left( y^* - y^y \right) \quad [\text{same terms as in Nash}] \\
&\quad + \frac{1}{b} \frac{\beta M^d y^d}{\gamma F^d} (1 + \alpha \chi) \\
&\quad - \frac{2 \beta M^d \gamma M^d}{b \theta F^d + c^2 \theta F^d} (ac)^2 S_i^t. \\
\end{align*}
\]
\[\text{(A-47)}\]

\[
\begin{align*}
d_t^* &= \beta F^d \gamma y^d + (1 - \theta^F) \gamma y^d d^* \quad [\text{same terms as in Nash and in MP leader}] \\
&\quad + \frac{\beta M^d \gamma M^d a^2}{b \theta F^d + c^2 \theta F^d} \left( \gamma^* - \pi^* \right) + \beta M^d \gamma y^y c \left( y^* - y^y \right) \\
&\quad - \frac{\theta F^d \gamma y^y a c b}{b \theta F^d + c^2 \theta F^d} (ac)^2 S_i^t. \\
\end{align*}
\]
\[\text{(A-49)}\]

\[
\begin{align*}
\pi_t^* &= \beta M^d \gamma^* + (1 - \theta M) \gamma M^d \pi^* + \beta M^d \gamma y^y c \left( y^* - y^y \right) \\
&\quad - \frac{\gamma^*_a}{\gamma^*_d} \gamma y^y b (1 + \alpha \chi) (ac)^2 S_i^t. \\
\end{align*}
\]
\[\text{(A-50)}\]

\[
\begin{align*}
\delta_t^* &= d_t^* + \frac{2 \beta^2 \chi M^d}{b \theta F^d + c^2 \theta F^d} (ac)^2 S_i^t \quad \text{(A-52)} \\
y_t^* &= y^y - \frac{2 \beta^2 \chi M^d}{b \theta F^d + c^2 \theta F^d} (ac)^2 S_i^t. \\
\end{align*}
\]
\[\text{(A-53)}\]

\[\text{A.3.2 Special Cases: Corner Degrees of Independence}\]

Institution-Design Regime A1f1: The Government as a Single Sequential-Move Policymaker with Two Instruments, Three Targets and Fiscal Leadership

\[
\begin{align*}
i_t^{11} &= \pi^* + a \frac{d^* + \gamma y^y (\gamma y^y a^2 + \gamma y^y b^2) c}{\gamma y^y d b^2} \left( y^* - y^y \right) \\
&\quad + \frac{1}{b} \frac{\gamma y^y b (1 + \alpha \chi)}{\gamma y^y d b^2 + \gamma y^y y^y (ac)^2 S_i^t}, \\
\end{align*}
\]
\[\text{(A-54)}\]

\[
\begin{align*}
d_t^{11} &= d^* + \gamma y^y b \left( y^* - y^y \right) - \frac{\gamma y^y b c}{\gamma y^y d b^2 + \gamma y^y y^y (ac)^2 S_i^t}, \\
\end{align*}
\]
\[\text{(A-55)}\]

\[
\begin{align*}
\pi_t^{11} &= \pi^* + \gamma y^y c \left( y^* - y^y \right) - \frac{\gamma y^y b c}{\gamma y^y d b^2 + \gamma y^y y^y (ac)^2 S_i^t}, \\
\end{align*}
\]
\[\text{(A-56)}\]

\[
\begin{align*}
\delta_t^{11} &= d_t^{11} + \gamma y^y b \left( y^* - y^y \right) - \frac{\gamma y^y b c}{\gamma y^y d b^2 + \gamma y^y y^y (ac)^2 S_i^t}, \\
y_t^{11} &= y^y + \frac{\gamma y^y b^2}{\gamma y^y d b^2 + \gamma y^y y^y (ac)^2 S_i^t}. \\
\end{align*}
\]
\[\text{(A-57)}\]

\[\text{(A-58)}\]
Institution-Design Regime A0f0l: Independent Monetary Follower and Independent Fiscal Leader Each with a Single Instrument

In a sequential-move von Stackelberg game equilibrium where the fiscal authority is the leader, this institution-design regime implements the “Svensson solution” not only for monetary policy but also for fiscal policy. In it, there is a shared secondary/output target by assignment, \( y^* = y^*F = y^*G \), but different weights, \( \gamma^* = \gamma^*F \neq \gamma^*G \), for the monetary and fiscal policymakers, and own respective primary targets and weights.

\[
\begin{align*}
\pi^0_{0f0l} & = \pi^* + \frac{a}{b} d^* + \frac{1}{b} \varepsilon^D - \frac{2\gamma^*M (1 + a\chi)}{\Gamma_M} \varepsilon^S, \\
d^0_{0f0l} & = d^* = \text{const}, \\
\pi^0_{0f0l} & = \pi^* - \frac{\gamma^*C a \gamma^*C}{\Gamma_M b} (\pi^* - \pi^*), \\
\delta^0_{0f0l} & = \delta^0_{0f0l} = \frac{2\gamma^*M \gamma^*G}{\Gamma_M} \varepsilon^S, \\
y^0_{0f0l} & = y^* + \frac{2\gamma^*M \gamma^*C (ac)}{\Gamma_M b} \varepsilon^S.
\end{align*}
\]

Institution-Design Regime A1f0l: Independent Monetary Follower and Dependent Fiscal Leader Each with a Single Instrument

In a sequential-move von Stackelberg game equilibrium where the fiscal authority is the leader, this institution-design regime implements the “Svensson solution” for fiscal policy but not for monetary policy, which is decided by the Government. It is, in the latter sense, the reverse case considered in the monetary policy literature on the inflationary bias.

\[
\begin{align*}
\pi^0_{1f1l} & = \pi^* + \frac{a}{b} d^* - \frac{\gamma^*G a \gamma^*G}{\gamma^*G b} \left( \pi^* - \pi^* \right) \\
& + \frac{1}{b} \varepsilon^D - \frac{2\gamma^*M \gamma^*G}{\gamma^*G b} (1 + a\chi) \varepsilon^S, \\
d^0_{1f1l} & = d^* - \frac{\gamma^*G a \gamma^*G}{\gamma^*G b} \left( \pi^* - \pi^* \right) - \gamma^*G \gamma^*G \gamma^*G (ac) \varepsilon^S, \\
\pi^0_{1f1l} & = \pi^* - \frac{\gamma^*G a \gamma^*G}{\gamma^*G b} \left( \pi^* - \pi^* \right) - \frac{\gamma^*G \gamma^*G (ac)}{\gamma^*G b} \varepsilon^S, \\
\delta^0_{1f1l} & = \delta^0_{1f1l} = \frac{2\gamma^*M \gamma^*G (ac)}{\gamma^*G b} \varepsilon^S, \\
y^0_{1f1l} & = y^* + \frac{2\gamma^*M \gamma^*G (ac)}{\gamma^*G b} \varepsilon^S.
\end{align*}
\]
the standard one considered in the monetary policy literature on the inflationary bias (just above).

\[
\begin{align*}
\dot{\pi}_t^f &= \frac{\pi^G}{\alpha} + \frac{\gamma^G_{\pi c}}{\gamma^G_{\pi}} \left( y^{*,G} - y^N \right) \\
&+ \frac{1}{b} \delta_t G + \frac{\gamma^G_{\pi c}}{\gamma^G_{\pi}} (1 + \alpha \chi) \varepsilon_t, \\
\dot{d}_t^f &= d^* = \text{const}, \\
\dot{\pi}_t^f &= \pi^* + \frac{\gamma^G_{\pi c}}{\gamma^G_{\pi}} \left( y^{*,G} - y^N \right) - \frac{\gamma^G_{\pi c}}{\Gamma \varepsilon_t} \\
\delta_t^f &= \frac{d^f_0}{\Gamma} - \frac{\gamma^G_{\pi c}}{\gamma^G_{\pi}} \varepsilon_t, \\
y_t^f &= y^N + \frac{\gamma^G_{\pi c}}{\Gamma \varepsilon_t} \\
\end{align*}
\]
References


