Accounting for Credibility: Fiscal-Monetary Interactions and the Credibility of Central Bank Mandates*

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Abstract

We develop a model for fiscal and monetary policy determination in the tradition of Sargent and Wallace (1981). Ex-ante, the government has incentives to delegate monetary policy to a central bank with an inflation targeting mandate. Ex-post, however, the government faces temptations to revoke the mandate to generate seigniorage revenues. The likelihood that the government will adhere to its commitment depends on shocks to fiscal fundamentals and the costs of reneging on the mandate. The economy endogenously transitions between a "monetary-dominant" regime where monetary policy adheres to its commitment and a "fiscal-dominant" regime where the fiscal authority interferes with monetary policy. These two regimes sharply differ in their implications for the comovement of inflation and debt-to-GDP ratios. We use the model as a measurement device to interpret the fiscal and monetary history in Colombia, Chile, and the U.S.

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1 Introduction

In the decades that followed the inflation crises of the 1980s and early 1990s, many emerging and advanced economies attempted to stabilize prices by delegating monetary policy to newly independent central banks operating under explicit inflation-targeting mandates. The effectiveness of these measures ultimately rests on whether governments remain willing and able to respect the mandate once macroeconomic conditions change. In many instances, governments have revoked such mandates during crises. For example, in early 2002, Argentina decided to repeal the Convertibility Law and exit from the currency-board regime, a decision taken in the face of mounting debt servicing pressures. More recently, there has been mounting political pressure on the Federal Reserve and other central banks around the world, prompting concerns about their independence.[1]

This paper develops a framework for analyzing the credibility of inflation-targeting mandates in the presence of fiscal–monetary interactions, in the tradition of Sargent and Wallace (1981). We study a benevolent government that cannot commit. Ex ante, it may find it optimal to delegate monetary policy to a central bank with a narrow inflation-targeting mandate; ex post, it may choose to override the mandate in order to raise seigniorage and reduce the real value of its liabilities. The incentive to override the mandate depends on fiscal fundamentals, summarized by outstanding public debt and the marginal value of public spending, and on a stochastic institutional cost of deviation that reflects the legal, reputational, and political hurdles associated with overriding the mandate.

The economy endogenously fluctuates between two regimes: a *monetary-dominant* regime in which the target is honored, and a *fiscal-dominant* regime in which it is overridden. The two generate sharply different dynamics for inflation and government indebtedness. Under monetary dominance, inflation is low and insulated from fiscal conditions, while the debt-to-GDP ratio is high. Under fiscal dominance, inflation is high on average, volatile, and closely tied to fiscal conditions, while public debt is low. We show that credible delegation is necessary to support high levels of public debt, yet high debt itself endogenously undermines credibility. We use the model to interpret fiscal and monetary histories in Colombia, Chile, and the United States by accounting for the relative role of credibility and fiscal fundamentals in shaping them.

We consider a monetary economy where households work, consume and derive utility from real money balances, like in Calvo (1978). A benevolent government chooses how to finance government expenditures using distortionary labor income taxes, issuing government debt and money. The fundamental shock in the economy is a preference shock to

[1] See, for example, Yellen (2026) and Canepa, Schneider, and Kihara (2026).

the marginal utility of government expenditures. This term captures the various reasons a government might find it optimal to increase expenditures, such as a recession, an increase in demand for transfers, etc. The equilibrium conditions let us write an indirect utility function for the government over primary surpluses. The government's problem then reduces to choosing policies that maximize this function, subject to the government budget constraint and a money demand condition. (A large class of economies admits a representation of the government problem similar to the one we derive, albeit with a different indirect utility function. If this function is concave in surpluses, our conclusions continue to hold.)

If the government could perfectly commit, the Ramsey outcome would follow the Friedman rule and realized inflation would not be sensitive to fiscal shocks.[2] This outcome could be implemented by delegating monetary policy to an independent central bank with a narrow inflation-targeting mandate, while fiscal policy is determined by the treasury. The treasury solves a problem like that in the real economy studied by Aiyagari, Marcet, Sargent, and Seppälä (2002), taking as given a constant flow of seigniorage revenues.

Our objective, however, is to study optimal policy when the government lacks such commitment. In those cases, it is well known that the policy game admits a continuum of sustainable equilibria—that is, subgame perfect equilibria (SPE). Most of the previous literature has analyzed two extreme cases, either focusing on the best sustainable equilibrium, which often coincides with the Ramsey outcome and in which policy promises are perfectly credible; or on the Markov perfect equilibrium (often the worst sustainable equilibrium), in which promises about future policies are not at all credible. These approaches, while useful, cannot speak to optimal policy in the empirically plausible case, that is, when promises are *imperfectly credible*. For this reason, rather than picking one of these two extremes, we develop a flexible approach to represent a large set of equilibria of the policy game. This nesting model will then be used to study optimal fiscal and monetary policy with imperfect credibility and to select the equilibrium that best describes the data.

Our construction of the nesting model is motivated by the observation that many countries have recently adopted some form of an inflation-targeting regime. Specifically, we allow the government in every period to promise a target for next period's inflation. In each period, the government can decide whether to honor the promised target from the previous period or to pay a random cost to deviate from it. This cost is exogenous and is intended to capture various frictions, such as reputational losses, coordination failures that lead to inferior equilibria, institutional constraints like the protection offered by a con-

[2]This result holds under standard assumptions on preferences for the stand-in household. Even when these assumptions are not satisfied, we can show numerically that the Ramsey outcome has a nominal interest rate close to zero and a roughly constant inflation rate.

stitutional court to the independence of the central bank, and the political costs faced by policymakers.[3] We show that this framework captures policy determination and expectation formation in a way that continuously nests both the Ramsey and Markov equilibria, and outcomes in between.

We use this framework to examine how changes in the credibility of promises influence the dynamics of fiscal and monetary outcomes. Specifically, we show that the possibility that the government will not honor the inflation target in the future has important implications for the conduct of fiscal and monetary policy. On the monetary side, the inflation target is raised relative to what the full commitment solution would prescribe, in order to incentivize the government to adhere to it. On the fiscal side, optimal debt issuance is distorted down, in order to reduce the government's temptation to override the mandate in the future. These effects are stronger when the government is more likely to override the mandate in the future, which occurs when the marginal utility of spending is large, public debt is high, and the institutional costs of deviating are small.

In our application, we first calibrate the model to an average of Latin American economies from 1960–2017 and use it to study the drivers of large disinflation episodes. Specifically, in our model there are two ways in which inflationary episodes end. Inflation can decline either due to a reduction in the marginal value of government spending, or due to an increase in the (expected) cost of deviating from the promised inflation. We refer to the former as *fundamental disinflation* and to the latter as *institutional disinflation*. These distinct paths have different implications for the dynamics of public debt: while fundamental disinflations are associated with a declining path for real debt, institutional disinflations are characterized by an increasing path for real debt. The reason for this is that increased institutional costs weaken the incentive effect and allow the government to borrow more. In contrast, reductions in the marginal value of government spending lower the government's desire to issue debt and generate inflation. This contrasting comovement is the identification logic we use in the case studies to interpret observed disinflations.[4]

We apply particle filter methods to recover the sequences of fiscal and institutional shocks consistent with observed data on inflation and debt-to-GDP ratios in Chile and Colombia. The experience of these two countries illustrates the two disinflation channels implied by our model. In Colombia, inflation fell sharply while debt rose—the signature of an institutional disinflation. The particle filter identifies a significant increase in credibility beginning in 1999, and a counterfactual holding institutional costs at zero shows that infla-

[3] Lohmann (1992) studies the optimal size of such a cost in a Barro–Gordon model, trading off commitment and flexibility.

[4] This approach is similar to the one used by Aguiar and Gopinath (2007) and Bocola and Dovis (2019) in different contexts.

tion would have increased sharply, contrary to the data. In Chile, both inflation and debt declined, consistent with a fundamental disinflation driven by fiscal consolidation. However, institutional improvements were still necessary: in the late 1990s, inflation continued to fall while debt stabilized, a pattern that fiscal consolidation alone cannot explain. We then recalibrate the model to U.S. data over 1914–2017 and apply the same methodology to the rise and fall of inflation in the United States over 1960–2008. The Great Inflation of the 1970s reflects a collapse in credibility amid political pressure on the Federal Reserve, while the Volcker disinflation marks a gradual restoration of credibility that enabled rising debt alongside stable low inflation from the mid-1980s onward.

Our case studies provide a model and outcome-based measure of the credibility of the inflation-targeting mandate. Such a measure complements purely legal measures of central bank independence that do not fully capture the credibility of the mandate. For example, for the case of Colombia, we do not identify an increase in credibility in 1992, the first year after the reform, but only in 1999. In contrast, the credibility index for Colombia in Romelli (2022) increases in 1992 and stays constant at this level afterwards. This may be driven by the fact that it took time for the government to convince private agents that the new institutional arrangement was credible and not just a cosmetic adjustment. Relatedly, Cukierman (2008) finds that legal independence is associated with low inflation only in advanced economies and not in developing ones, indicating that credibility issues can be important in the latter group.

Furthermore, our measure provides more information than simply examining the discrepancy between inflation expectations and the announced target. Consider a Markov equilibrium where credibility is zero: the announced inflation target has no effect on allocations, so the central bank may as well announce the policy it will actually implement. Expectations then align with the announced target and realized inflation. One might read this as evidence of high credibility, but it is not. Our outcome-based measure captures the distinction.

Related literature Our paper is related to a large literature that studies optimal monetary and fiscal policy with and without commitment. See, for example, Calvo (1978), Lucas and Stokey (1983), Chang (1998), Chari and Kehoe (1999), Aiyagari et al. (2002), Alvarez, Kehoe, and Neumeyer (2004), Aguiar, Amador, Farhi, and Gopinath (2013), and more recently Espino, Kozlowski, Martin, and Sánchez (2022) and Espino, Kozlowski, Martin, and Sánchez (2023). We depart from this literature by considering an economy where, in addition to fundamental shocks, there are shocks to the cost of deviating from the promised policy path. These costs allow us to span a large class of sustainable equilibrium outcomes and

not just focus on the best or Markov equilibrium. Moreover, they allow us to quantify the component of inflation that is driven by institutional changes (the cost of deviation) and fundamentals.

The transition between a monetary-dominant and a fiscal-dominant regime in the conduct of monetary policy is related to the work of Leeper (1991), Sims (1994), Woodford (1994), Bianchi (2013), Bianchi and Ilut (2017), Bianchi, Faccini, and Melosi (2023), Cochrane (2023) and Witheridge (2024). Our modeling approach differs from this line of work on two fronts. First, in our model, the switches from one regime to the other are endogenous.[5] Second, the policy chosen in each regime is also endogenous in our model, while papers in this literature consider exogenous monetary and fiscal rules. This allows us to study how changes in the credibility of the monetary policy mandate influence the optimal conduct of fiscal and monetary policy. Moreover, in our model, movements in inflation are the direct consequence of deliberate policy choices as in Sargent and Wallace (1981) and not the result of an equilibrium selection mechanism. Another difference is that in this class of economies, long-run inflation and debt remain constant across regimes, varying only in their response to shocks, which can be quite persistent. In contrast, our economy exhibits different long-run inflation and debt levels in the two regimes.

Closer to our paper is the work on loose commitment in Debortoli and Nunes (2010), Debortoli, Maih, and Nunes (2014), and Debortoli and Lakdawala (2016) that also considers economies where the government can re-optimize its choices with some random probability. In this line of work, the policy is endogenous as in our model, but the regime is exogenous.[6] The endogeneity of the regime is critical for our results because the government chooses a different inflation target and level of debt to influence the decision of the next period's government. This incentive effect is critical for the different debt dynamics in disinflation episodes driven by institutional or fundamental forces.

Our quantitative analysis complements work that studies the joint dynamics of debt and inflation. Among these papers are the seminal narrative analysis in Sargent (1982), and the various chapters in the volume edited by Kehoe and Nicolini (2022).[7] Our contribution is to provide a quantitative theory of these joint dynamics driven by government incentives. Like

[5] Barthélemy, Mengus, and Plantin (2024) consider endogenous movements between fiscal- and monetary-dominant regimes as the outcome of a "chicken game." We take a different view: the fiscal side (the government) can always take away central bank independence – say by changing the central bank mandate – but doing so has a cost. These two approaches have very different implications for debt dynamics: in the chicken game, the fiscal authority issues more debt to induce the central bank to cave. In our model, higher risk of fiscal dominance leads to less debt, and more debt is issued only when monetary dominance is expected. The dynamics predicted by our model are consistent with the narrative around important historical episodes.

[6] Debortoli and Nunes (2010) consider an extension where the probability of re-optimization depends on the state variable but this is an exogenous function.

[7] See also Sargent, Williams, and Zha (2009).

our paper, Rogoff (2003) asks whether the general disinflation of the 1990s across advanced and emerging economies primarily reflected improved central banking independence and practices or instead lower fiscal needs, productivity growth, globalization, deregulation, and declining monopoly power.[8] Relatedly, Gao, Kulish, and Nicolini (2025) show that medium-run movements in nominal variables are explained by movements in the inflation target. Our theory is consistent with this finding as the inflation targets and expected inflation fluctuate between regimes and depending on fiscal fundamentals.

Finally, our paper is related to deeper theories of credibility and reputation building like Atkeson and Kehoe (2001), Atkeson, Chari, and Kehoe (2007), Dovis and Kirpalani (2021), Piguillem and Schneider (2013), King and Lu (2022), Lu, King, and Pasten (2016), Halac and Yared (2021), Halac and Yared (2025), de Aguilar (2024), Kostadinov and Roldán (2024), and Bocola, Dovis, Jørgensen, and Kirpalani (2025). The dynamics of the credibility measure we derive in our application can serve to discipline and discriminate between these models.

2 A Sargent-Wallace economy

2.1 Environment

Consider an economy that blends elements of Aiyagari et al. (2002) and Calvo (1978). Time is discrete and indexed by $t = 0, 1, ...$ The exogenous state of the economy is $s_t \in S$. We assume that s_t follows a Markov process with transition $\Pr(s_{t+1}|s_t)$. The economy is composed of a stand-in household, competitive firms, and a benevolent government. The stand-in household supplies labor and has utility over private consumption $c(s^t)$, labor $l(s^t)$, real money balances $m(s^t)$, and public consumption $g(s^t)$ given by

$$\sum_t \sum_{s^t} \beta^t \Pr(s^t|s_0)\, \mathcal{U}(c(s^t), l(s^t), m(s^t), g(s^t), s_t) \tag{1}$$

where β is the stand-in household discount factor. We assume that

$$\mathcal{U}(c, l, m, g, s) = c - \varpi(l) + v(m) + \theta(s)\, u(g) \tag{2}$$

[8] He argues that globalization reduced monopoly power in goods and labor markets, thereby weakening central banks' incentives to generate inflation. In our model, the gains from ex post inflation arise from fiscal considerations, but our results would be similar in an economy in which they instead arise from an output–inflation trade-off.

where $\varpi(l)$ is a strictly increasing and convex function, $\theta(s)$ is a preference shock to the marginal utility of government spending, $v(m)$ and $u(g)$ are strictly increasing and concave functions. We further assume that all functions are twice differentiable and ϖ is such that $\varpi'(l)\, l$ is convex.[9]

The resource constraint for the economy is

$$c\left(s^t\right) + g\left(s^t\right) \leq l\left(s^t\right). \tag{3}$$

The linear production technology is operated by competitive firms.

The government is benevolent but it may have a different discount factor than the stand-in household. Let $\hat{\beta} \leq \beta$ be the government's discount factor. The government finances government spending with linear taxes on labor income, $\tau\left(s^t\right)$, by issuing real noncontingent debt, $b\left(s^t\right)$, and by printing money, $M\left(s^t\right)$, injected into the economy via open market operations. We also allow the government to make positive lump-sum transfers, $T\left(s^t\right)$, to the stand-in household. The government budget constraint is

$$\begin{aligned} & P\left(s^t\right) g\left(s^t\right) + P\left(s^t\right) b\left(s^{t-1}\right) + M\left(s^{t-1}\right) + T\left(s^t\right) \\ \leq & \tau\left(s^t\right) W\left(s^t\right) l\left(s^t\right) + Q\left(s^t\right) b\left(s^t\right) + M\left(s^t\right) \end{aligned} \tag{4}$$

where $P\left(s^t\right)$ is the nominal price level, $W\left(s^t\right)$ is the nominal wage, and $Q\left(s^t\right)$ is the price of real debt (in terms of money).

The household problem is to choose $\left\{c\left(s^t\right), l\left(s^t\right), M\left(s^t\right), b\left(s^t\right)\right\}$ to maximize (1) subject to the budget constraint

$$\begin{aligned} & P\left(s^t\right) c\left(s^t\right) + Q\left(s^t\right) b\left(s^t\right) + M\left(s^t\right) \\ \leq & \left(1 - \tau\left(s^t\right)\right) W\left(s^t\right) l\left(s^t\right) + M\left(s^{t-1}\right) + P\left(s^t\right) b\left(s^{t-1}\right) + T\left(s^t\right) \end{aligned}$$

where real balances are given by $M\left(s^{t-1}\right)/P\left(s^t\right)$. We adopt the Nicolini (1998)-timing where only money carried over from last period enters the utility function and not newly issued money. This timing convention creates costs to unexpected inflation and guarantees the existence of a Markov perfect equilibrium with positive real balances.

Given initial (M_0, b_0), an equilibrium is a set of allocations $\left\{c\left(s^t\right), l\left(s^t\right), M\left(s^t\right), b\left(s^t\right)\right\}$, policies $\left\{g\left(s^t\right), \tau\left(s^t\right), M\left(s^t\right), b\left(s^t\right), T\left(s^t\right)\right\}$, and prices $\left\{P\left(s^t\right), W\left(s^t\right), Q\left(s^t\right)\right\}$ such that i) the allocation solves household's maximization problem, ii) the government budget con-

[9] For example, this last assumption is satisfied if the labor disutility has a constant Frisch elasticity, $\varpi(l) = \chi l^{1+\psi}/(1+\psi)$, or more generally if $2\varpi''(l) + \varpi'''(l)\, l \geq 0$.

straint holds, iii) $W\left(s^t\right) = P\left(s^t\right)$ and asset markets clear.

2.2 Implementable allocations

We next derive implementability conditions that characterize the set of fiscal and monetary outcomes that can be supported as a competitive equilibrium. We focus on fiscal and monetary outcomes —rather than allocations, as is standard in the Ramsey literature— because they are the objects of interest in our empirical analysis.

Optimality for the stand-in household's problem requires that the labor supply satisfies

$$\left(1 - \tau\left(s^t\right)\right) = \varpi'\left(l\left(s^t\right)\right), \tag{5}$$

the Euler equation for money holdings holds

$$\frac{1}{P\left(s^t\right)} = \beta E_t\left[\frac{1}{P\left(s^{t+1}\right)} + v'\left(\frac{M\left(s^t\right)}{P\left(s^{t+1}\right)}\right)\frac{1}{P\left(s^{t+1}\right)}\right], \tag{6}$$

and the price for real bonds is given by

$$\frac{Q\left(s^t\right)}{P\left(s^t\right)} = \beta. \tag{7}$$

Following the insight in Aiyagari (1989) and Aiyagari et al. (2002), we define the static indirect utility function over primary surpluses.[10] Define the real primary surplus as

$$\Delta\left(s^t\right) \equiv \tau\left(s^t\right) l\left(s^t\right) - g\left(s^t\right) - \frac{T\left(s^t\right)}{P\left(s^t\right)}.$$

From the labor supply condition (5), we know that in any competitive equilibrium tax revenues must satisfy the following restriction

$$\tau\left(s^t\right) l\left(s^t\right) = \left(1 - \varpi'\left(l\left(s^t\right)\right)\right) l\left(s^t\right).$$

We can define the static indirect utility function over surpluses as

$$U\left(\Delta, s\right) = \max_{c,l,g} c - \varpi\left(l\right) + \theta\left(s\right) u\left(g\right) \tag{8}$$

[10] See also Chari, Dovis, and Kehoe (2020).

subject to the resource constraint (3) and the static implementability constraint

$$\left(1-\varpi'\left(l\right)\right)l-g\geq\Delta.$$

This function is well-defined for all surplus values at or below the maximal surplus implied by the static Laffer curve, $\Delta\leq\bar{\Delta}\equiv\max_{l}\left(1-\varpi'\left(l\right)\right)l$. Under the assumption that $\varpi'\left(l\right)l$ is convex, we have:

Lemma 1. *The indirect utility function $U\left(\Delta,s\right)$ is decreasing and concave in Δ for all s. Moreover, $\lim_{\Delta\to\bar{\Delta}}U'\left(\Delta,s\right)=-\infty$ and $U'\left(\Delta,s\right)=0$ for all $\Delta\leq-g^{*}\left(s\right)$, where $g^{*}\left(s\right)$ is implicitly defined by $\theta\left(s\right)u'\left(g^{*}\left(s\right)\right)=1$.*

The indirect utility function U captures the costs associated with distortionary labor taxation. In state s, the government can implement the efficient level of public spending, $g^{*}\left(s\right)$, only if it runs a primary deficit of at least $g^{*}\left(s\right)$, thereby financing public spending without relying on distortionary taxes. For any primary surplus above $-g^{*}\left(s\right)$, U is strictly decreasing in Δ: a larger required primary surplus makes the government reduce public spending below $g^{*}\left(s\right)$ and increase distortionary taxation, lowering static welfare. The concavity of U follows from the convex cost of distortionary taxes.

It is convenient to normalize all nominal variables by the amount of money inherited in each period. In particular, let the normalized price level be $p\left(s^{t}\right)=P\left(s^{t}\right)/M\left(s^{t-1}\right)$, the (gross) money growth rate be $\mu\left(s^{t}\right)\equiv M\left(s^{t}\right)/M\left(s^{t-1}\right)$, and let

$$\phi\left(s^{t}\right)\equiv1/p\left(s^{t}\right)=M\left(s^{t-1}\right)/P\left(s^{t}\right)$$

be the inverse of the normalized price level—the price of money in terms of the private consumption good—or the real money balances $M\left(s^{t-1}\right)/P\left(s^{t}\right)$. Using these normalizations and defining

$$H\left(\phi\right)\equiv\phi+v'\left(\phi\right)\phi,$$

we can rewrite the money demand condition (6) as

$$\mu\left(s^{t}\right)\phi\left(s^{t}\right)=\beta\sum_{s_{t+1}}\Pr\left(s_{t+1}|s_{t}\right)H\left(\phi\left(s^{t+1}\right)\right)\tag{9}$$

and, using (7) to substitute for $Q\left(s^{t}\right)$, the government budget constraint (4) as

$$b\left(s^{t-1}\right)+\phi\left(s^{t}\right)=\Delta\left(s^{t}\right)+\beta b\left(s^{t}\right)+\mu\left(s^{t}\right)\phi\left(s^{t}\right)\tag{10}$$

We can then state the implementability conditions:

Lemma 2. *A fiscal and monetary outcome* $\{\Delta(s^t), b(s^t), \phi(s^t), \mu(s^t), \pi(s^t)\}$ *is implementable as a competitive equilibrium given an initial level of real debt* b_0 *if and only if it satisfies the normalized version of the government budget constraint (10), a no-Ponzi-game condition, the Euler equation for money holdings (9), the feasibility condition for the primary surplus* $\Delta(s^t) \leq \bar{\Delta}$*, and inflation is given by*

$$1 + \pi\left(s^{t+1}\right) = \frac{\mu(s^t)\,\phi(s^t)}{\phi(s^{t+1})}. \tag{11}$$

The associated value for the government is given by

$$V_0 = \sum_t \sum_{s^t} \hat{\beta}^t \Pr(s^t|s_0) \left[U(\Delta(s^t), s_t) + v(\phi(s^t))\right]. \tag{12}$$

Note that we can combine the government budget constraint (10) with the money demand equation (9), iterating forward and invoking the household's transversality conditions to obtain

$$b\left(s^{t-1}\right) + \phi(s^t) = \sum_{j=0}^{\infty} \sum_{s^{t+j}} \beta^j \Pr\left(s^{t+j}|s^t\right) \Delta\left(s^{t+j}\right) + \sum_{j=1}^{\infty} \sum_{s^{t+j}} \beta^j \Pr\left(s^{t+j}|s^t\right) h\left(\phi\left(s^{t+j}\right)\right) \tag{13}$$

where $h(\phi) \equiv v'(\phi)\,\phi$. That is, after any s^t, the real value of the government's liabilities, $b\left(s^{t-1}\right) + \phi(s^t)$, equals the discounted value of current and future primary surpluses and future seigniorage revenues, $h\left(\phi\left(s^{t+j}\right)\right)$.

The conditions in Lemma 2 highlight the main forces shaping equilibrium outcomes. The concavity of the indirect utility function, U, gives the government an incentive to smooth the marginal cost of primary surpluses across both time and states as in a standard consumption-smoothing problem. At the same time, a benevolent government trades off the distortion associated with real balances against the cost of distortionary taxation. Distortions in real balances generate seigniorage revenues that relax the government budget constraint (10), allowing the government to run a smaller primary surplus and therefore to reduce taxes and keep government spending closer to its efficient level. Under standard preferences, however, the commitment solution satisfies the Friedman rule: the government issues the optimal quantity of real balances, $v'(\phi) = 0$, and raises no seigniorage revenue. That is, the trade-off is resolved entirely in favor of no monetary distortions.[11] This outcome is not time consistent: ex post, a benevolent government has an incentive to reduce the value of real balances, $\phi(s^t)$, relative to its promised value, thereby lowering the real value of its liabilities and reducing the costs associated with distortionary taxes.

[11] As discussed in Chari and Kehoe (1999), this follows from an application of the Diamond-Mirrlees production efficiency result.

3 Policy determination

We want to study fiscal and monetary outcomes when the government cannot commit. A common approach is to consider a sustainable equilibrium, i.e., a subgame perfect equilibrium (SPE) of the policy game. This equilibrium notion, however, does not sufficiently narrow down the set of outcomes that can occur when the government lacks commitment. Following the logic in Abreu (1988) and Chari and Kehoe (1990), a fiscal and monetary outcome is a valid sustainable equilibrium outcome whenever it satisfies both the implementability conditions in Lemma 2 and a *sustainability constraint* requiring that the government's continuation value after any history lie above the value of the worst equilibrium. To understand why, notice that the incentive for the government to follow the prescribed path of play depends on the consequences of the deviation. For example, one can construct an equilibrium in which the government faces no penalty from such deviations. That outcome can then serve as a threat to support better outcomes on path.

This multiplicity raises two natural questions when we want to contrast the model with the data: how should we select among these equilibria, and how should we model the way the government manages expectations and the way private agents coordinate on a continuation equilibrium after a deviation?[12] Previous work considers either the best sustainable equilibrium, in which the consequences of a deviation are maximal, or the Markov perfect equilibrium, in which there are no consequences for not respecting the promised or expected policy.

We take a different approach and instead construct a model that is flexible enough to nest these possibilities along with other sustainable equilibria in which policy promises are imperfectly credible. Motivated by the observation that several countries have recently adopted some form of an inflation-targeting regime, we assume that the government tries to manage expectations by promising to deliver an inflation target π^* next period. The government in the following period can choose whether to maintain the inflation target or to pay a random cost ξ to deviate from the target. This cost is exogenous and captures factors such as reputation losses, coordination of private agents leading to worse equilibria, institutional constraints, and the political costs faced by policymakers. This formulation enables us to confront the data and examine how changes in the credibility of promises — represented by changes in ξ— influence the dynamics of fiscal and monetary outcomes.

In Appendix B, we show in a deterministic economy that, given a specific sequence for ξ_t, our model can recover a subset of sustainable equilibrium outcomes. For example, our problem rules out the ones that allow for Pareto improvements: that is, those in which

[12] This problem is beautifully explained in Sargent (2024).

there are deviations in period $t+1$ that increase the government's value in both periods t and $t+1$.

Recursive formulation We next set up the problem of the government recursively. In addition to the exogenous state and the real value of debt, we also need to include the inflation target that was promised in the previous period, π^*. It is, however, more convenient and without loss of generality to keep track of the promised value for real balances ϕ. In fact, consider a government in period t that promises an inflation target π^* for the next period. From (11) we know that

$$1+\pi^* = \frac{\mu_t \phi_t}{\phi_{t+1}}.$$

Thus, from period t's perspective—given the current money growth rate and ϕ_t—there is a one-to-one map between the inflation target π^* and the promised value for real money balances ϕ_{t+1}. We can therefore keep track of promised real money balances and let the state be $x = (b, \phi, s)$.[13]

Note that we do not allow the promised value of real balances to be contingent on the next period's state. In principle, one could imagine that the delegation of monetary policy includes state-dependent escape clauses. However, a justification for our assumption is that it is difficult to detect deviations and impose penalties when promised inflation is state-dependent and information about the state is dispersed, as shown by Piguillem and Schneider (2013).

In any period, the economy can be in either a *monetary-dominant* regime (denoted by *md*) where the government satisfies the inflation target and attains value $V_{md}(x)$, or in a *fiscal-dominant* regime (denoted by fd) where the government deviates from the set target and attains a value net of the cost ξ given by $V_{fd}(b, s)$. The value for the government is then

$$V(b, \phi, s) = \max\left\{V_{md}(b, \phi, s), V_{fd}(b, s) - \xi(s)\right\} \tag{14}$$

We let $\eta(x)$ be an indicator variable that takes value 1 if it is optimal to satisfy the target and be in the monetary-dominant regime and 0 otherwise:

$$\eta(b', \phi', s') = \begin{cases} 1 & \text{if } V_{md}(b', \phi', s') \geq V_{fd}(b', s') - \xi(s') \\ 0 & \text{if } V_{md}(b', \phi', s') < V_{fd}(b', s') - \xi(s') \end{cases}. \tag{15}$$

Finally, we let $J(b', \phi', s)$ be the expected marginal value of real balances in the following

[13] We do not need to track additional state variables—such as the promised marginal utility for the stand-in household—because preferences are quasi-linear in consumption. As a result, there is no time-inconsistency problem arising from interest-rate manipulation.

period. As will become clear, this is a function of newly issued debt b', the next period's inflation target summarized by ϕ', and the current exogenous state s.

Monetary dominance The problem for the government when it respects the target is

$$V_{md}(b,\phi,s) = \max_{\Delta,b',\mu,\phi'} U(\Delta,s) + v(\phi) + \hat{\beta}\sum_{s'}\Pr(s'|s)\, V(b',\phi',s') \tag{16}$$

subject to the budget constraint

$$\Delta = b + \phi - \beta b' - \mu\phi$$

and the money-demand condition

$$\mu\phi = J(b',\phi',s)$$

with $b' \in [0,\bar{b}]$.

Fiscal dominance The problem when the inflation target is not satisfied is similar but now the government can choose the current value of real money balances, ϕ:

$$V_{fd}(b,s) = \max_{\phi,\Delta,b',\mu,\phi'} U(\Delta,s) + v(\phi) + \hat{\beta}\sum_{s'}\Pr(s'|s)\, V(b',\phi',s') \tag{17}$$

subject to

$$\Delta = b + \phi - \beta b' - \mu\phi$$

and

$$\mu\phi = J(b',\phi',s)$$

with $b' \in [0,\bar{b}]$. Note for later that in this case the value of real balances is determined by the static first-order condition

$$-U'(\Delta,s) = v'(\phi_{fd}). \tag{18}$$

That is, the marginal benefit of real balances is equated to the marginal cost of the primary surplus. Thus, since money supply is predetermined, the model predicts a higher price level (lower real balances) when the marginal cost of the surplus is high. This happens when either the value of public spending θ is high or when the amount of inherited debt is high and so the government must run a surplus just to stabilize the level of debt.

Equilibrium The expected marginal value of real balances in the following period is

$$J\left(b',\phi',s\right)=\beta\sum_{s'}\Pr\left(s'|s\right)\left[\eta\left(b',\phi',s'\right)H\left(\phi'\right)+\left(1-\eta\left(b',\phi',s'\right)\right)H\left(\phi_{fd}\left(b',s'\right)\right)\right] \quad (19)$$

We can then define an equilibrium as a set of value functions V, V_{md}, V_{fd}, policy functions $\phi_{fd}, \Delta_i, b_i', \mu_i, \phi_i'$ for $i = md, fd$, a regime choice function η and J that satisfy (14), (16), (17), (19), and (15).

Note that our equilibrium notion nests the Ramsey outcome if the lower bound of the support of ξ is large enough so that $\eta = 1$ in every period, in which case $J\left(b',\phi',s\right) = \beta H\left(\phi'\right)$ and the government in the current period controls the amount of inflation next period. The model also nests the Markov perfect equilibrium outcome if the cost ξ always equals 0 so that it is always better to be in the fiscal-dominant regime, $\eta = 0$, and $J\left(b',\phi',s\right)=\beta\sum_{s'}\Pr\left(s'|s\right)H\left(\phi_{fd}\left(b',s'\right)\right)$.

4 Model dynamics and credibility of inflation targets

We now analyze the implied dynamics for debt, inflation targets, and inflation. Before doing so, we consider two benchmarks: the Ramsey outcome and the Markov outcome. In the Ramsey outcome, inflation is approximately constant and insulated from fiscal conditions, and high levels of public debt can be sustained. In the Markov equilibrium, inflation responds strongly to fiscal pressures and debt capacity is sharply limited. The full model interpolates between these extremes depending on the costs ξ_t.

A central mechanism emphasized in this section is an incentive effect operating through debt issuance and promised inflation targets. Specifically, current policymakers have incentives to limit borrowing and to choose less ambitious inflation targets when credibility is fragile, as those will reduce the incentives of the government to override the mandate in the future. These incentive motives distort policy relative to the Ramsey benchmark, especially when the probability of switching from monetary to fiscal dominance is high..

4.1 Ramsey outcome

The Ramsey outcome is the best allocation consistent with a competitive equilibrium. Given our definition of indirect utility $U\left(\Delta,s\right)$ and the characterization of implementable allocations in Lemma 2, we can write the Ramsey problem as choosing $\left\{\Delta\left(s^t\right),b\left(s^t\right),\phi\left(s^t\right),\mu\left(s^t\right)\right\}$ to maximize (12) subject to (9), (10) and $b\left(s^t\right)\leq\bar{b}$ given b_0.

Note that the Ramsey outcome, other than assuming commitment, allows for greater flexibility than the equilibrium considered here because the promised value $\phi\left(s^{t+1}\right)$ can be contingent on the state of the world in period $t+1$. This can be valuable because it allows the government's total real liabilities to be state-contingent and overcome the assumed market incompleteness for real debt.

To keep the analysis parallel with our recursive formulation of the full model above, we express the Ramsey problem in a quasi-recursive form. The Ramsey outcome from period 1 onward solves the following recursive problem:

$$V_R(b,\phi,s) = \max_{\Delta,b',\phi'(s')} U(\Delta,s) + v(\phi) + \hat{\beta}\sum_{s'}\Pr\left(s'|s\right) V_R\left(b',\phi'\left(s'\right),s'\right) \tag{20}$$

subject to

$$\Delta = b + \phi - \beta b' - \beta\sum_{s'}\Pr\left(s'|s\right) H\left(\phi'\left(s'\right)\right)$$

and $0 \leq b' \leq \bar{b}$. In period 0, the Ramsey outcome solves (20) with $\phi_0 = \arg\max_{\phi} V_R(b_0,\phi,s_0)$.

Proposition 3. *Suppose* $v(\phi) = \kappa\frac{\phi^{1-\zeta}}{1-\zeta}$ *for* $\zeta \in (0,1)$, $\kappa > 0$, *and there is a bound on real balances,* $\phi\left(s^t\right) \leq \phi^*$. *Let* $S = \{s_1,...,s_N\}$ *be a Markov chain with associated* $\Theta = \{\theta_1,...,\theta_N\}$. *Without loss of generality let* $\theta_n < \theta_{n+1}$ *for all* n. *If* θ_1 *and* θ_N *are close enough,*

$$\theta_N/\theta_1 < 1 + (1-\zeta)\, v'(\phi^*), \tag{21}$$

and b_0 *is large enough so that debt is interior, then the Ramsey outcome has* $\phi'\left(s^t\right) = \phi^*$ *for all* $t \geq 1$ *and* s^t. *Suppose in addition that the promised value of real balances cannot be made contingent on next period's state then* $\phi'\left(s^{t-1}\right) = \phi^*$ *for all* s^{t-1}*and for all processes for* θ_t.

Under our assumptions, there is a trade-off between following the Friedman rule and making real debt state-contingent.[14] If the volatility of the marginal value of government expenditures is sufficiently small, the benefits of making the real debt state-contingent are small relative to the cost of anticipated inflation and it is optimal to set $\phi(s') = \phi^*$ for all s' next period. Thus, the constraint that the promised value of money must be constant across states in the next period is not binding.

Under the conditions in the proposition, the Ramsey outcome has a fixed inflation level

[14] Chari and Kehoe (1999) show how in a cash-credit good economy it is possible to simultaneously follow the Friedman rule and use inflation to generate state contingencies.

given by[15]

$$1+\pi_R=\frac{\beta H\left(\phi^*\right)}{\phi^*}=\beta\left(1+\kappa\left(\phi^*\right)^{-\zeta}\right).$$

In particular, the inflation level does not depend on the fiscal fundamentals—the level of debt and θ.

One way to implement the Ramsey outcome is to delegate monetary policy to an independent central bank with a mandate to target an inflation rate of π_R, while fiscal policy is determined by the treasury, which solves a problem similar to that in the real economy studied by Aiyagari et al. (2002), taking as given a constant flow of seigniorage revenues (which may be negative). The dynamics of surpluses and real debt, when interior, must be consistent with the Euler equation

$$-U'\left(\Delta,s\right)=-\frac{\hat{\beta}}{\beta}\sum_{s'}\Pr\left(s'|s\right)U'\left(\Delta\left(s'\right),s'\right) \tag{22}$$

and the budget constraint. This arrangement, while optimal, relies on the government's ability to commit. In the subsequent sections, we will see how the optimal mandate changes if the government cannot commit.

When the preferences over real money balances take a different form than the iso-elastic one considered in the proposition, we cannot prove that a version of the Friedman rule is optimal. For example, if $v\left(\phi\right)$ is quadratic, the optimal value for ϕ in the Ramsey outcome will typically be different from the satiation point and dependent on fiscal fundamentals. However, in numerical simulations, we find that such variations are small and that the delegation of monetary policy to an independent central bank with a fixed inflation target is approximately optimal under commitment. See Figure 1 for a typical outcome where $v\left(\phi\right)$ is quadratic.

4.2 Markov outcome

We now turn to the polar opposite case in which the government has no way to commit to inflation and consider a Markov equilibrium outcome. This is a special case of our environment with $\xi\left(s\right)=0$ for all s, in which case the fiscal-dominant regime is always optimal. Consequently, we can drop ϕ' as a choice in (17) since it has no effect on the value.

[15]The case with no bounds on real balances has $\phi^*\to\infty$ and so the inflation rate in the Ramsey outcome equals $\beta-1$.

The problem reduces to

$$V_M(b,s) = \max_{\phi,\Delta,b'} U(\Delta,s) + v(\phi) + \hat{\beta}\sum_{s'} \Pr(s'|s)\, V_M(b',s') \tag{23}$$

subject to

$$\Delta = b + \phi - \beta b' - \beta \sum_{s'} \Pr(s'|s)\, H\left(\phi_M(b',s')\right).$$

The optimum is then characterized by a static optimality condition that relates the surplus to the level of inflation, (18), and an intertemporal optimality condition,

$$\begin{aligned} -U'(\Delta,s)\left[1 + \sum_{s'} \Pr(s'|s)\, H'\left(\phi_M(b',s')\right) \frac{\partial \phi_M(b',s')}{\partial b'}\right] &= \frac{\hat{\beta}}{\beta}\sum_{s'} \Pr(s'|s)\, V_M'(b',s') \\ &= -\frac{\hat{\beta}}{\beta}\sum_{s'} \Pr(s'|s)\, U'(\Delta',s') \end{aligned} \tag{24}$$

The term $\sum_{s'} \Pr(s'|s)\, H'\left(\phi_M(b',s')\right) \frac{\partial \phi_M(b',s')}{\partial b'}$ captures the incentive effect of debt issuance. The current government can influence the choices of next period's government only indirectly by affecting the amount of debt inherited by the next period's government. Since $\partial \phi_M(b',s')/\partial b' < 0$ and $H' > 0$ in the relevant range, this term is negative and acts as a tax on debt issuance relative to the Ramsey Euler equation (22). This is because the next period's value of real balances is too low from the perspective of the current government. The current government can thus boost next period's real balances by reducing the amount of debt inherited by its successor, which in turn induces a higher choice of ϕ'. Therefore, debt issuances are distorted downward relative to the Ramsey outcome.

4.3 Full model

Credibility of inflation targets We first analyze the credibility of an inflation target summarized by a promised ϕ. The inflation target is satisfied if and only if

$$\xi \geq \xi^* = V_{fd}(b,s) - V_{md}(b,\phi,s) = \max_{\phi_{fd}} V_{md}\left(b,\phi_{fd},s\right) - V_{md}(b,\phi,s)$$

Deviating from the target allows the government to attain the maximum utility possible net of the cost ξ. Thus, a cost ξ greater than the cutoff ξ^* is required for the target to be sustained and for $\eta = 1$. In particular, the cutoff ξ^* is larger the more ambitious the inflation target. That is, inflation targets closer to the Ramsey value ϕ^* are harder to achieve than higher inflation targets.

To make further progress on the characterization, we assume that the value function is concave, as verified in all our numerical solutions. In particular, note that we can write $V_{md}(b, \phi, s)$ as $W(b + \phi, s) + v(\phi)$ because only the total amount of real liabilities, $B = b + \phi$, is relevant for dynamic decisions. We will assume that $W(B)$ is concave. The inflation target is easier to achieve when the marginal utility of government expenditure is lower. This is because the value of reducing the distortions associated with positive surpluses is smaller when θ is low and government expenditures are less valuable.[16] A similar argument applies to the level of inherited debt: a lower initial stock of debt b reduces the minimum cost required to satisfy the target, thereby making it more likely that the target can be met.

The next lemma summarizes the above discussion:

Lemma 4. *Assume that $W(B, s)$ is concave in B. The primary surplus is increasing in total government real liabilities. If $\phi > \phi_{fd}(b, s)$, then the cutoff $\xi^*(b, \phi, s)$ is increasing in b and ϕ. If, in addition, θ is iid then $\xi^*(b, \phi, s)$ is also increasing in θ.*

Optimal inflation target We now characterize the optimal inflation target. Recall that inflation target π^* for the next period is given by $1 + \pi^* = \mu\phi/\phi'$. Thus given current $\mu\phi$, there is an inverse relationship between π^* and ϕ'. We show that it is optimal to choose a lower promised ϕ' (higher inflation target) than under the Ramsey outcome, in order to better incentivize the next period's government not to deviate from the plan.[17]

To see this, we assume that ξ follows a continuous distribution $f(\xi'|\xi)$. If the optimal inflation target is interior, it must satisfy the following necessary condition whenever the equilibrium objects are differentiable:

$$-U'(\Delta, s)\frac{\partial J(b', \phi', s)}{\partial \phi'} + \hat{\beta}\sum_{s'}\Pr(s'|s)\frac{\partial V(b', \phi', s')}{\partial \phi'} = 0$$

where

$$\begin{aligned}\frac{\partial J(b', \phi', s)}{\partial \phi'}/\beta = &\sum_{s'}\Pr(s'|s)\,\eta(b', \phi', s')\,H'(\phi') \\ &-\sum_{\theta'}\Pr(\theta'|\theta)\frac{\partial \xi^*}{\partial \phi'}\left[H(\phi') - H(\phi_{fd}(b', s'))\right]f(\xi^*|\xi)\end{aligned}$$

[16] For a general Markov process, concavity of W in B is not sufficient to establish monotonicity of the cutoff ξ^* in θ because a different realization of θ affects the distribution of future shocks. It is sufficient to show that W has decreasing differences in B and θ. If the process for θ is iid then this is guaranteed.

[17] This is similar to the logic in Dovis and Kirpalani (2021).

and

$$\sum_{s'} \Pr\left(s'|s\right) \frac{\partial V\left(b',\phi',s'\right)}{\partial \phi'} = \sum_{s'} \Pr\left(s'|s\right) \eta\left(b',\phi',s'\right) \left[v'\left(\phi'\right) + \frac{\partial V\left(b',\phi',s'\right)}{\partial b'}\right].$$

Combining these three expressions, we obtain

$$\begin{aligned} 0 = & -U'\left(\Delta,s\right)\beta H'\left(\phi'\right) + \hat{\beta}\left[v'\left(\phi'\right) + \mathbb{E}\left(\frac{\partial V\left(b',\phi',s'\right)}{\partial b'}|\eta'=1\right)\right] \\ & + \frac{\beta U'\left(\Delta,s\right)}{N\left(b',\phi',s\right)} \sum_{\theta'} \Pr\left(\theta'|\theta\right) \frac{\partial \xi^*}{\partial \phi'} \left[H\left(\phi'\right) - H\left(\phi_{fd}\left(b',s'\right)\right)\right] f\left(\xi^*|\xi\right) \end{aligned} \tag{25}$$

where $N\left(b',\phi',s\right) \equiv \sum_{s'} \Pr\left(s'|s\right) \eta\left(b',\phi',s'\right)$ is the probability that the target is satisfied next period.

The first line in (25) is the optimality condition that must be satisfied in the Ramsey outcome (with $\eta = 1$ always). It equates the marginal benefits of increasing promised ϕ' coming from higher resources raised today, $-U'\left(\Delta,s\right)\beta H'\left(\phi'\right)$, and a higher value of real balances tomorrow, $\hat{\beta}v'\left(\phi'\right)$, to the marginal cost of having higher total real liabilities, captured by the term $\hat{\beta}\mathbb{E}\left(\frac{\partial V\left(b',\phi',s'\right)}{\partial b'}|\eta'=1\right)$. The term in the second line represents the additional marginal cost of increasing ϕ' due to the incentive provision. The term is negative since $\partial\xi^*/\partial\phi' > 0$, $H\left(\phi'\right) \geq H\left(\phi'_{fd}\right)$ and $U' < 0$. A lower ϕ' increases incentives to respect the target ($V_{md} > V_{fd} - \xi'$). This in turn increases the expected marginal value of money as $\phi' > \phi'_{fd}$.

The presence of the last term makes it optimal to promise a higher inflation target (lower ϕ') than under the Ramsey outcome, in order to better incentivize the next period's government not to deviate from the plan. [18]

Realized inflation and money growth rate Realized inflation differs from the announced inflation target because of the possibility that the government ignores the target and chooses the statically optimal inflation level. Using the definition of J in (19), we can express the

[18] However, if we have CRRA preferences with a maximal amount of real balances, ϕ^*, the constraint $\phi' \leq \phi^*$ can be binding if

$$\begin{aligned} & -U'\left(\Delta,s\right)\beta H'\left(\phi^*\right) + \hat{\beta}\left[v'\left(\phi^*\right) + \mathbb{E}\left(\frac{\partial V\left(b',\phi^*,s'\right)}{\partial b'}|\eta'=1\right)\right] \\ & > -\frac{\beta U'\left(\Delta,s\right)}{N\left(b',\phi^*,s\right)} \sum_{\theta'} \Pr\left(\theta'|\theta\right) \frac{\partial \xi^*}{\partial \phi'} \left[H\left(\phi^*\right) - H\left(\phi_{fd}\left(b',s'\right)\right)\right] f\left(\xi^*|\xi\right) \end{aligned}$$

in which case $\phi' = \phi^*$. In the quantitative analysis we assume quadratic utility for real balances and $\phi' < \phi^R \leq \phi^*$ where ϕ^R is the promise for real balances in the Ramsey outcome and ϕ^* is the satiation point, $v'\left(\phi^*\right) = 0$.

realized inflation level in the monetary-dominant regime as

$$1+\pi\left(b,\phi,s_{-}\right)=\frac{J\left(b,\phi,s_{-}\right)}{\phi}$$

Note that realized inflation in a given period depends on the inherited debt b, the promised value of money holdings, and the state of the economy in the previous period, s_{-}, (and not the current state s).

If instead we are in the fiscal-dominant regime then inflation depends on the current state as well:

$$1+\pi_{fd}\left(b,\phi,s_{-},s\right)=\frac{J\left(b,\phi,s_{-}\right)}{\phi_{fd}\left(b,s\right)}.$$

This is because s affects the current fiscal surpluses and therefore the chosen $\phi_{fd}\left(b,s\right)$. Since in equilibrium $\phi_{fd}\left(b,s\right)<\phi$, the realized inflation is higher in the fiscal-dominant regime than in the monetary-dominant regime.

The model also has implications about the growth rate of money supply. In particular, if the perceived commitment to monetary dominance in the future is weak, the government must follow a much tighter monetary policy to implement its target ϕ. To see this, note that the gross money growth rate is

$$\mu=J\left(b',\phi',s\right)/\phi.$$

If the expected value of money $J\left(b',\phi',s\right)$ falls, then money growth μ must also fall to implement the target ϕ.

Debt dynamics We next consider the optimal debt issuance. We show that debt issuance is lower than in the Ramsey outcome. This is because of the presence of a wedge in the government's Euler equation that acts as a tax on debt issuance, similarly to the Markov equilibrium. The magnitude of the wedge, and therefore of the amount of underborrowing, depends on ξ. If this shock is large then the wedge is small.

The necessary condition for an optimal interior b' is

$$\begin{aligned}-U'\left(\Delta,s\right)\left(1+\frac{\partial J\left(b',\phi',s\right)}{\partial b'}/\beta\right) &= -\frac{\hat{\beta}}{\beta}\sum_{s'}\Pr\left(s'|s\right)\frac{\partial V\left(b',\phi',s'\right)}{\partial b'} \\ &= -\frac{\hat{\beta}}{\beta}\sum_{s'}\Pr\left(s'|s\right)U'\left(\Delta\left(s'\right),s'\right)\end{aligned} \tag{26}$$

The term $\frac{\partial J\left(b',\phi',s\right)}{\partial b'}/\beta$ is negative and effectively acts as a tax on debt issuance, leading to

lower debt levels relative to the Ramsey Euler equation (22). To see this, note that

$$\frac{\partial J\left(b',\phi',s\right)}{\partial b'}/\beta = \sum_{s'}\Pr\left(s'|s\right)\left(1-\eta\left(b',\phi',s'\right)\right)H'\left(\phi_{fd}\left(b',s'\right)\right)\frac{\partial \phi_{fd}\left(b',s'\right)}{\partial b'} \tag{27}$$
$$-\sum_{\theta'}\Pr\left(\theta'|\theta\right)\frac{\partial \xi^*}{\partial b'}\left[H\left(\phi'\right)-H\left(\phi_{fd}\left(b',s'\right)\right)\right]f\left(\xi^*|\xi\right)\leq 0$$

The first term captures the incentive effect described in the Markov equilibrium, which operates for next-period states where it is optimal to deviate from the inflation target and enter the fiscal-dominant regime ($\eta' = 0$). This term is negative since $H' > 0$ and $\partial\phi_{fd}\left(b',s'\right)/\partial b' < 0$.[19] The second term is also negative because, as explained above, the cutoff ξ^* is increasing in the amount of inherited debt and $H\left(\phi'\right) > H\left(\phi_{fd}\left(b',s'\right)\right)$.

It is therefore optimal to reduce debt issuance in order to induce a higher ϕ_{fd} in the event of a switch to the fiscal-dominant regime in the next period, and to strengthen the next-period government's incentive to adhere to the inflation target. This incentive to limit indebtedness becomes stronger as the probability of switching to the fiscal-dominant regime increases.

Heuristically, if there are two distributions for ξ' and one first-order stochastically dominates the other, we should expect that the wedge in the Euler equation (26), $|\frac{\partial J(b',\phi',s)}{\partial b'}/\beta|$, is larger for the dominated distribution. That is, the higher the expected future costs of switching to the fiscal-dominant regime, the smaller the wedge becomes. In the limiting case where only the monetary-dominant regime is possible next period—as in the Ramsey outcome—the wedge disappears entirely, and there are no downward distortions to debt issuance. This basic intuition is central to understanding the different responses of debt to shocks to θ or ξ, which we study next.

In Appendix C, we prove for a deterministic economy with $\beta = \hat{\beta}$ that a Markov equilibrium outcome is characterized by a higher level of inflation and a lower level of debt relative to the Ramsey outcome that starts with the same level of inherited debt. This result illustrates how greater commitment allows for lower inflation and higher debt.

To better understand these dynamics, we consider a typical equilibrium outcome for a calibrated version of our model.[20] The solid lines in Figure 1 plot a representative path

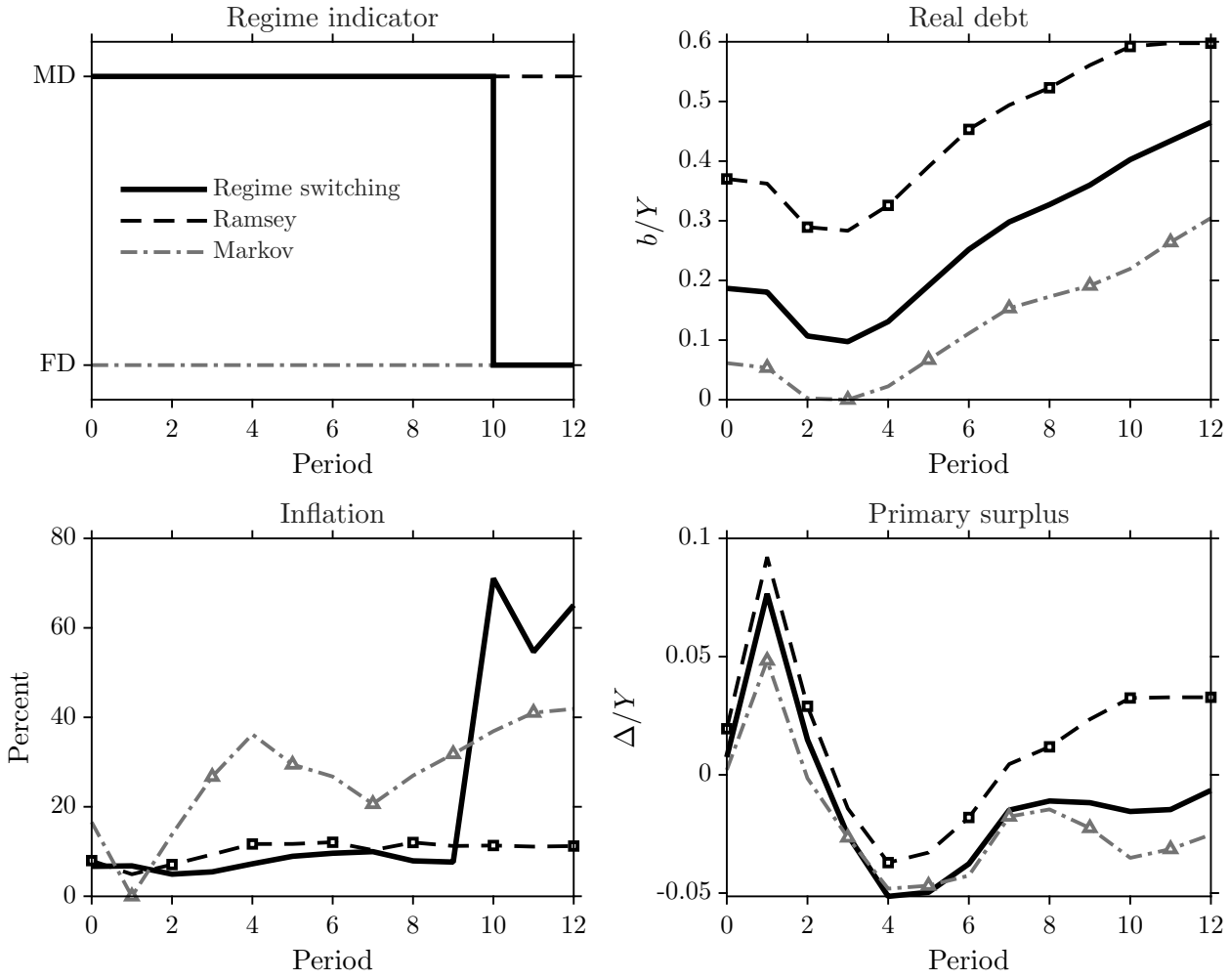
[19] To see that $\partial\phi_{fd}/\partial b < 0$, note that totally differentiating (18) we have

$$\frac{\partial \phi_{fd}}{\partial b} = \frac{-U''\left(\Delta,\theta\right)}{v''\left(\phi_{fd}\right)}\frac{\partial \Delta}{\partial b} < 0$$

where the inequality follows because U and v are concave and $\partial\Delta/\partial b > 0$ as shown in Lemma 4.

[20] The calibration is the one for the Latin American (LA) economies presented in Section 6.1.

Figure 1: Typical outcomes



Notes: The figure plots a representative path from a long simulation of the model calibrated to the Latin American economies (see Section 6.1 for details on the calibration). The solid black lines report outcomes under endogenous regime switching, the dashed black lines report the Ramsey equilibrium outcome, and the dash-dotted gray lines report the Markov equilibrium outcome, all subject to the same sequence of θ shocks. The top-left panel plots the regime indicator, where MD denotes monetary dominance and FD denotes fiscal dominance. The top-right panel reports the real debt-to-GDP ratio, the bottom-left panel reports inflation in annualized percent, and the bottom-right panel reports the primary surplus-to-GDP ratio. The x-axis represents time in years.

for our model. It is instructive to compare these outcomes with those under the Ramsey and Markov equilibria for the same sequence of θ shocks (dashed black and dash-dotted gray lines respectively). We observe that the Markov equilibrium sustains very little debt and exhibits high and volatile inflation.[21] In contrast, the Ramsey equilibrium supports substantially higher debt levels along with lower and more stable inflation.

5 Two types of disinflation

We now describe how the restrictions implied by the model on equilibrium outcomes can help to disentangle the role played by ξ_t and θ_t. Specifically, in our application we will focus on big disinflation episodes, that is, periods during which governments managed to bring inflation under control after years of high inflation. There are two ways in which the model can generate these dynamics. Inflation can decline either due to a reduction in the marginal value of government spending, θ, or due to an increase in the (expected) cost of deviating from the promised inflation. We will refer to the former as *fundamental disinflation* and to the latter as *institutional disinflation*.

In this section, we will show that these types of disinflation have distinct implications for the dynamics of public debt. In particular, fundamental disinflations are associated with a declining path for real debt, while institutional disinflations are characterized by an increasing path for real debt. In Section 6 we will use this logic along with data on inflation and debt to disentangle the relative importance of institutional and fundamental considerations.

Fundamental disinflation Consider a path in which the realization of ξ_t is low enough so that it is always optimal to be in the fiscal-dominant regime. Along this path, the value of real money balances (and inflation) is determined by the static condition (18) and is therefore closely tied to fiscal considerations, as in a Markov equilibrium.

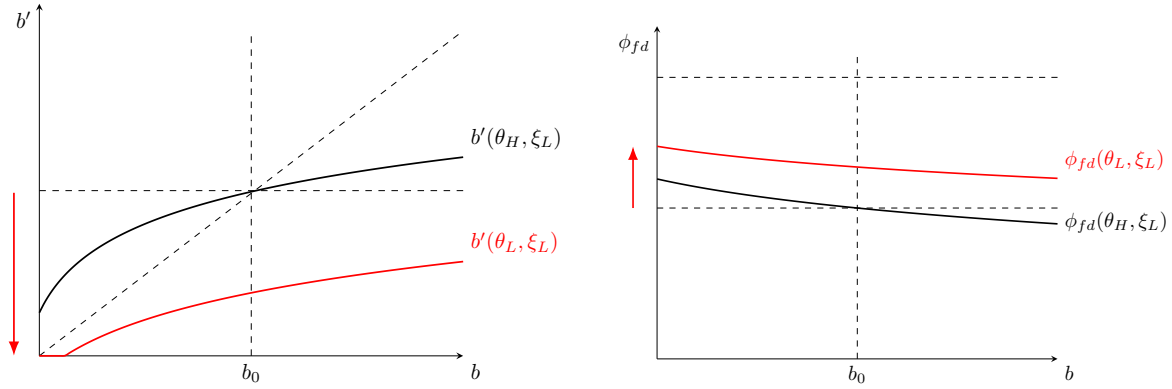
Suppose next that the desirability of government expenditures falls from θ_H to θ_L in period t_0 but it remains optimal to stay in the fiscal-dominant regime. As illustrated in the top-right panel of Figure 2, the reduction in θ shifts the policy function $\phi_{fd}(b, s)$ upward: for any level of real debt, the government finds it optimal to choose a higher value for real balances, reflecting the lower marginal value of relaxing its budget constraint when government spending is less valuable. This has the effect of reducing inflation.[22]

[21] This finding echoes the result we prove for a deterministic economy with $\beta = \hat{\beta}$ in Appendix C.

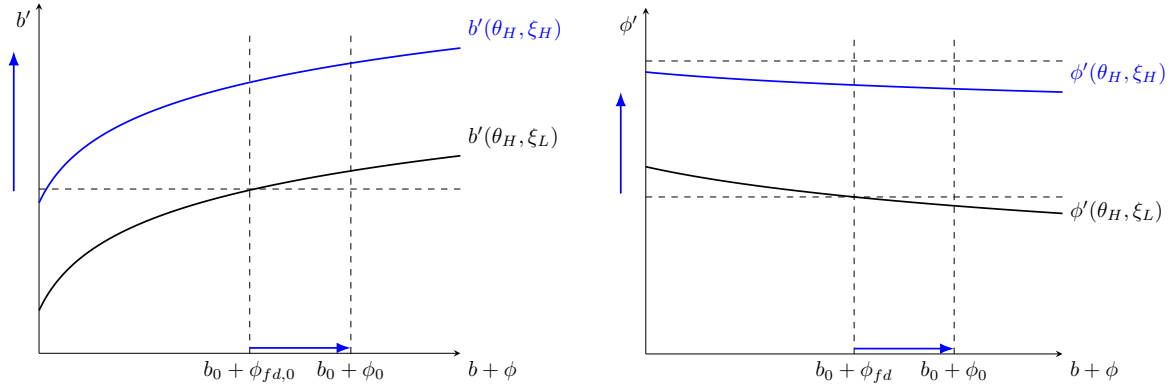
[22] Note that, in the fiscal-dominant regime, the amount of real debt, b, is the only endogenous state variable.

Figure 2: Two types of disinflation

a) Fundamental disinflation



b) Institutional disinflation



The optimal policy for debt issuance, by contrast, shifts downward (see the top-left panel of the figure). This is true under the assumption that the process for θ is sufficiently mean-reverting.[23] Thus, the government wants to reduce indebtedness in order to smooth tax revenues over time. As a result, a decline in θ while keeping ξ at a low level (e.g. $\xi = 0$) leads to a decline in inflation and a decrease in real debt.

The dashed lines in Figure 3 depict the impulse response function (IRF) to a reduction in θ in our calibrated model (see below for details). The realized shocks are shown in the first two panels. Following the shock, the debt-to-GDP ratio declines, while the inflation rate initially drops sharply in the period when θ falls, reflecting the lower marginal cost of generating primary surpluses. Inflation then continues to decline gradually, tracking the falling path of debt, which further reduces the marginal cost of surpluses.

Institutional disinflation We now consider the effects of an increase in the cost of deviating from the promised inflation target. Specifically, we begin with the same path of low ξ and high θ considered above, and suppose that at t_0, the realized cost of deviation permanently rises from ξ_L to ξ_H, with ξ_H high enough to make it optimal to switch to the monetary-dominant regime. In this case, the reduction in inflation is driven by the change in the regime. The realized ϕ now equals the promised value of real balances which is higher than the statically optimal level ϕ_{fd}. Critically, if the process for ξ is persistent, an increase in current ξ implies an increase in the expected value of ξ'. Thus, as argued in the previous section, the government now has lower incentives to reduce the amount of debt it issues because the wedge in (26) given by (27) is smaller in absolute value.

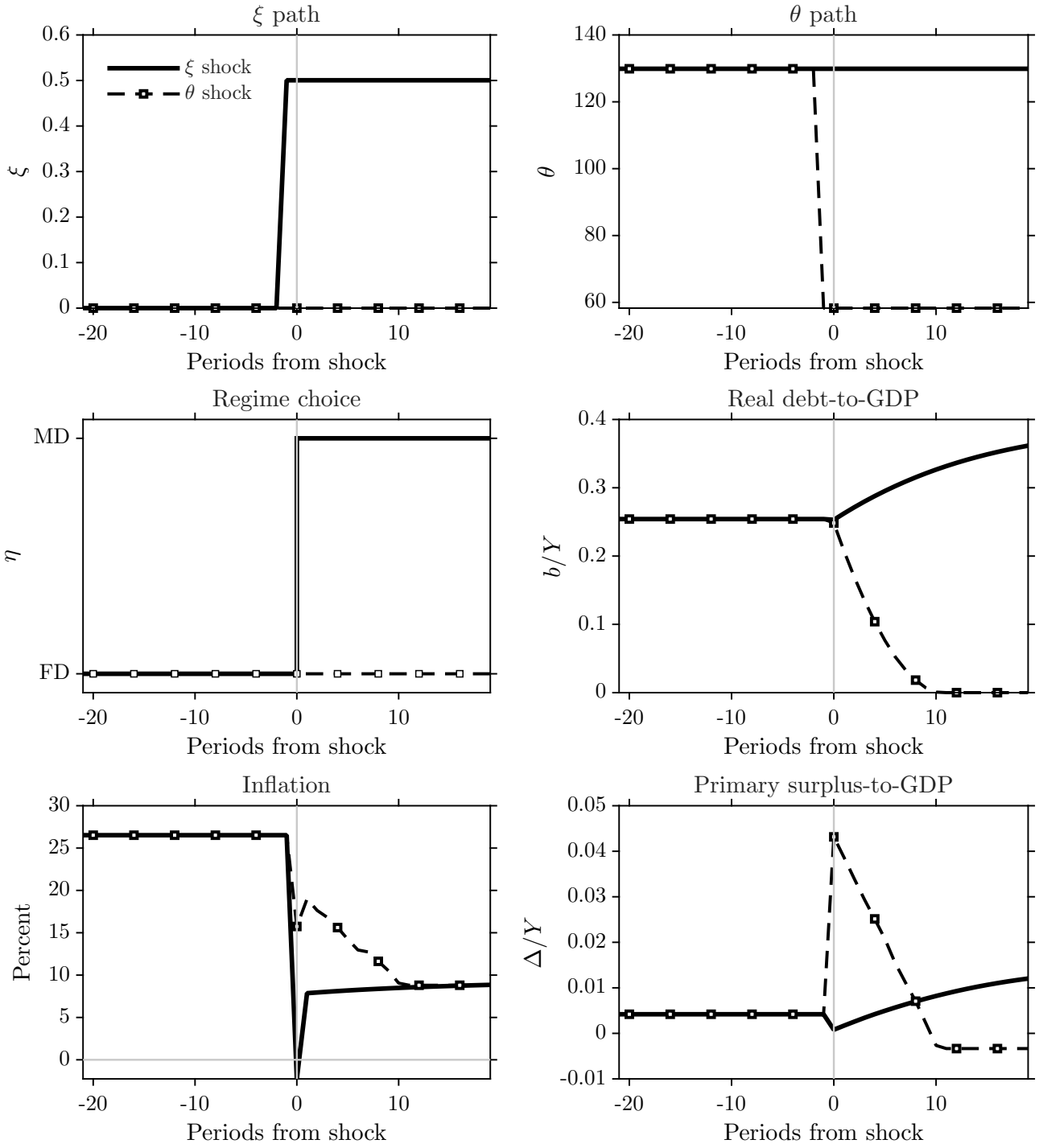
There are also two other effects at play. First, as the government shifts to the monetary-dominant regime, the government is delivering its inflation target and so the real value of government liabilities is higher because $b_0 + \phi_0 > b_0 + \phi_{fd}(b_0)$. Moreover, the present value of seigniorage revenues, the term $\sum_{j=1}^{\infty} \sum_{s^{t+j}} \beta^j \Pr\left(s^{t+j}|s^t\right) h\left(\phi\left(s^{t+j}\right)\right)$ in the intertemporal government budget constraint (13), falls, and the government must finance the inherited real liabilities with a higher present value of surpluses. Since the government is impatient, these higher surpluses are back-loaded. Both of these effects result in an increase in the level of debt issued. Thus, the government increases its debt issuance as shown in the bottom-left panel of Figure 2.[24]

The solid lines in Figure 3 depict an IRF to an increase in ξ for our calibrated model.

[23] For example, θ being iid over time is sufficient. But it is not necessary as illustrated in Figure 3 where θ follows a (discretized) AR(1) process with autocorrelation of 0.92.

[24] As discussed in the Appendix, in the monetary-dominant regime, the real value of government debt $b + \phi$ together with the exogenous state s is a sufficient statistic for the dynamics of real debt, b', and the promised target for real balances, ϕ'.

Figure 3: Impulse responses



Notes: The figure plots impulse response functions for the model calibrated to the Latin American economies (see Section 6.1). The solid black lines depict the response to a permanent increase in the cost of deviating from the inflation target, ξ (institutional disinflation), while the dashed black lines depict the response to a permanent decrease in the marginal value of government spending, θ (fundamental disinflation). The top two panels show the paths of the exogenous shocks ξ and θ, respectively. The middle-left panel reports the regime choice, where MD denotes monetary dominance and FD denotes fiscal dominance. The middle-right panel reports the real debt-to-GDP ratio. The bottom-left panel reports inflation in annualized percent and the bottom-right panel reports the primary surplus-to-GDP ratio. Time is measured in years, with the shock occurring at time 0.

The path of real government debt is increasing as argued above. The inflation rate instead initially jumps downward at t_0. The level of inflation may overshoot its value a few years out because as the level of debt increases the government may find it optimal to reduce the promised value for real balances (increase the inflation target) to ensure that the target is satisfied.

6 Case studies

In this section, we take the model to the data and uses it as a measurement device to interpret actual disinflation episodes through the identification logic developed in the previous section. We fit the model to data from Colombia, Chile, and the United States and we apply a particle filter to recover the realizations of $\{\theta_t, \xi_t\}$ that account for the observed paths of inflation and debt-to-GDP.

6.1 Calibration

We assume the following functional form for the preferences of the stand-in household:

$$\varpi(l) = \chi \frac{l^{1+\psi}}{1+\psi}, \quad v(m) = \kappa m - \zeta m^2, \quad u(g) = \frac{g^{1-\sigma}}{1-\sigma}.$$

The fundamental shock θ_t follows a truncated AR(1) process given by:

$$\theta_{t+1} = (1-\rho_\theta)\overline{\theta} + \rho_\theta \theta_t + \sigma_\theta \varepsilon_{t+1}$$

where we only allow positive values. Similarly, ξ_t also follows a truncated AR(1) process with parameters $\overline{\xi}, \rho_\xi, \sigma_\xi$. Both processes are discretized using the Tauchen method. To smooth the regime-choice indicator and aid convergence of the solution algorithm, we add iid Type-I Extreme Value shocks to the value of each regime; they are switched off when simulating the model. See Appendix D for details about the computation.

The model is parameterized by the preference parameters $(\beta, \hat{\beta}, \chi, \psi, \kappa, \zeta, \sigma)$ and the parameters governing the stochastic processes for θ_t and ξ_t, $(\rho_\theta, \sigma_\theta, \bar{\theta})$ and $(\rho_\xi, \sigma_\xi, \bar{\xi})$. We set a subset of parameters to some predetermined values, and we calibrate the remaining to match a set of moments related to fiscal and monetary variables.

We set the inverse of the Frisch elasticity, ψ, to 1 and the inverse of the elasticity of substitution, σ, for government expenditures to the common parameter of 2. We set the

Table 1: Calibration: Parameters

Parameter	Description	Value	
		LA Calibration	US Calibration
β	Households' discount factor	0.95	0.95
ψ	Inverse Frisch elasticity	1	1
σ	Inverse EIS gov't expenditures	2	2
$\hat{\beta}$	Gov'ts discount factor	0.93	0.92
χ	Labor disutility parameter	0.0142	0.019
κ	Money-demand parameter	0.75	0.63
ζ	Money-demand parameter	0.128	0.07
$\bar{\theta}$	AR1 parameter	120	2
ρ_θ	Persistence of θ	0.92	0.9
σ_θ	Standard Deviation of θ	60	20
$\rho_{\tilde{\xi}}$	Persistence of $\tilde{\xi}$	0.995	0.99
$\sigma_{\tilde{\xi}}$	Standard Deviation of $\tilde{\xi}$	0.04	0.3

stand-in household's discount factor, β, to 0.95 so that the real interest rate is approximately 5 percent at our chosen annual frequency. Finally, we set $\overline{\tilde{\xi}} = 0.1$.

We calibrate the other parameters to match key moments for fiscal and monetary variables. We target the average real money balances, the mean, autocorrelation and standard deviation of primary surpluses, and key moments summarizing the distribution of inflation: average inflation in the first and fourth quartile of the distribution, and the probabilities that inflation remains in either the top or bottom quartile from one period to the next. We consider two calibrations: one for Latin American economies ("LA calibration") from 1960–2017 and one for the United States ("US calibration") from 1914–2017.[25] Table 1 reports the parameter values for these two calibrations, and Table 2 reports the target moments in the data and in the model.

Heuristically, the persistence, mean, and variance of primary surpluses are informative for the parameters governing θ_t, $\left(\rho_\theta, \sigma_\theta, \bar{\theta}\right)$. The persistence of inflation in Q1 and Q4 is informative about the persistence of the costs of deviating from the target. The remaining parameters χ, ζ, and κ are informed by the average inflation in the first quartile (Q1), the average inflation in the fourth quartile (Q4), and the average real money balances.

The model defines a nonlinear state-space system

$$y_t = f\left(S_t\right) + \varepsilon_{yt}$$
$$S_{t+1} = k\left(S_t, \varepsilon_{t+1}\right)$$

[25]The countries included are Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay, and Venezuela.

Table 2: Calibration: Moments

Moment	LA Calibration		US Calibration	
	Data	Model	Data	Model
Avg. inflation in Q1	3.41%	3.84%	-1%	1.38%
Avg. inflation in Q4	57.0%	56.39%	9.0%	7.46%
Prob. of staying in Q1	0.69	0.58	0.56	0.63
Prob. of staying in Q4	0.77	0.65	0.73	0.58
Average debt-to-GDP	35.38%	34.91%	56.0%	60.3%
Avg. real money balances-to-GDP	9.89%	3.78%	8.06%	8.45%
Variance of primary surplus	10.68	8.96	29.68	4.61
Autocorr. of primary surplus	0.67	0.63	0.82	0.33
Avg. of primary surplus-to-GDP	0.42%	1.23%	2.42%	2.71%

Notes: The table reports targeted moments in the data and their model counterparts for both the Latin American (LA) and US calibrations. The LA calibration uses data from 11 Latin American economies (ARG, BOL, BRA, CHL, COL, ECU, MEX, PAR, PER, URU, VEN) over 1960–2017; the US calibration uses US data over 1914–2017. Q1 and Q4 denote the first and fourth quartiles of the inflation distribution, respectively. The probability of staying in Q1 (Q4) is the frequency with which inflation remains in the bottom (top) quartile from one year to the next. Inflation is expressed in annualized percent. The variance and autocorrelation of primary surpluses are computed over the full sample. The model moments are computed from a long simulation.

where y_t is a vector of observable variables, $S_t = (b_t, \phi_t, \theta_t, \xi_t)$ is the state vector, ε_t are the innovations to the exogenous states $s_t = (\theta_t, \xi_t)$, and ε_{yt} is a vector of uncorrelated Gaussian measurement errors. The functions f and k are obtained using the model's numerical solution. The vector of observables includes inflation and the debt-to-GDP ratio, $y_t = (\pi_t, b_t/l_t)$. We use the model to recover the path for $\{\theta_t, \xi_t\}$ given the observed path for these variables by applying a non-linear particle filter. The measurement errors are assumed to be independent and normally distributed, $\varepsilon_{yt} \sim N(0, \Sigma)$, where $\Sigma = \text{diag}(\sigma_\pi^2, \sigma_b^2)$ with σ_π^2 and σ_b^2 set to be 5% of the unconditional variance of the series.[26]

6.2 Colombia

We first consider the disinflation episode in Colombia during the 1990s. In 1991, Colombia instituted a new constitution that granted substantial independence to its central bank, Banco de la República, explicitly mandating price stability as its primary objective and significantly insulating monetary policy from political influence. As written in Perez-Reyna and Osorio-Rodríguez (2017):

> The central bank was given technical independence as to the instruments employed to achieve its main task, which was defined solely as the control of

[26] We set $\sigma_\pi = 2.1$pp,$\sigma_b = 2.9$pp for Colombia, $\sigma_\pi = 1.3$pp,$\sigma_b = 2.4$pp for Chile, and $\sigma_\pi = 0.6$pp,$\sigma_b = 2.2$pp for the US.

> inflation. In addition, the monetary board was replaced by a board of governors in which the minister of finance had only one vote (of seven) and no veto power. Finally, the constitution prescribed that any direct loan from the central bank to the central government would require unanimous approval by the members of the board, thus all but forbidding monetary financing under this guise. To date, the independent central bank has never granted any direct loans to the central government.

In 2001, Colombia adopted an explicit inflation targeting regime with a long-term inflation goal of 3%. Prior to the 1991 reform, the central bank lacked autonomy, often making monetary policy susceptible to government pressures. As a result Colombia suffered from persistent high inflation despite the relatively low level of debt. Starting in 1991, inflation started falling.

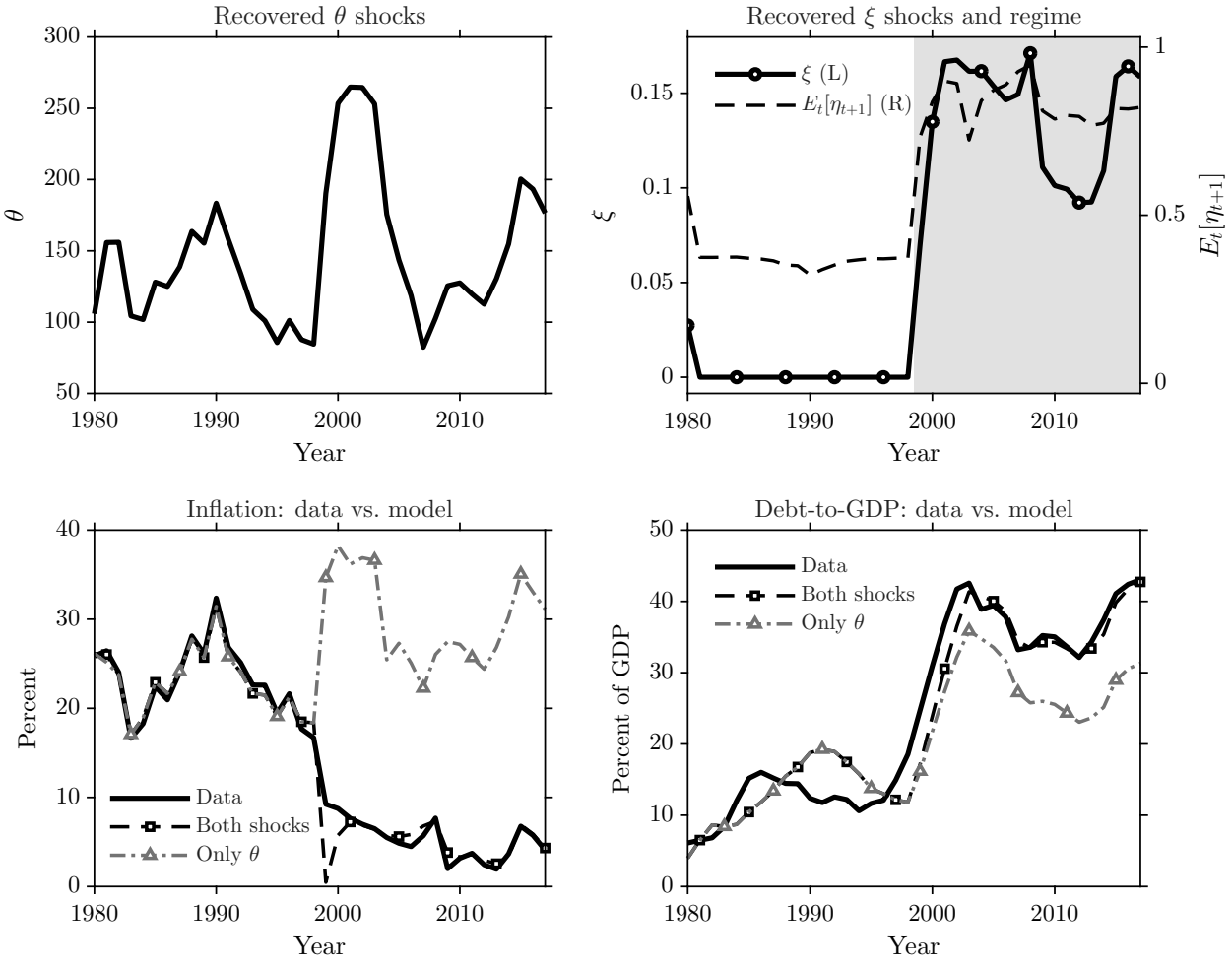
We apply the particle filter to our model and estimate the path of the structural shocks $\{\theta_t, \xi_t\}$ for the period 1980–2017. The results are presented in Figure 4. The top two panels display the resulting series of θ and ξ shocks. The bottom two panels show that the model implied paths for inflation and debt (the dashed lines) closely match the observed trajectories of debt and inflation (solid black lines).

The model accounts for the reduction in inflation in the 1990s with an increase in the cost of deviating from the inflation target in 1999. Such an increase results in a persistent shift to a monetary-dominant regime from 1999 onward. The observed increase in the debt-to-GDP ratio from 1994 to 2002 is driven by the switch to a monetary-dominant regime that allows for greater debt issuance and by higher-than-average realizations of θ_t.[27] The model can account for the stable and low inflation (at least from 1999 onward) and the increasing path for the debt-to-GDP ratio because in the MD regime, fiscal considerations—θ_t and the inherited debt—have little effect on inflation. Monetary policy is credibly delegated, and there is little spillover to monetary variables from the fiscal side. It is then possible to find a path of θ_t to match the debt dynamics.

To understand the importance of the detected change in the regime, we also conduct a counterfactual exercise in which we retain the computed sequence of θ shocks but hold $\xi_t = 0$ throughout the entire period, so it is optimal to always be in the FD regime. This corresponds to the dash-dotted lines in the bottom two panels. This scenario aims to replicate the conditions that would have prevailed had Colombia not undertaken a *credible* constitutional reform. As illustrated, without this institutional change, debt would have

[27] The increasing path for θ_t is consistent with the observation that in Colombia the "size of the government almost doubled between 1991 and 1999, as the ratio of central government expenditures to GDP increased from 8.9 percent to 16.9 percent, Perez-Reyna and Osorio-Rodríguez (2017)."

Figure 4: Colombia



Notes: The figure reports results from applying the particle filter to Colombian data over 1980--2017 using the LA calibration (see Section 6.1). The top-left panel plots the recovered path of the fundamental shock θ. The top-right panel plots the recovered credibility shock ξ (solid line, left axis) along with the expected regime $E_t[\eta_{t+1}]$ (dashed line, right axis), where $\eta_t = 1$ under monetary dominance (MD) and $\eta_t = 0$ under fiscal dominance (FD); shaded areas denote periods in which the economy is in the monetary-dominant regime. The bottom two panels compare the data (solid lines) with the model-implied paths under both shocks (dashed lines) and under only θ shocks with ξ set to zero (dash-dotted lines) for inflation (bottom-left, in annualized percent) and the debt-to-GDP ratio (bottom-right, in percent).

similarly increased, driven by the high realizations of θ_t, but inflation would have remained constant or even risen during the latter half of the decade. This result underscores the crucial role credible institutional reforms played in simultaneously achieving higher debt levels and declining inflation in Colombia during this period.

Our result of an institutional improvement in Colombia in the mid-90s is consistent with prior narrative analyses and also with the behavior of other macroeconomic variables.[28] Interestingly, the model does not identify the increase in the credibility of the reform in 1992, the first year after the reform, but only in 1999. This is because inflation was still relatively high, and the level of debt only started to increase in that period. This may be driven by the fact that it took time for the government to convince private agents that the new institutional arrangement was credible and not just a cosmetic adjustment. Our measure thus brings a complementary perspective to purely de jure measures of central bank credibility like Grilli, Masciandaro, and Tabellini (1991); Cukierman (2008); Romelli (2022). For example, the credibility index for Colombia in Romelli (2022) increases in 1992 and stays constant at this level.

The identified switch to a monetary-dominant regime in 1999 coincides with one of the largest contractions and deepest financial crises in the history of Colombia. Consistent with the recovered large increase in θ , these were times of high fiscal needs for the consolidated government budget constraint as "the central bank also heavily used its lender of last resort facilities, but unlike in the eighties, it was not allowed to finance bailout operations with monetary emission" (Perez-Reyna and Osorio-Rodríguez, 2017). This pattern is consistent with a theory of reputation based on signaling with hidden types: the institutional arrangement centered on an independent central bank became credible when the economy was hit by a large adverse shock and the government nevertheless chose not to monetize the associated debt and expand the monetary base.

6.3 Chile

Beginning in the late 1980s, Chile enacted a variety of fiscal and monetary reforms. It tightened public finances and, for roughly three decades, consistently posted budget surpluses (Caputo and Saravia (2018)). Since 2001 these efforts have been formalized by a structural fiscal rule that targets a surplus of 1 percent of GDP. On the monetary front, a 1989 constitutional law granted the Central Bank of Chile full autonomy and the country moved to an explicit inflation-targeting regime soon after.

[28]For example, starting from the mid 1990s the Colombia government started to issue a progressively larger share of debt to foreigners in local currency (Perez-Reyna and Osorio-Rodríguez, 2017), which would also be consistent with more credible inflation promises, see Du, Pflueger, and Schreger (2020).

As we did for the case of Colombia, we use the model to filter a sequence of fiscal-needs shocks (θ_t) and credibility shocks (ξ_t) to reconcile our model with Chile's post-1990 data shown in Figure 5. In contrast to Colombia, both inflation and the debt-to-GDP ratio declined over this period.

During the first half of the 1990s, the drop in inflation can be replicated either by a fall in fiscal needs or by a rise in the penalty for deviating from the inflation target; each channel on its own is sufficient to match the joint movements in inflation and debt. The distinction between them becomes critical in the second half of the decade: inflation keeps falling while debt-to-GDP merely flattens out. Replicating this pattern requires credibility shocks—an isolated increase in fiscal needs would stabilize the debt ratio but, counterfactually, would drive inflation back up. As in the case of Colombia, we also use a particle filter to compute a path of θ shocks that only targets the path of inflation when $\xi_t = 0$ for the entire period. As in Colombia, one can find a path of θ_t shocks that replicates the declining path of inflation but this would not be able to sustain the level of debt.

The contrasting experiences of Colombia and Chile illuminate the two disinflation channels implied by our model. In Colombia, the data can only be reconciled with a credibility gain—modeled as positive ξ_t shocks—because a pure drop in fiscal needs would have driven both inflation and the debt ratio lower, which the data do not show. In Chile, the early-1990s disinflation could be matched either by stronger credibility or by lower fiscal needs. Yet our calibrated paths indicate that, once debt-to-GDP leveled off in the second half of the 1990s, the continued decline in inflation required additional credibility gains.

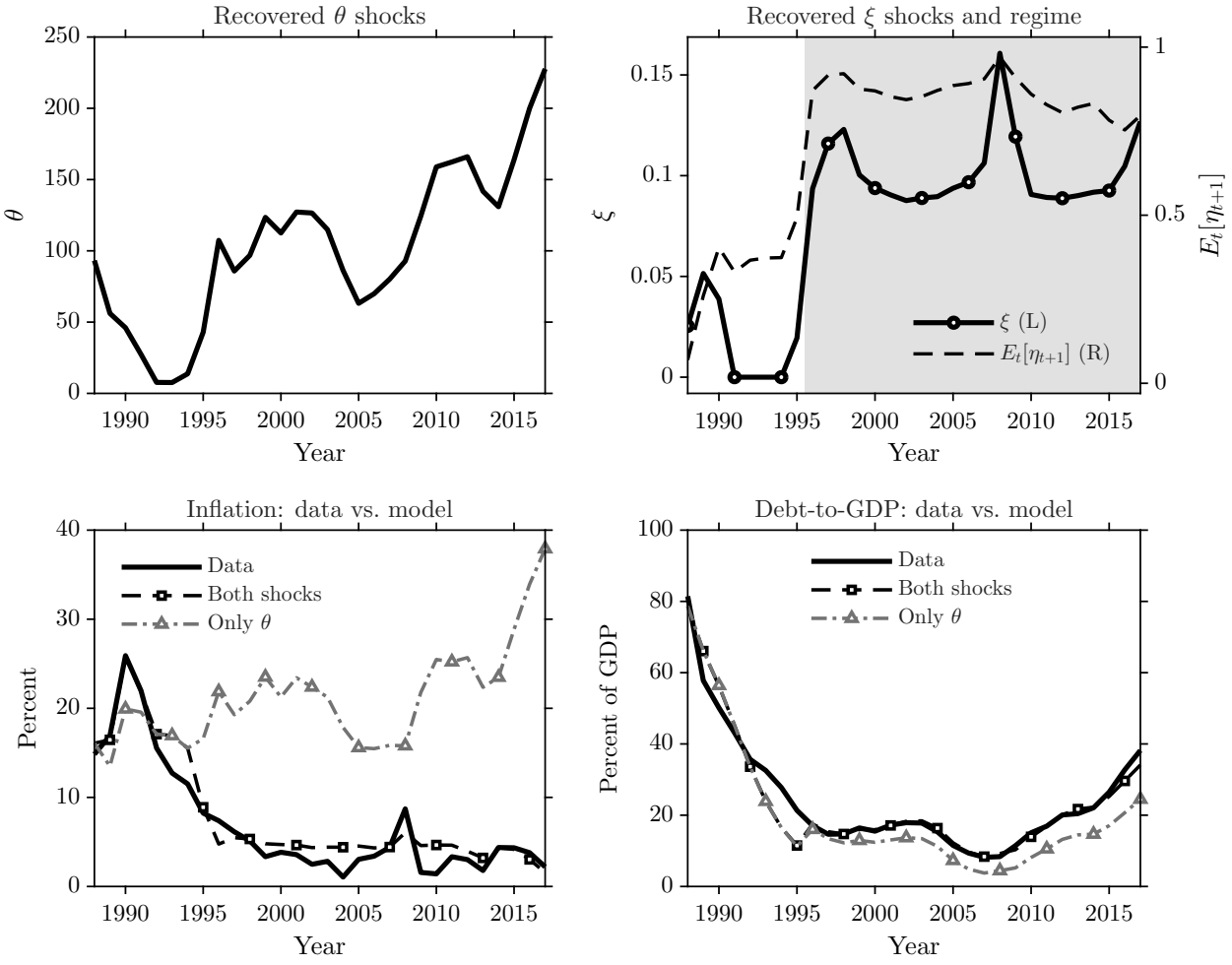
6.4 United States

We apply the same methodology to understand the US inflation and disinflation experience from 1960–2008. To do so, we first recalibrate the model to fit US data from 1914–2017.

The filtering results are presented in Figure 6, which shows the recovered paths of θ and ξ shocks alongside the model's fit to the data.

The model identifies an interesting pattern in the evolution of monetary credibility over this period. The recovered ξ path shows a significant decline in credibility beginning in the late 1960s and persisting through the 1970s. This erosion of credibility coincides with the "Great Inflation" episode—the recovered regime indicator shows the economy switching to the fiscal-dominant regime during this period, with inflation rising from around 2% in the mid-1960s to double digits by the late 1970s. The collapse in credibility is consistent with well-documented historical accounts of political pressure on the Federal Reserve during this era. Most notably, President Nixon pressured Fed Chairman Arthur Burns to pursue

Figure 5: Chile



Notes: The figure reports results from applying the particle filter to Chilean data over 1990–2017 using the LA calibration (see Section 6.1). The top-left panel plots the recovered path of the fundamental shock θ. The top-right panel plots the recovered credibility shock ξ (solid line, left axis) along with the expected regime $E_t[\eta_{t+1}]$ (dashed line, right axis), where $\eta_t = 1$ under monetary dominance (MD) and $\eta_t = 0$ under fiscal dominance (FD); shaded areas denote periods in which the economy is in the monetary-dominant regime. The bottom two panels compare the data (solid lines) with the model-implied paths under both shocks (dashed lines) and under only θ shocks with ξ set to zero (dash-dotted lines) for inflation (bottom-left, in annualized percent) and the debt-to-GDP ratio (bottom-right, in percent).

accommodative monetary policy in the lead-up to the 1972 election, subordinating price stability to short-term political and fiscal objectives (Blinder (2022)). The model attributes this inflationary period to both rising fiscal needs (elevated θ_t)—driven by the costs of the Vietnam War and expanding social programs—and collapsing credibility (declining ξ_t), which together pushed the economy into the fiscal-dominant regime.

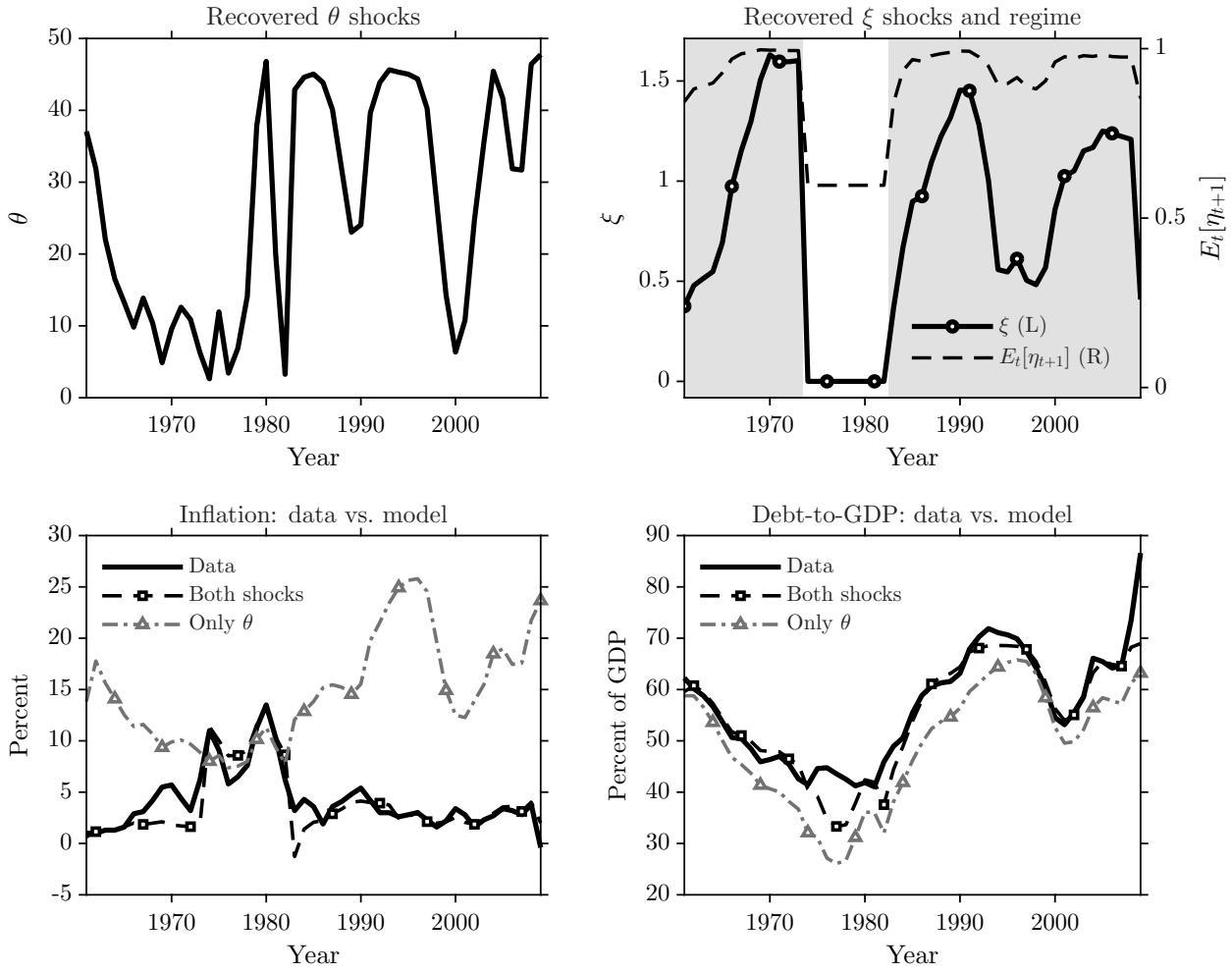
The Volcker disinflation beginning in 1979 marks a turning point. The model accounts for the sharp reduction in inflation through a combination of declining fiscal needs and, critically, a restoration of credibility in the early 1980s that triggers a switch back to monetary dominance. The timing is notable: credibility does not recover immediately with Volcker's appointment or the October 1979 policy shift, but rather builds gradually as the Fed demonstrates its willingness to maintain tight policy despite a severe recession. This echoes our finding for Colombia, where credibility lagged formal institutional reform by several years.

Critically, the debt-to-GDP ratio rose substantially from the early 1980s onward, from around 45% to over 70% by the mid 1990s, even as inflation declined and stabilized. This rising debt trajectory alongside falling inflation is what identifies the institutional disinflation. To illustrate the importance of credibility gains, we conduct the same counterfactual exercise as for Colombia and Chile: we retain the computed sequence of θ shocks but hold $\xi_t = 0$ throughout, so the economy remains in the fiscal-dominant regime. The dash-dotted lines show that without institutional changes, the rising debt levels driven by elevated θ_t realizations would have generated much higher inflation in the latter half of the sample period. The model would predict debt levels closer to those observed in the data, but inflation would have remained elevated or even increased, contrary to the pattern of stable, low inflation actually observed from the mid-1980s onward. This exercise illustrates that the credibility of the Federal Reserve's commitment to price stability, built through the 1980s, was essential for the United States to simultaneously achieve higher debt levels and low inflation in subsequent decades.

7 Discussion

So far, we have shown how the model's restrictions can be used to identify the relative importance of institutional and fundamental drivers of disinflation episodes. In this section, we show that this identification logic is robust to alternative mappings between the model and the data and to the inclusion of additional shocks. We also discuss how the recovered series for fiscal needs and institutional costs, $\{\theta_t, \xi_t\}$, can be used to discipline deeper models of credibility building.

Figure 6: USA



Notes: The figure reports results from applying the particle filter to US data over 1960–2008 using the US calibration (see Section 6.1). The top-left panel plots the recovered path of the fundamental shock θ. The top-right panel plots the recovered credibility shock ξ (solid line, left axis) along with the expected regime $E_t[\eta_{t+1}]$ (dashed line, right axis), where $\eta_t = 1$ under monetary dominance (MD) and $\eta_t = 0$ under fiscal dominance (FD); shaded areas denote periods in which the economy is in the monetary-dominant regime. The bottom two panels compare the data (solid lines) with the model-implied paths under both shocks (dashed lines) and under only θ shocks with ξ set to zero (dash-dotted lines) for inflation (bottom-left, in annualized percent) and the debt-to-GDP ratio (bottom-right, in percent).

Mapping model to data: costs and benefits of inflation Our identification logic relies on the comovement between inflation and government debt, particularly during disinflation episodes. Although the underlying mechanism is general, the precise decomposition between changes driven by fundamentals and those driven by changes in the cost of deviating depends on the costs and benefits of ex-post inflation. The benefits of generating ex-post, or surprise, inflation depend critically on the composition of government liabilities, since this composition determines how much a given increase in inflation reduces the real value of those liabilities.

In our baseline calibration, we map all government liabilities other than the monetary base into the real-debt component, b, while ϕ represents only M0. This mapping minimizes the benefits of generating ex-post inflation. Consequently, to match the observed moments of inflation, the calibration may underestimate the costs of inflation captured by the value of real money balances, $v(m)$.

Our choice of baseline is motivated by the following observation. If the government could choose the composition of its debt and hedging motives were small, it would minimize its incentives to generate ex post inflation by issuing real debt, such as foreign-currency debt. Moreover, any domestic-currency debt would be short term and therefore difficult to inflate away. The currency composition and maturity structure of government debt can thus provide additional information about government credibility in addition to the dynamics of total liabilities. In particular, our finding that credibility improved in Colombia and Chile during the mid-to-late-1990s is consistent with the increase in the share of debt issued in local currency documented by Du et al. (2020), as well as with an increase in the duration of outstanding government debt.[29]

As a robustness exercise, we consider an alternative mapping between the model and the data in which b includes only foreign-currency debt and debt indexed to the domestic price level, while ϕ includes the monetary base together with all non-indexed domestic-currency debt. This calibration maximizes the benefits of generating ex-post inflation. We show in the Appendix that our main results are largely unchanged. For example, for Colombia, the model continues to identify a switch to a monetary-dominant regime around the 1998 recession, reflecting the large increase in the real value of government liabilities associated with the decline in inflation.

Confounding factors We consider an economy with two shocks that have different implications for the joint dynamics of debt and inflation. There are, however, other factors that drive the dynamics of debt and inflation and that were left out of our model for tractability.

[29] See Arellano, Bai, Kehoe, and Ramanarayanan (2013) for a similar argument.

Some of these factors may drive inflation and debt in opposite directions, as the institutional cost ξ_t does in our framework, so a relevant question is whether our measurement overstates the importance of institutional forces in driving disinflation episodes. As we argue below, however, while these forces may temporarily generate a negative comovement between debt and inflation, in the long run they will lead to a positive comovement unless the monetary-dominant regime becomes credible.

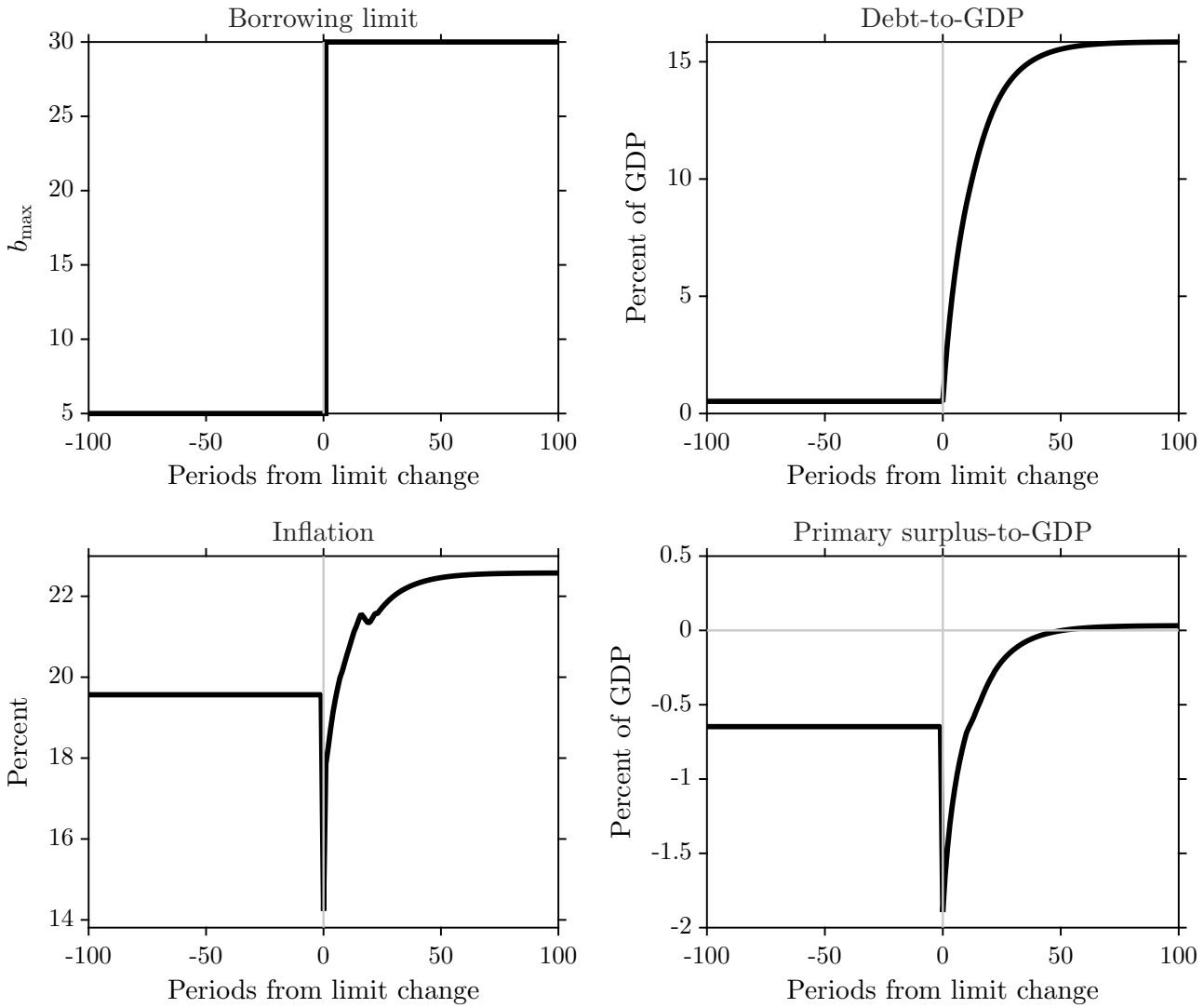
To understand this point, let us consider a fundamental shock that improves the government's ability to issue debt, a factor that could lead simultaneously to a decline in inflation and an increase in debt in our framework. Suppose that before period t_0 the government is constrained by a tight debt limit, $b' \leq \bar{b}$, but in t_0 the debt limit is relaxed. This higher debt capacity allows the (impatient) government to initially run lower surpluses by borrowing more, something that puts less pressure on inflation. Eventually, however, higher surpluses will be required to service the higher level of debt, and this will result in higher inflation if the central bank's credibility does not increase. Thus, higher debt capacity can only be associated with higher debt and lower inflation temporarily, as illustrated in Figure 7, if there is no increase in credibility of the monetary regime. In this sense, the credibility of the monetary-dominant regime is a necessary condition for the ability to support high levels of debt with low levels of inflation.

Deeper models of credibility Our recovered credibility measure can help discipline deeper theories of reputation and credibility by mapping their distinct implications into testable restrictions on the path of $\{\xi_t\}$. Mechanisms in the spirit of Atkeson et al. (2007); Halac and Yared (2025, 2021)—building on the logic of Green and Porter (1984)—naturally generate discrete regime changes, with ξ_t switching abruptly between low values (periods in which promises are weakly enforced) and high values (periods in which deviations are prohibitively costly). By contrast, reputation theories based on signaling with hidden types, in which private agents gradually update beliefs about the government's type from observed actions—as in King and Lu (2022); Bocola et al. (2025)—imply a more persistent and smooth evolution of $\{\xi_t\}$.

Our formulation is flexible enough to accommodate either pattern, and this flexibility may be empirically important: the end of four big inflations detailed by Sargent (1982) appears closer to abrupt credibility shifts, whereas the end of the Great Inflation in the United States is associated in our estimates with a gradual increase in ξ_t between 1980 and 1984.

The joint behavior of $\{\xi_t\}$ and $\{\theta_t\}$ is also informative about the forces underlying improvements in credibility. In particular, as we find for Colombia in 1999, a large increase in

Figure 7: Relaxation of a tight debt limit



Notes: The figure plots the response of the model with endogenous regime switching to a one-time relaxation of the borrowing limit at time 0, using the Latin American calibration (see Section 6.1). Before time 0, the government faces a tight debt limit $b' \leq \bar{b}$; at time 0, the constraint is permanently relaxed. The credibility shock ξ is held constant throughout, so there is no change in the monetary regime. The top-left panel reports the borrowing limit, the top-right panel reports the debt-to-GDP ratio, the bottom-left panel reports inflation in annualized percent, and the bottom-right panel reports the primary surplus-to-GDP ratio. Time is measured in years.

ξ_t during a period of high fiscal needs—that is, when θ_t is high—is consistent with a reputation model based on hidden types. In fact, a robust prediction of this class of models is that the government's credibility rises substantially when it resists the temptation to inflate precisely when fiscal pressures, and hence the temptation to do so, are especially strong.

Developing and formally testing these microfoundations against the inferred dynamics of $\{\xi_t\}$ is an important direction for future research.

8 Conclusion

This paper develops a framework for analyzing the credibility of inflation-targeting mandates in environments with fiscal-monetary interactions. We model a government that delegates monetary policy to a central bank but retains the option to override the mandate when fiscal pressures mount. The decision to honor or override it depends on two forces: fiscal fundamentals, captured by outstanding debt and the marginal utility of public spending, and a stochastic institutional cost of deviation that reflects legal, reputational, and political constraints on government interference with monetary policy.

The model generates endogenous transitions between monetary-dominant and fiscal-dominant regimes. In the fiscal-dominant regime, inflation is high, volatile, and tightly linked to fiscal conditions, while debt levels remain low. In the monetary-dominant regime, inflation is low and insulated from fiscal shocks, and the economy can sustain higher levels of public debt. Credible delegation is thus a necessary condition for supporting high debt-to-GDP ratios with low inflation.

We find that the endogeneity of regime switching creates incentive effects that distort government policy choices. Governments strategically limit debt issuance and choose less ambitious inflation targets to reduce future temptations to override the mandate. These incentive effects generate distinct predictions for disinflation episodes: fundamental disinflations driven by reduced fiscal needs produce declining paths for both inflation and debt, while institutional disinflations driven by increased credibility produce declining inflation alongside rising debt. This contrasting behavior allows us to identify the contribution of institutional changes to observed disinflation episodes. We apply the framework to study disinflation experiences in Colombia, Chile, and the United States. In each case, the joint dynamics of inflation and debt allow us to decompose the relative contributions of fiscal consolidation and institutional change to the decline in inflation.

References

Abreu, D. (1988): "On the theory of infinitely repeated games with discounting," *Econometrica: Journal of the Econometric Society*, 383–396. 3, B

Abreu, D., D. Pearce, and E. Stacchetti (1990): "Toward a theory of discounted repeated games with imperfect monitoring," *Econometrica: Journal of the Econometric Society*, 1041–1063. B

Aguiar, M., M. Amador, E. Farhi, and G. Gopinath (2013): "Crisis and commitment: Inflation credibility and the vulnerability to sovereign debt crises," Tech. rep., National Bureau of Economic Research. 1

Aguiar, M. and G. Gopinath (2007): "Emerging market business cycles: The cycle is the trend," *Journal of political Economy*, 115, 69–102. 4

Aiyagari, S. R. (1989): "How should taxes be set," *Quarterly Review*, 13, 22–32. 2.2

Aiyagari, S. R., A. Marcet, T. J. Sargent, and J. Seppälä (2002): "Optimal taxation without state-contingent debt," *Journal of Political Economy*, 110, 1220–1254. 1, 1, 2.1, 2.2, 4.1

Alvarez, F., P. J. Kehoe, and P. A. Neumeyer (2004): "The time consistency of optimal monetary and fiscal policies," *Econometrica*, 72, 541–567. 1

Arellano, C., Y. Bai, P. Kehoe, and A. Ramanarayanan (2013): "Credibility and the Maturity of Government Debt," *Federal Reserve Bank of Minneapolis, Manuscript*. 29

Atkeson, A., V. V. Chari, and P. J. Kehoe (2007): "On the optimal choice of a monetary policy instrument," . 1, 7

Atkeson, A. and P. J. Kehoe (2001): "The advantage of transparent instruments of monetary policy," Tech. rep., National Bureau of Economic Research. 1

Barthélemy, J., E. Mengus, and G. Plantin (2024): "The central bank, the treasury, or the market: Which one determines the price level?" *Journal of Economic Theory*, 220, 105885. 5

Bianchi, F. (2013): "Regime switches, agents' beliefs, and post-World War II US macroeconomic dynamics," *Review of Economic studies*, 80, 463–490. 1

Bianchi, F., R. Faccini, and L. Melosi (2023): "A fiscal theory of persistent inflation," *The Quarterly Journal of Economics*, 138, 2127–2179. 1

Bianchi, F. and C. Ilut (2017): "Monetary/fiscal policy mix and agents' beliefs," *Review of economic Dynamics*, 26, 113–139. 1

Blinder, A. S. (2022): "A Monetary and Fiscal History of the United States, 1961–2021," in *A Monetary and Fiscal History of the United States, 1961–2021*, Princeton University Press. 6.4

Bocola, L. and A. Dovis (2019): "Self-fulfilling debt crises: A quantitative analysis," *American Economic Review*, 109, 4343–4377. 4

Bocola, L., A. Dovis, K. Jørgensen, and R. Kirpalani (2025): "Monetary Policy without an Anchor," Tech. rep., National Bureau of Economic Research. 1, 7

Calvo, G. A. (1978): "On the time consistency of optimal policy in a monetary economy," *Econometrica: Journal of the Econometric Society*, 1411–1428. 1, 1, 2.1

Canepa, F., H. Schneider, and L. Kihara (2026): "Under Siege from Politics, Central Bankers Fight Back – at a Cost," Reuters. 1

Caputo, R. and D. Saravia (2018): "The monetary and fiscal history of chile: 19x60-2016," *University of Chicago, Becker Friedman Institute for Economics Working Paper*. 6.3

Chang, R. (1998): "Credible monetary policy in an infinite horizon model: Recursive approaches," *journal of economic theory*, 81, 431–461. 1, B

Chari, V., A. Dovis, and P. J. Kehoe (2020): "On the Optimality of Financial Repression," *Journal of Political Economy*, 128, 710–739. 10

Chari, V. V. and P. J. Kehoe (1990): "Sustainable plans," *Journal of political economy*, 98, 783–802. 3, B

——— (1999): "Optimal fiscal and monetary policy," *Handbook of macroeconomics*, 1, 1671–1745. 1, 11, 14

Cochrane, J. H. (2023): "The Fiscal Theory of the Price Level," in *The Fiscal Theory of the Price Level*, Princeton University Press. 1

Cukierman, A. (2008): "Central bank independence and monetary policymaking institutions–Past, present and future," *European Journal of Political Economy*, 24, 722–736. 1, 6.2

de Aguilar, A. R. (2024): "Debt, Inflation, And Government Reputation," . 1

Debortoli, D. and A. Lakdawala (2016): "How credible is the federal reserve? a structural estimation of policy re-optimizations," *American Economic Journal: Macroeconomics*, 8, 42–76. 1

Debortoli, D., J. Maih, and R. Nunes (2014): "Loose commitment in medium-scale macroeconomic models: Theory and applications," *Macroeconomic Dynamics*, 18, 175–198. 1

Debortoli, D. and R. Nunes (2010): "Fiscal policy under loose commitment," *Journal of Economic Theory*, 145, 1005–1032. 1, 6

Dovis, A. and R. Kirpalani (2021): "Rules without commitment: Reputation and incentives," *The Review of Economic Studies*, 88, 2833–2856. 1, 17

Du, W., C. E. Pflueger, and J. Schreger (2020): "Sovereign debt portfolios, bond risks, and the credibility of monetary policy," *The Journal of Finance*, 75, 3097–3138. 28, 7

Espino, E., J. Kozlowski, F. M. Martin, and J. M. Sánchez (2022): "Policy rules and large crises in emerging markets," *FRB St. Louis Working Paper*. 1

——— (2023): "External shocks versus domestic policies in emerging markets," . 1

Gao, H., M. Kulish, and J. P. Nicolini (2025): "Two illustrations of the quantity theory of money reloaded," *Journal of International Economics*, 104058. 1

Green, E. J. and R. H. Porter (1984): "Noncooperative collusion under imperfect price information," *Econometrica: Journal of the Econometric Society*, 87–100. 7

Grilli, V., D. Masciandaro, and G. Tabellini (1991): "Political and monetary institutions and public financial policies in the industrial countries," *Economic policy*, 6, 341–392. 6.2

Halac, M. and P. Yared (2021): "Inflation targeting under political pressure," *INDEPENDENCE, CREDIBILITY, AND COMMUNICATION OF CENTRAL BANKING*. 1, 7

——— (2025): "A theory of fiscal responsibility and irresponsibility," *Journal of Political Economy*, 133, 000–000. 1, 7

Kehoe, T. J. and J. P. Nicolini (2022): *A monetary and fiscal history of Latin America, 1960–2017*, U of Minnesota Press. 1, E, E

King, R. G. and Y. K. Lu (2022): "Evolving Reputation for Commitment: The Rise, Fall and Stabilization of US Inflation," Tech. rep., National Bureau of Economic Research. 1, 7

Kostadinov, R. and F. Roldán (2024): "Reputation and the Credibility of Inflation Plans," *Available at SSRN 4567776*. 1

Leeper, E. M. (1991): "Equilibria under active and passive monetary and fiscal policies," *Journal of monetary Economics*, 27, 129–147. 1

Lohmann, S. (1992): "Optimal commitment in monetary policy: credibility versus flexibility," *The American Economic Review*, 82, 273–286. 3

Lu, Y. K., R. G. King, and E. Pasten (2016): "Optimal reputation building in the New Keynesian model," *Journal of Monetary Economics*, 84, 233–249. 1

Lucas, R. E. and N. L. Stokey (1983): "Optimal fiscal and monetary policy in an economy without capital," *Journal of monetary Economics*, 12, 55–93. 1

Nicolini, J. P. (1998): "More on the time consistency of monetary policy," *Journal of Monetary Economics*, 41, 333–350. 2.1

Perez-Reyna, D. and D. Osorio-Rodríguez (2017): "The Case of Colombia," *A Monetary and Fiscal History of Latin America*, 2017. 6.2, 27, 6.2, 28

Piguillem, F. and A. Schneider (2013): "Coordination, Efficiency and Policy Discretion," Tech. rep., Einaudi Institute for Economics and Finance (EIEF). 1, 3

Rincon, H. and R. Junguito (2007): "La Politica fiscal en el siglo XX en Colombia," *Economia Colombiana del Siglo XX: Un Analisis Cuantitativo, Bogota and Mexico DF, Fondo de Cultura Economica*. E

Rogoff, K. (2003): "Globalization and global disinflation," *Economic Review-Federal Reserve Bank of Kansas City*, 88, 45–80. 1

Romelli, D. (2022): "The political economy of reforms in Central Bank design: evidence from a new dataset," *Economic Policy*, 37, 641–688. 1, 6.2

Sargent, T. (1982): "The End of Four Big Inflations" in Robert Hall, ed., Inflation: Causes and Effects, Chicago University Press," . 1, 7

Sargent, T., N. Williams, and T. Zha (2009): "The conquest of South American inflation," *Journal of Political Economy*, 117, 211–256. 7

Sargent, T. J. (2024): "Critique and consequence," *Journal of Monetary Economics*, 141, 2–13. 12

Sargent, T. J. and N. Wallace (1981): "Some unpleasant monetarist arithmetic," *Federal reserve bank of minneapolis quarterly review*, 5, 1–17. 1, 1

Sims, C. A. (1994): "A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy," *Economic theory*, 4, 381–399. 1

Witheridge, W. (2024): "Monetary Policy and Fiscal-led Inflation in Emerging Markets," *JMP NYU University*. 1

Woodford, M. (1994): "Monetary policy and price level determinacy in a cash-in-advance economy," *Economic theory*, 4, 345–380. 1

Yellen, J. L. (2026): "Remarks by Janet L. Yellen on the Future of the Fed: Central Bank Independence and Fiscal Dominance," Remarks at the American Economic Association annual meetings. 1

Appendix

A Omitted proofs

A.1 Proof of Lemma 1

Concavity follows from concavity of the objective function and convexity of the constraint set in (8) under the assumption that $\varpi'(l)\, l$ is convex.

To characterize the derivative of U with respect to primary surpluses, it is useful to rewrite the problem in (8) in terms of labor tax revenues and g only. To this end, as noted in the text, in any competitive equilibrium tax revenues, $Z \equiv \tau l$, must satisfy the following restriction

$$Z = \left(1 - \varpi'(l)\right) l. \tag{28}$$

We can then define $\ell(Z)$ as the largest labor supply that solves the expression above (so we are always on the upward side of the Laffer curve). Defining

$$W(Z) = \ell(Z) - \varpi(\ell(Z)), \tag{29}$$

we can then rewrite problem (8) as

$$U(\Delta, s) = \max_{Z,g} W(Z) - g + \theta(s)\, u(g)$$

subject to

$$\Delta \leq Z - g.$$

The optimality conditions for this problem are

$$-W'(Z) = \lambda$$
$$\theta(s)\, u'(g) = 1 + \lambda$$

where λ is the multiplier on the constraint. Moreover, by the envelope theorem, we have that $U'(\Delta, s) = -\lambda$. Thus,

$$U'(\Delta, s) = W'(Z). \tag{30}$$

Note that from (29) we have

$$W'(Z) = \ell'(Z)\left[1 - \varpi'(\ell(Z))\right] = \ell'(Z)\, Z/\ell(Z)$$

and from (28), by the implicit function theorem, we have

$$\ell'(Z) = \frac{1}{[1 - \varpi'(\ell(Z)) - \varpi''(\ell(Z))\ell(Z)]} = \frac{1}{[Z/\ell(Z) - \varpi''(\ell(Z))\ell(Z)]} \leq 0.$$

Hence,

$$W'(Z) = \frac{Z/\ell(Z)}{Z/\ell(Z) - \varpi''(\ell(Z))\ell(Z)} = \frac{Z}{Z - \varpi''(\ell)\ell^2} \leq 0$$

since $\ell'(Z) \leq 0$. As $\Delta \to \bar{\Delta}$, then feasibility requires that $Z \to Z_{max} = \bar{\Delta}$ and $g \to 0$. Since the top of the Laffer curve is characterized by

$$1 - \varpi'(\ell) = \ell\varpi''(\ell) \to Z_{max} = \varpi''(\ell(Z_{max}))\ell(Z_{max})^2$$

then the denominator in the expression for $W'(Z_{max})$ converges to 0. Thus,

$$\lim_{\Delta \to \bar{\Delta}} U'(\Delta, s) = \lim_{Z \to Z_{max}} W'(Z) = -\infty.$$

We implicitly define $g^*(s)$ by $\theta(s)u'(g^*(s)) = 1$. To see that $U'(\Delta, s) = 0$ for all $\Delta \leq -g^*(s)$, note that for such large deficits it is possible to finance the unconstrained optimal amount of government expenditures, $g^*(s)$, without raising any distortionary labor taxes. Thus, $\lambda = 0$ and $U'(\Delta, s) = 0$.

A.2 Proof of Proposition 3

Consider first the restricted Ramsey problem:

$$V_r(b, \phi, s) = \max_{\Delta, b', \phi'} U(\Delta, s) + v(\phi) + \hat{\beta} \sum_{s'} \Pr(s'|s) V_r(b', \phi', s') \tag{31}$$

subject to

$$\Delta = b + \phi - \beta b' - \beta H(\phi')$$

where we added the restriction $\phi'(s') = \phi'$ for all s'.

The first order conditions and the envelope condition imply

$$U'(\Delta, s) = \frac{\hat{\beta}}{\beta} \sum_{s'} \Pr(s'|s) U'(\Delta'(s'), s') \tag{32}$$

and

$$\hat{\beta} v'(\phi') - \beta U'(\Delta, s) h'(\phi') = 0 \tag{33}$$

Under the assumption $v(\phi) = \kappa \frac{\phi^{1-\zeta}}{1-\zeta}$ we have

$$h(\phi) = \kappa \phi^{1-\zeta}, \quad h'(\phi) = (1-\zeta)\kappa \phi^{-\zeta} = (1-\zeta) v'(\phi)$$

Suppose by way of contradiction that $v'(\phi(s')) > 0$. Condition (33) then implies

$$U'(\Delta, s) = \hat{\beta}/\beta \frac{v'(\phi')}{h'(\phi')} = \frac{\hat{\beta}/\beta}{1-\zeta} \tag{34}$$

Clearly, if $\zeta \in (0,1)$ we have a contradiction since $U'(\Delta) < 0$ so the left side of the equation above is negative while the right side is positive. Thus, it must be that $v'(\phi') = 0$. If instead there is an upper bound on real balances, $\phi' \leq \phi^*$ then the upper bound is always binding and $\phi' = \phi^*$.

Consider next the unrestricted Ramsey problem where we can choose a different value for ϕ' for all future states s':

$$V_R(b, \phi, s) = \max_{\Delta, b', \phi(s')} U(\Delta, s) + v(\phi) + \hat{\beta} \sum_{s'} \Pr(s'|s) V_R(b', \phi(s'), s')$$

subject to

$$\Delta = b + \phi - \beta b' - \beta \sum_{s'} \Pr(s'|s) H(\phi(s')) \tag{35}$$

$$\phi(s') \leq \phi^* \tag{36}$$

Impose the assumptions stated in the Proposition: let $S = \{s_1, ..., s_N\}$ be a Markov chain with associated $\Theta = \{\theta_1, ..., \theta_N\}$. Without loss let $\theta_n < \theta_{n+1}$ for all n. Define $R \equiv \theta_N/\theta_1$. Assume that

$$R < 1 + (1-\zeta)\kappa(\phi^*)^{-\zeta}. \tag{37}$$

Note first that, under our assumption that $v(\phi) = \kappa\phi^{1-\zeta}/(1-\zeta)$ for $\zeta \in (0,1)$, the function $H(\phi) = \phi(1 + v'(\phi)) = \phi + \kappa\phi^{1-\zeta}$ is concave. Thus, standard arguments imply that the Ramsey problem is a concave maximization problem and first order conditions are necessary and sufficient. Letting $\gamma(s')$ be the multiplier on constraint (36), the solution is characterized by

$$-U'(\Delta, s)\beta \Pr(s'|s) H'(\phi'(s')) + \hat{\beta} \Pr(s'|s) V_R'(b', \phi(s'), s') - \gamma(s') = 0$$

$$-U'(\Delta, s)\beta + \hat{\beta} \sum_{s'} \Pr(s'|s) U'(\Delta(s'), s') = 0 \tag{38}$$

and the complementary slackness condition

$$\gamma\left(s'\right)\left[\phi\left(s'\right)-\phi^{*}\right]=0$$

The envelope condition gives

$$V_{R}'\left(b,\phi,s\right)=U'\left(\Delta,s\right)+v'\left(\phi\right)$$

These conditions can be combined to obtain

$$\begin{aligned}\frac{\gamma\left(s'\right)}{\beta\Pr\left(s'|s\right)} &= -\left[\sum_{s'}\Pr\left(s'|s\right)U'\left(\Delta\left(s'\right),s'\right)\right]H'\left(\phi'\left(s'\right)\right)+\left[U'\left(\Delta\left(s'\right),s'\right)+v'\left(\phi\left(s'\right)\right)\right] \\ &= -\left[\mathbb{E}U'\left(\Delta\left(s'\right),s'\right)-U'\left(\Delta\left(s'\right),s'\right)\right]+\left[-\mathbb{E}U'\left(\Delta\left(s'\right),s'\right)\left(1-\zeta\right)+1\right]v'\left(\phi\left(s'\right)\right)\end{aligned} \tag{39}$$

where in the second equality we used that our functional form assumption gives $H'\left(\phi\right)=1+\left(1-\zeta\right)v'\left(\phi\right)$.

Next, we are going to show that the allocation that solves the restricted Ramsey problem satisfies the sufficient first order conditions and it is therefore optimal.

Towards this goal, note that we can extend the indirect utility function $U\left(\Delta,s\right)$ for all θ, not only the ones in the Markov chain. With some abuse of notation, let

$$U\left(\Delta,\theta\right)=\max_{Z,g}W\left(Z\right)-g+\theta u\left(g\right)\quad\text{subject to } Z-g\geq\Delta,$$

where $U\left(\Delta,\theta_{n}\right)=U\left(\Delta,s_{n}\right)$. The optimality condition for $\Delta>-g^{*}\left(\theta\right)$ requires that the optimal g and Z satisfy

$$\theta u'\left(g\right)=1-W'\left(Z\right) \tag{40}$$

Let $x\left(\theta\right)\equiv-W'\left(Z\left(\theta\right)\right)$. We are going to show that $\theta x'\left(\theta\right)\leq1+x\left(\theta\right)$. Differentiating (40) with respect to θ, holding Δ fixed gives

$$u'\left(g\left(\theta\right)\right)+\theta u''\left(g\left(\theta\right)\right)g'\left(\theta\right)=x'\left(\theta\right)$$

where

$$x'\left(\theta\right)=-W''\left(Z\left(\theta\right)\right)Z'\left(\theta\right)=-W''\left(Z\left(\theta\right)\right)g'\left(\theta\right)$$

since $g'\left(\theta\right)=Z'\left(\theta\right)$. Thus,

$$u'\left(g\left(\theta\right)\right)=-\left[\theta u''\left(g\left(\theta\right)\right)+W''\left(Z\left(\theta\right)\right)\right]g'\left(\theta\right)$$

So,

$$x'(\theta) = \frac{-W''(Z(\theta))}{-[\theta u''(g(\theta)) + W''(Z(\theta))]} u'(g(\theta))$$

or

$$\begin{aligned} \theta x'(\theta) &= \frac{-W''(Z(\theta))}{-[\theta u''(g(\theta)) + W''(Z(\theta))]} \theta u'(g(\theta)) \\ &= \frac{-W''(Z(\theta))}{-[\theta u''(g(\theta)) + W''(Z(\theta))]} (1 + x(\theta)) \\ &\leq 1 + x(\theta) \end{aligned} \tag{41}$$

where the second equality follows from (40), and the last inequality from the fact that the fraction is in $(0, 1)$.

Moreover, note that $x(\theta)$ is weakly increasing in θ, while $f(\theta) \equiv (1 + x(\theta))/\theta$ is weakly decreasing in θ since

$$f'(\theta) = \frac{\theta x'(\theta) - (1 + x(\theta))}{\theta^2} \leq 0$$

by (41). Thus, for any θ_i and θ_k in Θ we have

$$1 + x(\theta_i) \leq \max\left\{1, \frac{\theta_i}{\theta_k}\right\} [1 + x(\theta_k)] \leq R[1 + x(\theta_k)]. \tag{42}$$

In fact, if $\theta_i > \theta_k$ then the above follows from $f(\theta)$ being decreasing in θ; if $\theta_i < \theta_k$ then the above follows from $x(\theta)$ being increasing in θ.

We are next finding a bound on the changes in marginal cost of surpluses in the constrained Ramsey allocation. Let

$$X(B, \theta) \equiv -U'(\Delta_r(B, \theta), \theta)$$

where $\Delta_r(B, \theta)$ is the optimal primary surplus in the restricted Ramsey problem. For any inherited B, we are going to show that if $\theta_H > \theta_L$ then

$$1 + X(B, s_j) \leq R[1 + X(B, s_k)].$$

We are going to prove this by induction. First, note that the right side of (31) defines an operator $\mathcal{T}$ that is a contraction mapping. Thus, starting from any initial guess V_0 we have that the sequence $\{V_n\} = \{\mathcal{T}^n V_0\}$ converges to V_r uniformly. Moreover, $\mathcal{T}$ preserves concavity, and the Benveniste–Scheinkman theorem implies that each V_n as well as the fixed point V_r is differentiable with respect to B in the interior of the state space. Since $V_n \to V_r$ uniformly and the functions V_n are concave, differentiability of V_r then implies

that $\partial V_n(B,s)/\partial B \to \partial V_r(B,s)/\partial B$ at every interior B. Moreover, by the envelope theorem, $X_n(B,s) = -\partial V_n(B,s)/\partial B$ and so $X_n(B,s) \to X(B,s) = -\partial V_r(B,s)/\partial B$. Let's assume that $V_0(B,s) = U((1-\beta)B,s)$ and $X_0(B,s) = -U_\Delta((1-\beta)B,s)$. By property of U for a fixed primary surplus we have

$$1 + X_n(B,s_i) \leq R\left[1 + X_n(B,s_k)\right] \tag{43}$$

for $n = 0$ where $X_n(B,s) = -U_\Delta(\Delta_n(B,\theta),\theta)$.

Now consider iteration $n+1$, assuming that (43) holds for n. Consider two cases. First, let us suppose that $\Delta_{n+1}(B,\theta_i) \leq \Delta_{n+1}(B,\theta_k)$. Then

$$\begin{aligned}
1 + X_{n+1}(B,s_i) &= 1 - U_\Delta(\Delta_{n+1}(B,\theta_i),\theta_i) \\
&\leq 1 - U_\Delta(\Delta_{n+1}(B,\theta_k),\theta_i) \\
&\leq R\left[1 - U_\Delta(\Delta_{n+1}(B,\theta_k),\theta_k)\right] \\
&= R\left[1 + X_{n+1}(B,s_k)\right]
\end{aligned}$$

where the third line follows from (42).

Second, suppose that $\Delta_{n+1}(B,\theta_i) > \Delta_{n+1}(B,\theta_k)$. Then it must be that $B'_{n+1}(\theta_i) < B'_{n+1}(\theta_k)$. Now, define

$$X_{max,n+1} = \max_j X_n\left(B'_{n+1}(\theta_k),\theta_j\right), \quad X_{min,n+1} = \min_j X_n\left(B'_{n+1}(\theta_k),\theta_j\right)$$

By the induction hypothesis, we know that

$$1 + X_{max,n+1} \leq R\left(1 + X_{min,n+1}\right). \tag{44}$$

Using the Euler equation (32), we can write

$$\begin{aligned}
X_{n+1}(B,s_i) &= \frac{\hat{\beta}}{\beta}\sum_{s'}\Pr\left(s_j|s_i\right) X_n\left(B'_{n+1}(\theta_i),\theta_j\right) \qquad (45)\\
&\leq \frac{\hat{\beta}}{\beta}\sum_{s'}\Pr\left(s_j|s_i\right) X_n\left(B'_{n+1}(\theta_k),\theta_j\right) \leq \frac{\hat{\beta}}{\beta}X_{max,n+1} \\
X_{n+1}(B,s_k) &= \frac{\hat{\beta}}{\beta}\sum_{s'}\Pr\left(s_j|s_k\right) X_n\left(B'_{n+1}(\theta_k),\theta_j\right) \geq \frac{\hat{\beta}}{\beta}X_{min,n+1} \qquad (46)
\end{aligned}$$

where the first inequality uses $B'_{n+1}(\theta_k) > B'_{n+1}(\theta_i)$, and X_n being increasing in the relevant range because by envelope theorem $X_n(B,\theta) = -\partial V_n(B,\theta)/\partial B$ and V_n is concave in B .

We can then write

$$\begin{aligned}
1 + X_{n+1}(B, s_i) &\leq 1 + \frac{\hat{\beta}}{\beta} X_{max,n+1} \\
&\leq 1 + \frac{\hat{\beta}}{\beta}\left[R\left(1 + X_{min,n+1}\right) - 1\right] = \left(1 - \frac{\hat{\beta}}{\beta}\right) + \frac{\hat{\beta}}{\beta} R\left(1 + X_{min,n+1}\right) \\
&\leq R\left(1 + \frac{\hat{\beta}}{\beta} X_{min,n+1}\right) \\
&\leq R\left(1 + X_{n+1}(B, s_k)\right)
\end{aligned}$$

where the first inequality follows from (45), the second from (44), the third uses $\hat{\beta}/\beta \leq 1$ and $R \geq 1$,[30] and the last one used (46). Thus, if condition (43) holds for iteration n, it holds also at $n+1$, completing the induction proof. Thus, in the limit:

$$1 + X(\theta_i) = 1 - U_\Delta\left(\Delta_r\left(B, \theta_i\right), \theta_i\right) \leq R\left[1 - U_\Delta\left(\Delta_r\left(B, \theta_k\right), \theta_k\right)\right] = R\left[1 + X(\theta_k)\right]. \tag{47}$$

Finally, we can verify that the solution from the constrained Ramsey problem satisfies the sufficient first order conditions. Define $X_{max}(B') \equiv \max_j X\left(B', \theta_j\right)$. Then, for any $\theta' \in \Theta$, by (47) it follows that

$$1 + X_{max}\left(B'\right) \leq R\left[1 + X\left(B', \theta'\right)\right]$$

averaging over s' given s we have

$$1 + X_{max}\left(B'\right) \leq R\left[1 + \bar{X}(s)\right]$$

where $\bar{X}(s) = \sum_{s'} \Pr(s'|s)\, X(B', \theta(s'))$. Equivalently, subtracting $1 + \bar{X}(s)$ on both sides

$$X_{max}\left(B'\right) - \bar{X}(s) \leq [R - 1]\left[1 + \bar{X}(s)\right]$$

Using the assumption (37) we have

$$X\left(B', \theta'\right) - \bar{X}(s) \leq X_{max}\left(B'\right) - \bar{X}(s) < \left[(1 - \zeta)\, v'(\phi^*)\right]\left[1 + \bar{X}(s)\right]$$

where the first inequality follows from $X(\theta') \leq X_{max}(B')$ for all $\theta' \in \Theta$. Using the above

[30] Note that

$$R\left(1 + \frac{\hat{\beta}}{\beta} X_{min,n+1}\right) - \left[\left(1 - \frac{\hat{\beta}}{\beta}\right) + \frac{\hat{\beta}}{\beta} R\left(1 + X_{min,n+1}\right)\right] = (R - 1)\left(1 - \frac{\hat{\beta}}{\beta}\right) \geq 0.$$

in (39), we have

$$\gamma\left(s'\right)=\left[\bar{X}\left(s\right)-X\left(B',\theta(s')\right)\right]+\left[1+\bar{X}\left(s\right)\left(1-\zeta\right)\right]v'\left(\phi\left(s'\right)\right)>0$$

Thus, the constraint (36) is satisfied with a strictly positive multiplier $\gamma\left(s'\right)$ when evaluated at the constrained Ramsey solution. Thus, $\phi'\left(s'\right)=\phi^{*}$ for all s' satisfies the foc and the complementary slackness condition. Moreover, the constrained Ramsey solution satisfies the Euler equation for real debt (38). Thus, the constrained Ramsey solution satisfies all the sufficient optimality conditions for the full Ramsey problem and it is therefore optimal. *Q.E.D.*

A.3 Proof of Lemma 4

Letting $B=b+\phi$, define

$$W\left(B,s\right)=\max_{\Delta,b',\phi'}U\left(\Delta,s\right)+\hat{\beta}\sum_{s'}\Pr\left(s'|s\right)V\left(b',\phi',s'\right) \tag{48}$$

subject to

$$\Delta=b+\phi-\beta b'-J\left(b',\phi',s\right)$$

and $b'\leq\bar{b}$. Clearly, $V_{md}\left(b,\phi,s\right)=W\left(b+\phi,s\right)+v\left(\phi\right)$ and

$$V_{fd}\left(b,s\right)=\max_{\phi_{fd}}\left\{W\left(b+\phi_{fd},s\right)+v\left(\phi_{fd}\right)\right\}.$$

We first show that the optimal Δ in (48) is increasing in B. From the envelope condition we have $W'\left(B,s\right)=U'\left(\Delta\left(B\right),s\right)$. Thus, because of concavity of W, if $B_H>B_L$

$$U'\left(\Delta_H,s\right)=W'\left(B_H,s\right)<W'\left(B_L,s\right)=U'\left(\Delta_L,s\right)$$

Hence, concavity of U implies that $\Delta_H>\Delta_L$ as wanted.

Consider next the comparative statics with respect to the cutoff

$$\xi^{*}\left(b,\phi,s\right)=V_{fd}\left(b,s\right)-V_{md}\left(b,\phi,s\right).$$

We first establish that if $\phi>\phi_{fd}\left(b,s\right)$ then $\xi^{*}\left(b,\phi,s\right)$ is increasing in b. To see this, note that

$$\frac{\partial\xi^{*}\left(b,\phi,s\right)}{\partial b}=\frac{\partial V_{fd}\left(b,s\right)}{\partial b}-\frac{\partial V_{md}\left(b,\phi,s\right)}{\partial b}=U'\left(\Delta_{fd},s\right)-U'\left(\Delta_{md},s\right)$$

where the second equality follows from the envelope condition in problem (48) with $\Delta_{fd} = \Delta\left(b + \phi_{fd}\left(b,s\right),s\right)$ and $\Delta_{md} = \Delta\left(b+\phi,s\right)$, where $\Delta\left(B,s\right)$ is the policy function associated with problem (48). Thus, because of concavity of U, $\partial\xi^*/\partial b > 0$ if and only if $\Delta_{fd} < \Delta_{md}$. To see that this is the case, note that, since we are considering ϕ such that $\phi > \phi_{fd}\left(b,s\right)$, it follows that $B_{md} \equiv b + \phi > B_{fd} \equiv b + \phi_{fd}\left(b,s\right)$ and we just proved that $\Delta\left(B\right)$ is increasing. Thus, $\Delta_{fd} < \Delta_{md}$ and ξ^* is increasing in b.

Next, note that

$$\frac{\partial\xi^*\left(b,\phi,s\right)}{\partial\phi} = -\frac{\partial V_{md}\left(b,\phi,s\right)}{\partial\phi} = -\left[W'\left(b+\phi,s\right) + v'\left(\phi\right)\right] > 0$$

since we are considering $\phi > \phi_{fd}\left(b,s\right)$ and W and v are concave so

$$0 = W'\left(b+\phi_{fd}\left(b,s\right),s\right) + v'\left(\phi_{fd}\left(b,s\right)\right) > W'\left(b+\phi,s\right) + v'\left(\phi\right).$$

Thus, ξ^* is increasing in ϕ.

Finally, consider θ. Assuming that θ is iid over time, note that

$$\begin{aligned}\frac{\partial\xi^*\left(b,\phi,s\right)}{\partial\theta} &= \frac{\partial V_{fd}\left(b,s\right)}{\partial\theta} - \frac{\partial V_{md}\left(b,\phi,s\right)}{\partial\theta} \\ &= \frac{\partial U\left(\Delta_{fd},s\right)}{\partial\theta} - \frac{\partial U\left(\Delta_{md},s\right)}{\partial\theta} \\ &= u\left(g\left(\Delta_{fd},s\right)\right) - u\left(g\left(\Delta_{md},s\right)\right)\end{aligned}$$

where the last equality follows from the envelope condition applied to the indirect utility function (8) where $g\left(\Delta,s\right)$ is the optimal policy function associated to the problem. As shown above, $\Delta_{fd} < \Delta_{md}$ and g is decreasing in Δ. Hence $u\left(g\left(\Delta_{fd},s\right)\right) > u\left(g\left(\Delta_{md},s\right)\right)$ and ξ^* is increasing in θ. *Q.E.D.*

B Partial equivalence with set of sustainable equilibrium outcomes

Consider an economy without shocks with a given sequence of fiscal needs, $\{\theta_t\}$.

Set of Sustainable Equilibrium Outcomes Using the logic in Abreu (1988) and Chari and Kehoe (1990), an outcome $y = \{\phi_t, b_t, \Delta_t\}$ is a sustainable equilibrium outcome if and

only if it satisfies for all t

$$\Delta_t = b_t + \phi_t - \beta b_{t+1} - \beta H(\phi_{t+1}) \tag{49}$$

$$\sum_{s\geq 0} \hat{\beta}^s \left[U(\Delta_{t+s}, \theta_{t+s}) + v(\phi_{t+s})\right] \geq \underline{V}(b_t) \tag{50}$$

where $\underline{V}(b_t)$ is the value of the worst sustainable equilibrium given b_t.The value of the worst equilibrium can be characterized using the techniques in Abreu, Pearce, and Stacchetti (1990) and Chang (1998). Let $\mathcal{Y}(b_0)$ be the set of sustainable equilibrium outcomes given some inherited debt b_0,

$$\mathcal{Y}(b_0) = \{y = \{\phi_t, b_t, \Delta_t\} : (49) \text{ and } (50) \text{ hold } \}.$$

We can also define the equilibrium value correspondences as $\mathcal{V}(b) = [\underline{V}(b), \bar{V}(b)]$

Our problem Consider next a version of our problem given a path $\{\xi_t\}$ with $\xi_t \geq 0$:

$$W_t(b+\phi) = \max_{\Delta, b', \phi'} U(\Delta, \theta_t) + \hat{\beta}\left[W_{t+1}(b'+\phi') + v(\phi')\right] \tag{51}$$

subject to

$$\Delta = b + \phi - \beta b' - \beta H(\phi')$$

$$W_{t+1}(b'+\phi') + v(\phi') \geq \underline{W}_{t+1}(b') - \xi_{t+1} \tag{52}$$

where

$$\underline{W}_{t+1}(b) = \max_{\phi} \{W_{t+1}(b+\phi) + v(\phi)\}. \tag{53}$$

Note for later that $\partial \underline{W}_{t+1}(b)/\partial b = -v'(\phi_{fd}(b))$.Let $x(\{\xi_t\})$ be the outcome y that that solves the problem (51) for $t \geq 0$ given some initial (b_0, ϕ_0) such that $W_0(b_0+\phi_0) + v(\phi_0) \geq \underline{W}_0(b') - \xi_0$.[31] Define

$$\hat{\mathcal{Y}}(b_0) = \{y : \exists \{\xi_t\} \geq 0 \text{ such that } y = x(\{\xi_t\}) \text{ and } \underline{W}_{t+1}(b_{t+1}(s)) - \xi_t \geq \underline{V}(b_{t+1}(s))\}.$$

Partial equivalence

Proposition. *For any feasible b_0, $\hat{\mathcal{Y}}(b_0) \subset \mathcal{Y}(b_0)$.*

Proof. Consider $y \in \hat{\mathcal{Y}}(b_0)$. Then, there exists $\{\xi_t\}$ such that $y = x(\{\xi_t\})$ and $\underline{W}_{t+1}(b_{t+1}(s)) - \xi_t \geq \underline{V}(b_{t+1}(s))$. A solution to our problem must satisfy the government budget constraint

[31] Alternatively, we could let ϕ_0 being optimal in period 0: $\phi_0 = \arg\max_\phi \{W_0(b_0+\phi) + v(\phi)\}$.

in every period and the sustainability constraint because

$$W_{t+1}\left(b_{t+1}+\phi_{t+1}\right)+v\left(\phi_{t+1}\right)\geq\underline{W}_{t+1}\left(b_{t+1}\left(s\right)\right)-\xi_{t}\geq\underline{V}\left(b_{t+1}\right)$$

Thus, y is a sustainable equilibrium. $Q.E.D.$

The equilibrium outcome associated with problem (51) is a sustainable equilibrium outcome provided that $\{\xi_t\}$ are not too large. The converse is more limited. There are sustainable equilibrium outcomes that are not solutions to our problem for some $\{\xi_t\}$: $\hat{\mathcal{Y}}\left(b_0\right)$ is a strict subset of $\mathcal{Y}\left(b_0\right)$. We now briefly discuss the restrictions imposed by (51). To this end, it is useful to consider the necessary first order conditions for (51):[32]

$$-U'\left(\Delta_t,\theta_t\right)\beta H'\left(\phi_{t+1}\right)=-\hat{\beta}\left(1+\kappa_{t+1}\right)\left[U'\left(\Delta_{t+1},\theta_{t+1}\right)+v'\left(\phi_{t+1}\right)\right] \tag{54}$$

$$-U'\left(\Delta_t,\theta_t\right)\beta=-\hat{\beta}U'\left(\Delta_{t+1},\theta_{t+1}\right)+\hat{\beta}\kappa_{t+1}\left[-U'\left(\Delta_{t+1},\theta_{t+1}\right)+\frac{\partial\underline{W}_{t+1}\left(b_{t+1}\right)}{\partial b}\right] \tag{55}$$

and the complementary slackness condition

$$\kappa_{t+1}\left[W_{t+1}\left(b_{t+1}+\phi_{t+1}\right)+v\left(\phi_{t+1}\right)-\left(\underline{W}_{t+1}\left(b_{t+1}\right)-\xi_{t+1}\right)\right]=0 \tag{56}$$

where $\hat{\beta}\kappa_{t+1}$ is the multiplier on the sustainability constraint. These conditions can be combined to obtain

$$\beta H'\left(\phi_{t+1}\right)=\frac{-U'\left(\Delta_t,\theta_t\right)\beta-\hat{\beta}v'\left(\phi_{fd}\left(b_{t+1}\right)\right)}{-U'\left(\Delta_{t+1},\theta_{t+1}\right)-v'\left(\phi_{fd}\left(b_{t+1}\right)\right)}\frac{\left[-U'\left(\Delta_{t+1},\theta_{t+1}\right)-v'\left(\phi_{t+1}\right)\right]}{-U'\left(\Delta_t,\theta_t\right)} \tag{57}$$

$$-U'\left(\Delta_t,\theta_t\right)\beta\geq-\hat{\beta}U'\left(\Delta_{t+1},\theta_{t+1}\right) \tag{58}$$

where we used that $-U'\left(\Delta_{t+1},\theta_{t+1}\right)\geq-v'\left(\phi_{fd}\left(b_{t+1}\right)\right)$ in the relevant region.

Conditions (57) and (58) are then necessary conditions that a sustainable equilibrium outcome must satisfy to be a solution to our problem also in $\hat{\mathcal{Y}}\left(b_0\right)$. For example, (58) imposes the usual back-loading of rewards.[33]

Intuitively, our problem rules out sustainable equilibrium outcomes that allows for

[32]The first order conditions are not necessarily sufficient because the constraint set in (51) may not be convex because of the presence of a potentially concave function $\underline{W}_{t+1}\left(b'\right)$ on the right side of the sustainability constraint. One could prove that the constraint set is convex if $\left[\frac{1}{-W''(b+\phi)}+\frac{1}{-v''(\phi)}\right]^{-1}$ is increasing in ϕ for any b.

[33]In a simpler economy where the government cannot issue any real debt and money balances are the only government liability, a sustainable outcome $\{\Delta_t,\phi_t\}$ is the solution to our problem for some $\{\xi_t\}$ if and

"good" deviations. That is, deviations in period $t+1$ that increase the government's value in both period $t+1$ and t. In a general sustainable equilibrium, even good deviations may be deterred if private agents coordinate on an unfavorable continuation equilibrium following such a deviation. The solution to our programming problem does not allow the presence of such good deviations. This is because the punishment ξ_t is activated only when the government in period $t+1$ deviates from the policy proposed by the government in period t.

Moreover, the exact form of $\underline{W}(b)$ on the right side of the sustainability constraint (52) is important for the split between real debt, b', and money, ϕ', given the total amount of government liabilities $B' = b' + \phi'$. This aspect is captured by the restriction (57) that uses that $\partial \underline{W}_{t+1}(b)/\partial b = -v'\left(\phi_{fd}(b)\right)$ under (53). Under a different assumption, for example $\underline{W}_{t+1}(b) = \underline{V}(b) + \bar{\xi}$, then we would need to revise restriction (57) accordingly.[34]

In this simplified model without shocks—or, equivalently, if the government can make state-contingent promises over real money balances— the economy is always in the monetary-dominant regime. The cost ξ_t affects only the value of a deviation that never occurs in equilibrium. Changes in ξ_t affect the (b_{t+1}, ϕ_{t+1}) that can be credibly promised in equilibrium. In the extreme case in which $\xi_t = 0$ for all t, the equilibrium is formally in the monetary-dominant regime, since the inflation target is always satisfied, but the resulting allocation coincides with the Markov equilibrium outcome.

More generally, fluctuations in ξ_t affect the level of promises that can be sustained in equilibrium and, in turn, the government's incentives to adjust both the level and composition of its liabilities, b_t and ϕ_t, in order to affect the tightness of the sustainability constraint (52). In this sense, the version of the model without shocks—or, equivalently, with state-contingent promises—retains the key features of the model in the main text: movements in ξ_t have implications for the joint equilibrium dynamics of debt and real balances, and therefore for inflation. In particular, a reduction in ξ_t leading to a tightening of the period t sustainability constraint (increase in κ_t) leads to a bigger wedge in the Euler equation for primary surpluses (see equation (55)) that leads to lower indebtedness, and it affects promised real balances according to (54).

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only if

$$-U'(\Delta_t, \theta_t)\,\beta H'(\phi_{t+1}) \geq -\hat{\beta}\left[U'(\Delta_{t+1}, \theta_{t+1}) + v'(\phi_{t+1})\right]$$

We can derive direct conditions on outcomes because in the simplified economy our problem is a concave maximization problem.

[34] Another possibility would be to allow for penalties that are dependent on the deviation. For example, we could replace (52) with

$$W_{t+1}(b' + \phi') + v(\phi') \geq \max_{\phi} \left\{ W_{t+1}(b' + \phi) + v(\phi) - \xi_{t+1}(\phi - \phi')^2 \right\}.$$

C Debt and inflation in the Markov and Ramsey Equilibria

In this section we provide an analytical result that makes clear the comparison between inflation and level of real debt in the Markov equilibrium and in a Ramsey outcome. To do so, we consider a deterministic economy with $\beta = \hat{\beta}$. We assume that $v(\phi) = \kappa\phi^{1-\zeta}/(1-\zeta)$ with $\zeta \in (0,1)$ and $\phi \leq \phi^*$ as in Proposition 3. Assume that ϕ^* is large enough that

$$-U'(\underline{D}) > v'(\phi^*)$$

where $\underline{D} \equiv \min_{\phi \leq \phi^*} \{(1-\beta)\phi - \beta h(\phi)\} < 0$ is the minimal surplus that can be supported in a stationary allocation with zero debt.

Proposition. *Consider a Markov equilibrium outcome $\{\phi_{Mt}, \Delta_{Mt}, \pi_{Mt+1}, b_{Mt+1}\}$ and a Ramsey outcome $\{\phi_{Rt}, \Delta_{Rt}, \pi_{Rt+1}, b_{Rt+1}\}$ starting from a common inherited level of real debt b_0 sufficiently large. In a Markov equilibrium the level of debt is decreasing and it converges to 0 in the limit, while the Ramsey outcome has constant debt $b_{Rt} > 0$ for all $t \geq 1$. As $t \to \infty$, $b_{Mt} \to 0$ while $b_{Rt} = b_R > 0$ for all $t \geq 1$. Moreover, for all $t \geq 1$, $\phi_{Rt} > \phi_{Mt}$ and $\pi_{Rt+1} < \pi_{Mt+1}$ for all $t \geq 1$.*

Proof. Consider first the Ramsey equilibrium. Letting $B = b + \phi$ be the total value for real government liabilities, we can write the recursive problem that characterizes the *continuation* Ramsey problem as

$$W_R(B) = \max_{\Delta, B', \phi'} U(\Delta) + \hat{\beta}\left[v(\phi') + W_R(B')\right]$$

subject to

$$\begin{aligned} \Delta &= B - \beta\left(h(\phi') + B'\right) \\ \phi' &\leq B' \leq \bar{b} + \phi', \quad \phi' \leq \phi^* \end{aligned}$$

In period 0 the Ramsey problem is

$$V_{R0}(b_0) = \max_{\phi, \Delta, b', \phi'} U(\Delta) + v(\phi) + \hat{\beta}\left[v(\phi') + W_R(B')\right]$$

subject to

$$\begin{aligned} \Delta &= b_0 + \phi - \beta\left(h(\phi') + B'\right), \\ \phi' &\leq B' \leq \bar{b} + \phi', \quad \phi, \phi' \leq \phi^* \end{aligned}$$

where $\bar{b}$ is the upper bound of real debt. As we proved in Proposition 3, $\phi_t = \phi^*$ for all

$t \geq 1$. Moreover, since $\beta = \hat{\beta}$, primarysurpluses are constant if debt is interior. In this case, the Ramsey outcome is fully characterized by (Δ_R, ϕ_{R0}) that solve

$$v'(\phi_{R0}) = -U'(\Delta_R) \tag{59}$$

$$b_0 + \phi_{R0} = \frac{\Delta_R}{1-\beta} + \frac{\beta h(\phi^*)}{1-\beta} \tag{60}$$

where recall that $h(\phi) = \kappa \phi^{1-\zeta}$. Moreover, the level of real debt from period 1 onward, b_{R1},

$$b_{R1} + \phi_{R1} = \frac{\Delta_R}{1-\beta} + \frac{\beta h(\phi^*)}{1-\beta}. \tag{61}$$

If b_0 is sufficiently high then $\Delta_R > 0$ and

$$-U'(\Delta_R) > -U'(0) > v'(\phi^*)$$

Combing the above with (59) we have that $\phi^* > \phi_{R0}$ and from (60) and (61) we have that $b_{R1} < b_0$, but choosing b_0 sufficiently high ensures that $b_{R1} > 0$.

The Markov equilibrium outcome solves the following problem

$$V_M(b) = \max_{\phi, \Delta, b'} U(\Delta) + v(\phi) + \hat{\beta} V_M(b')$$

subject to

$$\begin{aligned} b + \phi &= \Delta + \beta b' + \beta H(\phi_M(b')) \\ 0 &\leq b' \leq \bar{b} \end{aligned}$$

taking as given the value function $V_M(b')$ and the policy function $\phi_M(b')$ next period. Let $X(b) = -V_M'(b) = -U'(\Delta(b))$. Note that the first order condition for ϕ is

$$-U'(\Delta_t) \leq v'(\phi_t) \tag{62}$$

with equality whenever $\phi_t < \phi^*$.

Abstracting from $b' \leq \bar{b}$, the first order condition with respect to real debt and the envelope condition require

$$-U'(\Delta_t)\left[1 + H'(\phi_M(b_{t+1}))\frac{\partial \phi_M(b_{t+1})}{\partial b'}\right] \leq -U'(\Delta_{t+1})$$

with equality if $b_{t+1} > 0$. Since $\frac{\partial \phi_M(b_{t+1})}{\partial b'} < 0$ and $H'(\phi) = 1 + (1-\zeta)\kappa \phi^{-\zeta} > 0$ the term in

square brackets is less than 1, thus

$$b_{t+1} > 0 \to -U'(\Delta_t) > -U'(\Delta_{t+1}) \to \Delta_{t+1} < \Delta_t. \tag{63}$$

Next we show that zero debt is absorbing. That is, $b'_M(0) = 0$. Suppose by way of contradiction that $b'_M(0) = \tilde{b} > 0$. Then (63) implies that

$$X(\tilde{b}) < X(0) \tag{64}$$

But, since $\phi_M(b)$ is decreasing,

$$\phi_M(\tilde{b}) < \phi_M(0) \leq \phi^*$$

thus $\phi_M(\tilde{b})$ is interior and $X(\tilde{b}) = v'(\phi_M(\tilde{b}))$ while $X(0) \leq v'(\phi_M(0))$. Since v is strictly concave, then

$$X(\tilde{b}) = v'(\phi_M(\tilde{b})) > v'(\phi_M(0)) \geq X(0)$$

which contradicts (64). Thus, it must be that $b'_M(0) = 0$ and zero debt is absorbing.

Next, we show that debt is strictly decreasing, $b_{t+1} < b_t$, whenever inherited debt is positive, $b_t > 0$. Clearly, if $b'_M(b_t) = 0$ then $b_{t+1} < b_t$. If instead $b'_M(b_t) > 0$, then by (63) we have that

$$X(b'_M(b_t)) < X(b_t) \tag{65}$$

Suppose by way of contradiction that $b'_M(b_t) \geq b_t$. Consider two cases. If $b'_M(b_t) > b_t$, then because $\phi_M(b)$ is strictly decreasing,

$$\phi_M(b'_M(b_t)) < \phi_M(b_t) \leq \phi^*$$

so $\phi_M(b'_M(b_t))$ is interior and

$$X(b'_M(b_t)) = v'(\phi_M(b'_M(b_t))) > v'(\phi_M(b_t)) \geq X(b_t)$$

contradicting (65). If instead $b'_M(b_t) = b_t$ then $X(b'_M(b_t)) = X(b_t)$, again contradicting (65). Thus, $b'_M(b_t) < b_t$ for every $b_t > 0$.

Thus, we established that $\{b_t\}$ is decreasing and bounded below by 0. Therefore it must converge to some $b_{M\infty}$. By continuity of the Markov debt policy $b_{M\infty} = b'_M(b_{M\infty})$. The observation that if $b > 0$ then $b'_M(b) < b$ rules out a strictly positive fixed point. Thus, it must be that $b_t \to 0$.

Next, we prove that real balances $\{\phi_t\}$ are increasing. To see this simply observe that

since $\{b_t\}$ is decreasing then $\{\phi_t\} = \{\phi_M(b_t)\}$ must be increasing. Moreover, by continuity of $\phi_M(b)$, $\phi_t \to \phi_M(0)$.

We now show that primary surpluses are decreasing. If $b_{t+1} > 0$, (63) gives that $\Delta_{t+1} < \Delta_t$. If instead $b_t > b_{t+1} = 0$, then

$$-U'(\Delta_{t+1}) = X_{t+1} \leq v'(\phi_{t+1}) < v'(\phi_t) = X_t = -U'(\Delta_t)$$

where we used that if $b_{t+1} < b_t$ then $\phi^* \geq \phi_{t+1} > \phi_t$. Thus, $\Delta_t > \Delta_{t+1}$. If $b_t = b_{t+1} = 0$ then the equilibrium outcome is stationary and $\Delta_t = \Delta_{t+1}$. Thus, the surplus $\{\Delta_t\}$ is a decreasing sequence and it converges to

$$\Delta_\infty = (1-\beta)\phi_M(0) - \beta h(\phi_M(0)) \geq \underline{D}$$

We can further show that $\phi_t < \phi^*$ for all t. To see this, notice that for all t

$$-U'(\Delta_t) \geq -U'(\underline{D}) > v'(\phi^*)$$

Hence, the first order condition (62) must hold as an equality and $\phi_t < \phi^*$. Thus, for all $t \geq 1$, the value of real balances in the Markov equilibrium outcome is lower than in the Ramsey outcome.

Finally, note that in each regime

$$1 + \pi_t = \frac{\beta H(\phi_t)}{\phi_t} = \frac{\beta\left[\phi_t + \kappa\phi_t^{1-\zeta}\right]}{\phi_t} = \beta\left(1 + \kappa\phi_t^{-\zeta}\right)$$

which is strictly decreasing in ϕ_t. Therefore, for all $t \geq 1$

$$1 + \pi_{Rt} = \beta\left(1 + \kappa(\phi^*)^{-\zeta}\right) < \beta\left(1 + \kappa\phi_{Mt}^{-\zeta}\right) = 1 + \pi_{Mt}.$$

Q.E.D.

The result also remains true if we allow for the government to be more impatient than the stand-in household. If $\beta > \hat{\beta}$, the Ramsey outcome features an increasing path for primary surpluses with $\Delta_{Rt} \to \Delta_{max}$, the maximal surplus implied by the static Laffer curve. In the Markov equilibrium outcome, if $\hat{\beta}$ is sufficiently close to β, the incentive effects still dominate the impatience effect and the level of debt still converges to 0 with a decreasing sequence $\{\Delta_{Mt}\}$. Thus, the result in the proposition still holds provided that the gap between β and $\hat{\beta}$ is sufficiently small.

D Model solution

Here we describe how we solve the full model. We first write the government's problem recursively, then introduce the transitory shocks that smooth the regime decision, and finally state the algorithm.

D.1 The recursive problem

Note that we can reduce the number of endogenous state variables to one by considering the problem of the government after ϕ is chosen. In this case the unique state variable is the level of real government liabilities, $B = b + \phi$. Denote by $W(B, s)$ the value function at this stage. Then

$$V^{md}(b, \phi, s) = W(b + \phi, s) + v(\phi), \tag{66}$$

$$V^{fd}(b, s) = \max_{\phi^{fd}} \left\{ W\left(b + \phi^{fd}, s\right) + v\left(\phi^{fd}\right) \right\}, \tag{67}$$

$$\phi^{fd}(b, s) = \arg\max_{\phi^{fd}} \left\{ W\left(b + \phi^{fd}, s\right) + v\left(\phi^{fd}\right) \right\}, \tag{68}$$

and the government honors the target whenever doing so is worth the cost of reneging,

$$\eta(b, \phi, s) = \mathbf{1}\left\{ V^{md}(b, \phi, s) \geq V^{fd}(b, s) - \xi(s) \right\}. \tag{69}$$

The value function W solves the Bellman equation

$$W(B, s) = \max_{\Delta, b', \phi'} U(\Delta, \theta) + \hat{\beta} \sum_{s'} \Pr(s'|s) \max\left\{ V^{md}(b', \phi', s'), V^{fd}(b', s') - \xi(s') \right\} \tag{70}$$

subject to

$$\Delta = B - \beta b' - \beta \sum_{s'} \Pr(s'|s) \left[\eta(b', \phi', s') H(\phi') + (1 - \eta(b', \phi', s')) H\left(\phi^{fd}(b', s')\right) \right], \tag{71}$$

with ϕ^{fd} and η given by (68) and (69).

D.2 Smoothing the regime decision

We assume that ξ follows a Markov chain $\Gamma(\xi'|\xi)$. For computational purposes we introduce two i.i.d. shocks ω^{md} and ω^{fd}, drawn from a Gumbel distribution with scale $1/\lambda$ and normalized to have zero mean, that perturb the value of each regime. The parameter λ

governs the dispersion of these shocks: as $\lambda \to \infty$ they vanish and (69) is recovered. We set $\lambda = 0.2$.

Write $s_1 = (\theta, \xi)$ for the persistent exogenous state. Substituting this into (69), the government honors the target whenever $V^{md} + \omega^{fd} \geq V^{fd} - \xi + \omega^{md}$. Integrating over the two transitory components, the expected continuation value is

$$\begin{aligned}\Omega(b, \phi, s_1) &\equiv \iint \max\left\{V^{md}(b, \phi, s_1) + \omega^{fd},\ V^{fd}(b, s_1) - \xi + \omega^{md}\right\} f\left(\omega^{fd}\right) f\left(\omega^{md}\right) d\omega^{fd} d\omega^{md} \\ &= \frac{1}{\lambda} \log\left(\exp\left(\lambda V^{md}(b, \phi, s_1)\right) + \exp\left(\lambda\left(V^{fd}(b, s_1) - \xi\right)\right)\right), \end{aligned} \tag{72}$$

where the probability that the target is honored is

$$\bar{\eta}(b, \phi, s_1) = \frac{\exp\left(\lambda V^{md}(b, \phi, s_1)\right)}{\exp\left(\lambda V^{md}(b, \phi, s_1)\right) + \exp\left(\lambda\left(V^{fd}(b, s_1) - \xi\right)\right)} = \frac{1}{1 + \exp\left(-\lambda \Delta V(b, \phi, s_1)\right)}, \tag{73}$$

where $\Delta V(b, \phi, s_1) \equiv V^{md}(b, \phi, s_1) - V^{fd}(b, s_1) + \xi$. The Bellman equation becomes

$$W(B, s_1) = \max_{\Delta, b', \phi'} U(\Delta, \theta) + \hat{\beta} \sum_{s_1'} \Pr\left(s_1' | s_1\right) \Omega\left(b', \phi', s_1'\right) \tag{74}$$

subject to

$$\Delta = B - \beta b' - \beta \sum_{s_1'} \Pr\left(s_1' | s_1\right) \left[\bar{\eta}' H\left(\phi'\right) + \left(1 - \bar{\eta}'\right) H\left(\phi^{fd}\left(b', s_1'\right)\right)\right], \tag{75}$$

where $\bar{\eta}'$ denotes $\bar{\eta}\left(b', \phi', s_1'\right)$. Both (72) and (75) are smooth in (b', ϕ').

D.3 Algorithm

We solve (74) by value function iteration on W.

State space and discretization. We discretize $B \in [0, \bar{B}]$ with $\bar{B} = \bar{b} + \phi^*$, $b \in \left[0, \bar{b}\right]$, and $\phi \in [\phi_{\min}, \phi^*]$ using equally spaced nodes on each, where ϕ^* is the satiation level of real balances and $\phi_{\min} > 0$ is a small lower bound. The exogenous processes are discretized by Tauchen's method truncated below so that $\xi \geq 0$. Since θ and ξ are independent, the joint transition is the product $\Pr\left(s_1' | s_1\right) = \Gamma\left(\xi' | \xi\right) \Pr\left(\theta' | \theta\right)$.

Iteration. Start from an initial guess W_0 (in practice, a solution computed at nearby parameter values). Given W_n:

1. *Fiscal dominant solution.* For each (b, s_1) solve (67) by continuous maximization over $\phi^{fd} \in [\phi_{\min}, \phi^*]$, giving $V_n^{fd}(b, s_1)$ and $\phi_n^{fd}(b, s_1)$, and set V_n^{md} from (66).

2. *Regime probability and continuation value.* Evaluate $\bar{\eta}_n$ and Ω_n from (73) and (72) at (b', ϕ', s_1') using V_n^{md} and V_n^{fd}.

3. *Bellman update.* For each (B, s_1) evaluate the right-hand side of (74) subject to (75) at W_n, and denote the resulting value by $\tilde{W}_{n+1}(B, s_1)$. The maximization is carried out by a grid search for (b', ϕ'), refined by a continuous non-linear maximizer that allows (b', ϕ') to leave the grid.

4. *Damping and convergence.* Set

$$W_{n+1} = \nu \tilde{W}_{n+1} + (1 - \nu) W_n, \qquad \nu \in (0, 1],$$

and return to step 1, stopping when the Bellman residual $\left\| \tilde{W}_{n+1} - W_n \right\|$ falls below a tolerance.

Simulation and filtering. The transitory components ω^{fd} and ω^{md} smooth the solution algorithm only. When simulating the model and when applying the particle filter we set $\omega^{fd} = \omega^{md} = 0$, so that the regime is given by the exact indicator (69), and the expectations determining the price of government liabilities use that indicator rather than $\bar{\eta}$.

E Data appendix

Sample and definitions. The annual database combines the Latin American series from *A Monetary and Fiscal History of Latin America, 1960–2017* Kehoe and Nicolini (2022) with the U.S. series described below. The Latin American sample contains Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay, and Venezuela from 1960 to 2017.[35] The construction first computes each moment within a country and then averages across countries with available data, giving each country equal weight. The U.S. calibration uses data from 1914 to 2017 whenever available. The sources for the U.S. data are described below.

Inflation, π_t, measures the annual percentage change in the CPI. To characterize inflationary processes in Latin America and the United States, the data are divided into country-level quartiles using observations below 200 percent. This restriction prevents

[35] Debt data for Brazil is downloaded from the Central Bank of Brazil https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries.

hyperinflation episodes from making the fourth quartile unrepresentative of the typical inflation experience.

Inflation persistence is the fraction of observations followed by another observation in the same quartile. Observations above 200 percent remain in the calculation of fourth-quartile persistence.

The baseline measure of public debt, b_t, includes domestic and external debt in all issued denominations as a percentage of GDP.[36]

The database records the primary balances, Δ_t, as a percentage of GDP defined as revenues minus outlays, excluding interest payments. The fiscal moments omit Paraguay and Peru because of data limitations.

The monetary aggregate, M, is high-powered money. That is, the monetary base, or $M0$. Real money balances to GDP, ϕ_t, are calculated as

$$\phi_t = 100\frac{M_t}{P_t\, Y_t} = 100\frac{\text{nominal monetary base}_t}{\text{nominal GDP}_t}, \tag{76}$$

where P_t is the price level and Y_t is real GDP.

Public-debt construction and consolidation. In Kehoe and Nicolini (2022), the editors and country teams made a substantial effort to construct comparable fiscal and monetary series across countries. The information required to consolidate public balance sheets is not always available because many sources report debt by issuer but not the amount held by the central bank or other public institutions. The analysis therefore takes the Kehoe and Nicolini (2022) debt series as given rather than imputing unobserved cross-holdings. We refer the reader to the data appendix of each country chapter for details on how the data are constructed for each specific country. Because our accounting exercises focus on the disinflationary episodes in Chile and Colombia, we provide additional details on the construction of the public-debt series for these two countries.

Chile. Total public debt data as a percentage of GDP comes from the Chile chapter of Kehoe and Nicolini (2022). The series equals the sum of internal and external public debt. The underlying sources include the Central Bank of Chile, the General Comptroller, the General Treasury, and the public-sector financial-management reports. The book series enters the analysis without further adjustment.

[36] Appendix F considers an alternative calibration for Latin American countries that includes only foreign-currency and inflation-indexed debt as real debt and merges domestic debt with money balances as nominal liabilities.

Colombia. For the 1980–2017 analysis, total public debt is measured as a percentage of GDP. The historical series comes from Rincon and Junguito (2007), and Banco de la República extends it through 2017. It combines domestic and external claims on the national central government and excludes local governments and state-owned firms. The source does not identify the holders of these claims, so the series does not net out central-bank holdings. The 1991 Constitution made direct central-bank loans to the government subject to unanimous approval by the central bank's board, and the Colombia chapter of Kehoe and Nicolini (2022) reports no such loans thereafter.

United States. The database covers the U.S. series from 1914 to 2017, while the filtering exercise uses 1960–2008. The paper uses the following series:

Inflation. The Bureau of Labor Statistics series *Consumer Price Index for All Urban Consumers: All Items in U.S. City Average, not seasonally adjusted* (series `CUUR0000SA0`) supplies the CPI. Inflation equals the annual percentage change in its annual average.

Public Debt. The IMF *Public Finances in Modern History* database, downloaded from `https://www.imf.org/external/datamapper/datasets/FPP` on July 4, 2025, supplies the series *Gross public debt, percent of GDP* (indicator `d`).

Primary Fiscal Balance. The IMF *Public Finances in Modern History* database, downloaded from `https://www.imf.org/external/datamapper/datasets/FPP` on July 4, 2025, supplies the series *Government primary balance, percent of GDP* (indicator `pb`).

Money-to-GDP. FRED supplies *Monetary Base: Total* (`BOGMBASE`, Board of Governors of the Federal Reserve System) and *Gross Domestic Product* (`GDP`, Bureau of Economic Analysis). Annual averages of these series, both measured in billions of dollars, yield $100 \times$ `BOGMBASE/GDP`.

F Alternative calibration

In our baseline calibration we map the monetary base into ϕ and all remaining government liabilities into b. Here we describe an alternative calibration. We assign to b only those liabilities whose real value is insulated from domestic inflation—debt denominated in foreign currency and debt indexed to the domestic price level—and we assign to ϕ the monetary base together with all non-indexed domestic-currency debt. The alternative mapping requires a reinterpretation of v. In the baseline, $v(\phi)$ measures the liquidity services of real

Table 3: Calibration: Parameters under the alternative mapping

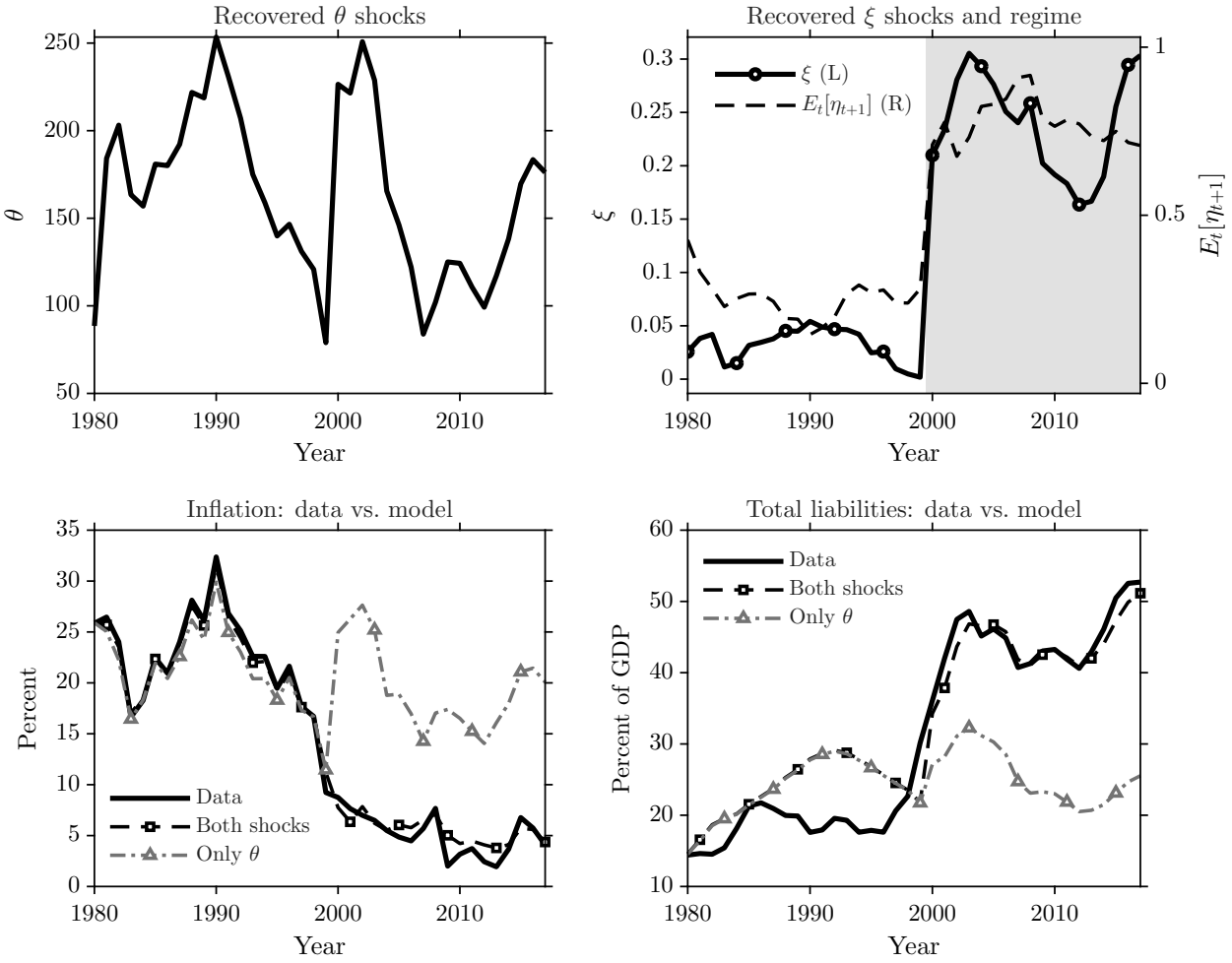
Parameter	Description	Value LA Calibration (Alternate)
β	Households' discount factor	0.95
ψ	Inverse Frisch elasticity	1
σ	Inverse EIS gov't expenditures	2
$\hat{\beta}$	Gov'ts discount factor	0.92
χ	Labor disutility parameter	0.0142
κ	Money-demand parameter	0.8
ζ	Money-demand parameter	0.04
$\bar{\theta}$	AR1 parameter	130
ρ_θ	Persistence of θ	0.92
σ_θ	Standard Deviation of θ	60
ρ_ξ	Persistence of ξ	0.995
σ_ξ	Standard Deviation of ξ	0.04

balances. Under the alternative mapping, ϕ also consists of interest-bearing debt. In this case, $v(\phi)$ can capture the costs of financial repression.

We recalibrate the model under this mapping following the same procedure as in Section 6.1, targeting the same set of moments except for the two describing the composition of liabilities. Table 3 reports the resulting parameter values and Table 4 reports the moments.

Figure 8 reports the results of applying the particle filter to Colombia under this calibration, using inflation and total liabilities as observables. The outcomes look very similar to the baseline. In particular, the model accounts for the reduction in inflation in the 1990s with an increase in the cost of deviating from the inflation target at the very end of the decade, and such an increase results in a persistent shift to a monetary-dominant regime from the late 1990s onward. As in the baseline, when we retain the computed sequence of θ shocks but hold $\xi_t = 0$ throughout the entire period, debt would have similarly increased (albeit less) but inflation would have remained constant or even risen during the latter half of the decade. This confirms that the crucial role credible institutional reforms played in simultaneously achieving higher debt levels and declining inflation in Colombia is robust to different specifications of b and ϕ.

Figure 8: Colombia



Notes: The figure reports results from applying the particle filter to Colombian data over 1980--2017 under the alternative mapping described in this appendix, using inflation and total liabilities as observables and the calibration reported in Table 3. The top-left panel plots the recovered path of the fundamental shock θ. The top-right panel plots the recovered credibility shock ξ (solid line, left axis) along with the expected regime $E_t[\eta_{t+1}]$ (dashed line, right axis), where $\eta_t = 1$ under monetary dominance (MD) and $\eta_t = 0$ under fiscal dominance (FD); shaded areas denote periods in which the economy is in the monetary-dominant regime. The bottom two panels compare the data (solid lines) with the model-implied paths under both shocks (dashed lines) and under only θ shocks with ξ set to zero (dash-dotted lines) for inflation (bottom-left, in annualized percent) and total liabilities as a share of GDP (bottom-right, in percent).

Table 4: Calibration: Moments under the alternative mapping

Moment	**LA Calibration (Alternate)**	
	Data	**Model**
Avg. inflation in Q1	3.41%	2.98%
Avg. inflation in Q4	57.0%	43.87%
Prob. of staying in Q1	0.69	0.44
Prob. of staying in Q4	0.77	0.56
Average debt-to-GDP	25.86%	23.44%
Avg. real money balances-to-GDP	19.41%	12.75%
Variance of primary surplus	10.68	7.36
Autocorr. of primary surplus	0.67	0.59
Avg. of primary surplus-to-GDP	0.42%	-0.61%

Notes: The table reports targeted moments in the data and their model counterparts for the Latin American (LA) calibration under the alternative mapping, in which real debt comprises only foreign-currency and inflation-indexed debt while real money balances comprise the monetary base together with all non-indexed domestic-currency debt. The LA calibration uses data from 11 Latin American economies (ARG, BOL, BRA, CHL, COL, ECU, MEX, PAR, PER, URU, VEN) over 1960–2017. Q1 and Q4 denote the first and fourth quartiles of the inflation distribution, respectively. The probability of staying in Q1 (Q4) is the frequency with which inflation remains in the bottom (top) quartile from one year to the next. Inflation is expressed in annualized percent. The variance and autocorrelation of primary surpluses are computed over the full sample. The model moments are computed from a long simulation.