# The Central Bank, the Treasury, or the Market: Which One Determines the Price Level?

Jean Barthélemy[1], Eric Mengus[2], and Guillaume Plantin*[3]

[1]Barthélemy: Banque de France, 31 rue Croix des Petits Champs, 75001 Paris, France. Email: jean.barthelemy@banque-france.fr.

[2]HEC Paris and CEPR, 1 rue de la Liberation, 78350 Jouy-en-Josas, France. Email: mengus@hec.fr.

[3]Sciences Po and CEPR, 28 rue des Saints-Pères, 75007 Paris, France. Email: guillaume.plantin@sciencespo.fr.

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**Abstract**

This paper studies a model in which the price level is the outcome of dynamic strategic interactions between fiscal and monetary authorities that pursue distinct objectives. The "unpleasant monetarist arithmetic", whereby aggressive fiscal expansion forces the monetary authority to chicken out and to lose control of inflation, occurs only if the public sector lacks fiscal space, in the sense that public debt along the optimal fiscal path gets sufficiently close to the threshold above which the fiscal authority would find default optimal. Otherwise, monetary dominance prevails even though the central bank has neither commitment power nor fiscal backing.

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*Corresponding author

# 1 Introduction

The outstanding liabilities of public sectors have reached volumes that are unprecedented in peacetime in many jurisdictions. Inflation has also recently hit levels that had been unseen in decades. This has led many observers to worry that the formal independence of central banks is not sufficient to shield them from the actual interdependence of monetary and fiscal policies imposed by the budget constraint of the public sector.

The underpinning of these concerns is primarily that fiscal and monetary authorities may sometimes have conflicting objectives, with the fiscal authority putting less weight on price stability than the monetary one.[1] This is a direct consequence from the independence of central banks with a prominent price-stability objective.[2] As is well understood since at least Alesina and Tabellini (1987), these conflicting objectives potentially lead to a non-cooperative game between fiscal and monetary authorities, and the list is long of examples in which they do not necessarily cooperate, and try instead to impose their views on each other.[3]

Ultimately, the risk is that despite formal central-bank independence, fiscal policy may make price stabilization difficult or even out of reach. Following Sargent and Wallace (1981)'s "unpleasant monetarist arithmetic", a large literature has studied how fiscal policy has the *ability* to constrain monetary policy. In Sargent and Wallace's seminal work, if the fiscal authority "moves first" in the sense that it commits at the outset to a path of deficits for the entire future, the monetary authority has no other option but to accommodate fiscal policy at the expense of controlling inflation in order to satisfy the public sector's budget constraint without resorting to sovereign default.

But to what extent is a fiscal authority actually *willing* to apply this arithmetic and impose its views on the monetary authority? If so, is there anything that the monetary authority can do to deter it or at least to mitigate its costs, or is it always poised to

[1]See the recent speech by Powell (2023): "But restoring price stability when inflation is high can require measures that are not popular in the short term as we raise interest rates to slow the economy. The absence of direct political control over our decisions allows us to take these necessary measures without considering short-term political factors." See also Schnabel (2022): "In the current environment, there is a risk that monetary and fiscal policies may pull in opposite directions [...]."

[2]The leading rationale for central-bank independence is time-inconsistency problems as initially studied by Kydland and Prescott (1977) and Barro and Gordon (1983a). The delegation of monetary policy to an independent authority with a price-stability objective is generally thought to alleviate these problems (see Rogoff, 1985; Walsh, 1995; Svensson, 1997, among others).

[3]See, e.g., Mee (2019) for a historical analysis of the rise of an independent Bundesbank, Silber (2012) for the Volker era, and Bianchi et al. (2019) or Camous and Matveev (2021) for evidence that markets reacted to Trump's comments on monetary policy.

accommodate fiscal expansion? Can their conflicting objectives even result either into sovereign default or into the reversal of central-bank independence to force debt monetization? How do financial markets assess the value of public liabilities given this "game of chicken" between two branches of the public sector? As Sargent and Wallace (1981) put it in conclusion of their unpleasant arithmetic: *"Who imposes discipline on whom?"*.

To address these questions, this paper studies a model of interactions between fiscal and monetary authorities with distinct objectives. The fiscal authority seeks to maximize the present value of government spending whereas the monetary one minimizes the departure of realized price levels from given targets. The fiscal authority may issue nominal bonds backed by future taxes and the monetary one issues the unit of account of the economy—reserves. Crucially, the fiscal authority cannot commit to repay its debt. Its incentives to make good on it stem only from costs of default. We assume that outright default is costly for the fiscal authority whereas inflating debt away is not.[4] As a result, the fiscal authority would be unable to borrow if it was in charge of monetary policy and thus directly determining the price level. We posit however that the fiscal authority delegates monetary policy to an independent monetary authority, whose objective is to keep the price level as close as possible to a given target. The monetary authority is independent in the sense that it has a free hand at managing its balance sheet, but it incurs costs from sovereign default. Finally, price-taking private investors form optimal portfolio of reserves and government bonds.

We solve for the subgame-perfect Nash equilibria of the game played between fiscal and monetary authorities. Our focus is on the equilibrium price level. We deem "monetary dominance" the situation in which the equilibrium price level corresponds to the target of the monetary authority. "Fiscal dominance" is the alternative in which the price level exceeds this target, and reaches instead a higher level that is consistent with the solvency of the public sector.

The fiscal authority has a strict preference for inflation ex-post as it erodes the value of outstanding public liabilities, thereby allowing for more spending holding taxes fixed. Unlike in Sargent and Wallace (1981), the fiscal authority lacks commitment power in

[4]This assumption, however extreme it may appear from a normative point of view, is consistent, from a positive point of view, with observed deficit biases for fiscal authorities. As our emphasis is on the game between fiscal and monetary authorities, we leave unmodelled the political process that would lead to such a bias and we connect our work with the literature explaining public-debt patterns using political-economy arguments in the literature review section.

our setup, and thus cannot credibly announce a path of surpluses that would induce the monetary authority to inflate away some public liabilities. In order to induce the monetary authority to do so, it must find a device that makes it credible that it will resort to default (or possibly to the reversal of central-bank independence) instead of raising taxes or/and cutting expenditures if future price levels are too low. The only way the fiscal authority can commit to such a future preference for default conditional on low inflation is by frontloading expenditures and financing them with enough debt. This way, it will credibly prefer default to the large fiscal consolidation that such a current expansion would make necessary in the absence of inflation.

We show that the fiscal authority chooses ex-ante one of two strategies. It either issues this large level of debt and forces the central bank away from its price-level objective—fiscal dominance—or issues a lower level of public debt that is optimal conditionally on price levels being on target—monetary dominance. The fiscal authority can always opt for fiscal dominance but chooses to do so only when the future gains from eroding outstanding public liabilities exceeds the costs of frontloading expenditures in comparison with the smoother optimal fiscal path that takes price levels on target. In particular, monetary dominance prevails if the public sector has enough fiscal space, in the sense that at any point along the optimal fiscal path taking given price levels on target, the fiscal authority would much prefer to respond to an exogenous increase in public liabilities with an increase in taxes or/and a reduction in expenditures rather than with formal default or a reversal of central-bank independence. Conversely, if the optimal fiscal path gets sufficiently close to this default boundary, then the fiscal authority may deviate from it, and double down on debt in order to force the monetary authority to erode public liabilities through inflation.

To be sure, our game is a very stylized representation of interactions between large branches of government in complex institutional settings. We do not expect to see any direct evidence that fiscal authorities deliberately and precisely design fiscal expansions as strategies to force monetary ones to deviate from their price-stability objectives this way. Instead, we may capture situations in which the fiscal authority "kicks the can down the road" by postponing the resolution of policy problems – a situation that can lead to "insidious fiscal dominance" as dubbed by Leeper (2023) – or in which the fiscal authority, focused on another objective, fails to internalize the inflationary consequences of its own actions when designing bold fiscal expansions, e.g. due to bailouts in a financial crisis, big welfare programs or, even, wars. More generally, we believe that the forces that we capture in our strategic setup manifest themselves in markets' and governments' expectations about the extent to which central banks would be willing to avoid a debt crisis in the face of fiscal expansions. These expectations have probably shifted significantly following the 2008 and Covid crises.

We also characterize the instruments that the monetary authority can avail itself of to prevent fiscal dominance, or at least to mitigate its costs. First, the central bank can partially control the size of legacy liabilities by maintaining the lowest possible volume of outstanding reserves. Second, even if the monetary authority is forced to deviate from its price-level objective, it still has some tools to limit the costs of fiscal dominance. Critically, which tool the monetary authority finds optimal depends on the amount of legacy liabilities. When public liabilities are small enough, the central bank may find it useful to engage in preemptive inflation—even before the fiscal authority issues debt—with the objective to reduce the real value of legacy liabilities. By generating fiscal space, this preemptive inflation limits the incentives of the fiscal authority to double down on debt issuance. When legacy liabilities are larger, the central bank may also inflate in the future, but at a smaller rate than what is implied by fiscal dominance. To commit to do so, the central bank reduces its net wealth through reserve issuance and a large remittance, which leads to future inflation. It may also be that the monetary authority just surrenders and lets sovereign solvency dictate the future price level.

The paper is organized as follows. Section 2 sets up the model. Section 3 solves for it. Section 4 discusses extensions. Section 5 offers concluding remarks.

**Related literature.** Our paper is at the crossroads of the political-economy literature that studies strategic interactions between multiple branches of government and of the less reduced-form literature that investigates the interactions between monetary and fiscal policies.

We share with the former literature the idea that fiscal and monetary authorities may have ex-post conflicting objectives (Alesina, 1987; Alesina and Tabellini, 1987; Tabellini, 1986, e.g.). More recent contributions include Dixit and Lambertini (2003) or Schreger et al. (2024) in which, as in our model, the commitment to price stability of the monetary authority may boost the borrowing capacity of the fiscal one. We also connect to the literature that explores disciplining mechanisms for the public sector in models following Barro and Gordon (1983a,b), such as Halac and Yared (2020). Our premises that fiscal authorities may prioritize spending over price stability also parallels the literature that explains the patterns of public debt accumulation using political-economy frictions and a resulting deficit bias (see Halac and Yared, 2022; Yared, 2019, and the references herein). In particular, short-termism on the fiscal side due to political constraints may push the fiscal authority to neglect long-term objectives such as price stability, as also well summarized by Powell (2023). Also, such short-termism emphasized in this literature leads the fiscal authority to frontload expenditures and issue more debt, and we show that it is conducive to fiscal dominance. With respect to this literature, our contribution is to provide an explicit set of instruments to both the fiscal and the monetary authorities as well as a game-theoretic foundation to fiscal and monetary interactions. Our approach of the resulting macroeconomic game follows Chari and Kehoe (1990), Stokey (1991) and Ljungqvist and Sargent (2018), but extended to multiple large agents and markets.

We also relate to the literature studying the interactions between monetary and fiscal policies pioneered by Sargent and Wallace (1981) (see Leeper, 1991; Sims, 1994; Woodford, 1994, 1995; Cochrane, 2001, 2005; McCallum, 2001; Buiter, 2002; Niepelt, 2004; Miller, 2016; Jacobson et al., 2019; Camous and Matveev, 2022; Bianchi et al., 2023, among others). In particular, in our setup, as in the fiscal theory of the price level, the monetary authority can adjust the price level to help the fiscal authority satisfy its budget constraint.[5] In this literature, fiscal or monetary dominance is typically an exogenously assumed regime, and so are regime switches. By contrast, we obtain fiscal or monetary dominance as an equilibrium outcome driven by the primitives of the economy. We cast our "game of chicken"—to borrow Wallace's words to describe fiscal-monetary interactions—in a simple economy, that relates in particular to that in which Bassetto and Sargent (2020) study fiscal and monetary interactions. Following Bassetto (2002), we write down a fully strategic model, and use (subgame-perfect) Nash equilibrium as our

[5]In Sargent and Wallace (1981), monetary policy accommodates by raising seignorage income despite the inflationary consequences — but public debt is real. In alternative models, such as the fiscal theory of the price level, and in this paper, an increase in the price level reduces the real value of nominal public debt. See Bassetto (2008) for a precise description of the connection between the fiscal theory of the price level and Sargent and Wallace (1981). See Reis (2017) for a description of the tools that the central bank has to increase fiscal resources.

concept of predictable outcome. Such a strategically closed environment is essential as it enables a distinction between on one hand the policies that are feasible, and on the other hand the policies that arise along the equilibrium path. Out-of-equilibrium policies, e.g., sovereign default, are essential in shaping the equilibrium fiscal or monetary dominance.

Our paper is also closely connected to the papers that identify fiscal requirements such that the central bank can attain its price stability objective, including fiscal rules (e.g. Woodford, 2001) or a ring-fenced balance sheet (e.g Sims, 2003; Bassetto and Messer, 2013; Hall and Reis, 2015; Benigno, 2020). Martin (2015) finds, as we do, that fiscal irresponsibility leads to long-term inflation.

Finally, our paper relates to the recent literature that compares formal sovereign default and soft default in the form of inflation (Bassetto and Galli, 2019; Galli, 2020). We cover the case in which distinct branches of government control each tool and act non-cooperatively.[6]

# 2 Setup

We study strategic interactions between a private and a public sector. There are two dates indexed by $t \in \{0; 1\}$. There is a single consumption good. The private sector is comprised of a continuum of agents with unit mass. The public sector is comprised of two agents, a monetary authority $M$ and a fiscal authority $F$. The public sector trades with the private one in two markets: the market for reserves and that for bonds. Reserves are the unit of account of the economy. They are claims with indefinite maturity that trade between $M$ and the private sector. Only the monetary authority $M$ can issue reserves. $M$ also decides on the interest rate that reserves earn between dates 0 and 1. A (nominal) bond is a claim to one unit of reserves at date 1. Bonds trade without restrictions between $F$ and the private sector. The fiscal authority, unlike private agents, cannot commit to make good on the repayment of the bonds that it issues.

The rest of the section is a presentation of the extensive form of the game and of the payoffs of the players in standard game-theoretic language. Before doing so, a more informal overview of the timing of the game and of the main tensions the model sheds light upon are in order.

[6]Notice also that the infinite-horizon extension of our model offers in particular a novel way of endogenizing the respective costs of each type of default.

**Timing.** At each date $t \in \{0; 1\}$, $M$ intervenes in the reserve market and the private sector clears it, which determines the current price level—the date-$t$ price of goods in terms of reserves. At date 0, after the reserve market clears this way, $F$ issues bonds. Then $M$ and $F$ bargain over a transfer between them. At date 1, after the reserve market has cleared again and $F$ and $M$ have bargained over a transfer, $F$ decides to make good on its outstanding debt (if any) or not.

**Fiscal and monetary objectives: the game of chicken.** The central ingredient of the model is a divergence between $F$ and $M$'s preferences. While both authorities incur utility costs from outright sovereign default, $M$ also seeks to keep the price level on some target at each date, whereas $F$ balances making good on sovereign debt with real government spending. $F$ would thus like $M$ to inflate away legacy public liabilities in order to be able to spend more without defaulting, whereas $M$ prefers that the public sector averts default with fiscal consolidation. Hence the fiscal and monetary authorities play a game of chicken at date 1. As both lack commitment power, $M$ and $F$ strategically issue reserves and bonds at date 0 in order to gain the upper hand in this future game of chicken. The private sector also forms (correct) expectations about the outcome of this date-1 game when pricing public liabilities.

Formally, the extensive form of the game is as follows.

## 2.1 Extensive-form game

The social interactions consist in a sequential game at each date. At date 0, the reserve market clears, then so does the bond market, and $M$ and $F$ bargain over a transfer of goods. Then at date 1, the reserve market reopens, $M$ and $F$ bargain over a real transfer, and bonds settle. We describe each stage in turn. We spell out this extensive form of the game treating the private sector as a single player. That this sector is comprised of price-taking, atomistic agents will show in our equilibrium concept.

**Date-0 market for reserves.** The sequence of actions at this stage is as follows. Unmodelled agents sell reserves $X_{-1} \geq 0$. $M$ announces a gross nominal interest rate $R_0 \geq 0$ on reserves between dates 0 and 1 and posts a demand for reserves $X_0^M \in \mathbb{R}$. If $X_0^M \leq 0$, M issues reserves. If $X_0^M \leq X_{-1}$, the private sector quotes the price level

$P_0 \geq 0$ at which it is willing to clear the market with the demand $X_0^H \geq 0$ such that

$$X_0^H + X_0^M = X_{-1}. \tag{1}$$

Otherwise $M$ is rationed down to $X_{-1}$ and $P_0 = 0$. Notice that this rationing is equivalent to imposing the restriction that $X_0^M \leq X_{-1}$.[7]

**Date-0 bond market.** The sequence of actions at this stage is as follows. $F$ posts a demand for one-period nominal bonds $B_0^F \in \mathbb{R}$. The private sector quotes a bond price in terms of reserves $Q_0 \geq 0$ at which it is willing to clear the bond market with a demand $B_0^H \in \mathbb{R}$ such that[8]

$$B_0^H + B_0^F = 0. \tag{2}$$

**Date-0 transfer between $M$ and $F$.** From the above market interventions, $M$ has a date-0 budget of $-X_0^M$ in nominal terms whereas $F$ has $-B_0^F$. $M$ makes a take-it-or leave-it offer to $F$ for a transfer between them. If $F$ refuses it, no transfer takes place. $F$ and $M$ then consume.

**Date-1 reserve market.** The sequence of actions at this stage is as follows. $M$ posts a demand for reserves $X_1^M \in \mathbb{R}$. The private sector posts a demand $X_1^H \geq -R_0 X_0^H$. If

$$X_1^H + X_1^M \leq 0, \tag{3}$$

an unmodelled agent quotes a price level $P_1 \geq 0$ and posts a market-clearing demand $P_1 \bar{x}$, where $\bar{x} > 0$:

$$P_1 \bar{x} + X_1^H + X_1^M = 0. \tag{4}$$

Otherwise $P_1 = 0$.[9]

[7] We will see that this particular rationing plays no role in the analysis since $M$ finds any $X_0^M > 0$ to be a strictly dominated strategy. Yet one has to spell out the consequences of all feasible actions no matter how suboptimal in a strategic setting.

[8] Notice that there are no legacy long-term bonds maturing at date 1. This is without loss of generality as their role would be symmetric to that of legacy reserves $X_{-1}$. We also abstract from bonds maturing at date 0.

[9] More precisely, if $X_1^H \leq 0$ ($X_1^M \leq 0$) then $M$ ($H$) is rationed until $P_1 = 0$ clears the market, and otherwise $X_1^H = X_1^M = 0$. Again, this particular rationing rule plays no role in the analysis.

**Date-1 transfers.** The fiscal authority $F$ collects taxes $P_1\bar{\tau} \geq 0$. Thus, $M$ has a date-1 budget of $-X_1^M$ in nominal terms whereas $F$ has $P_1\bar{\tau}$ gross of any debt repayment. $M$ makes a take-it-or leave-it offer to $F$ for a transfer between them. If $F$ refuses it, no transfer takes place.

**Bond settlement.** The private sector meets its bond repayments if any. If $B_0^F < 0$, $F$ selects a haircut $l_1 \in \{0, 1\}$, repaying $-(1 - l_1)B_0^F$. $F$ and $M$ then consume.

## 2.2 Payoffs

The preferences of private agents, $F$, and $M$ are as follows.

**Private sector.** Private agents rank consumption streams $(c_0, c_1)$ according to the criterion

$$c_0 + \frac{c_1}{r}, \tag{5}$$

where $r > 0$. Each private agent is endowed with a large quantity of the consumption good at dates 0 and 1, and so always consumes positively.

**Public sector.** Denoting $g_0$ and $g_1$ the date-0 and date-1 consumption of $F$, the objectives that $F$ and $M$ respectively seek to maximize are respectively:

$$U^F = g_0 + \beta^F \left(g_1 - \alpha^F l_1\right). \tag{6}$$

$$U^M = - \mid P_0 - P_0^M \mid - \beta^M \mid P_1 - P_1^M \mid - \beta^M \alpha^M l_1, \tag{7}$$

where $\beta^F, \beta^M \in (0, 1)$ are discount factors, $\alpha^F, \alpha^M > 0$, and $P_0^M, P_1^M > 0$. In words, each authority $X \in \{F; M\}$ incurs a cost $\alpha^X$ in case of outright sovereign default. The fiscal authority also values spending but does not care about the price level, whereas the monetary authority finds it costly to deviate from a given target $P_t^M$ for the date-$t$ price level.

In addition, $M$ incurs an arbitrarily large disutility if it consumes strictly negatively at date 0 or/and 1. So does $F$ if its consumption at either date is strictly smaller than an incompressible level $\underline{g}$ such that $0 \leq \underline{g} \leq \bar{\tau}/(1 + r)$.

Finally, if two strategies generate the same utility for $M$, it strictly prefers the one that maximizes the utility of $F$.

## 2.3 Equilibrium concept

A strategy profile $\sigma = (R_0, X_0^M, P_0, B_0^F, Q_0, X_1^M, X_1^H, P_1, l_1)$ describes all the actions for each agent given all possible histories.[10] The game is one of public information, and so each action is conditional on the entire history, which we omit in the notations for simplicity. Our equilibrium concept adapts subgame perfection to the presence of Walrasian market interactions. Subgame perfection encodes that the fiscal and monetary authorities both lack commitment.

**Definition 1.** ***(Equilibrium)*** *Given initially sold reserves $X_{-1}$, an equilibrium is a strategy profile $\sigma$ such that:*

1. *Each action by $F$ and $M$ is optimal given history and its beliefs that the future actions are taken according to the strategy profile.*

2. *Each saver, taking as given $(R_0, X_0^M, P_0)$, and believing that the future actions of $M$, $F$, and the private sector are taken according to the profile, finds it optimal to post an individual demand for reserves at date 0 equal to $X_0^H$ given by* (1)*. Similarly, she finds it optimal to post an individual date-0 bond demand $B_0^H$ as given by* (2)*, given history, $Q_0$, and the beliefs that future actions by $F$, $M$ and the private sector are taken according to the profile. Finally, she finds it optimal to post an individual date-1 reserve demand $X_1^H$ given history, $P_1$, and again the beliefs that $M$, $F$, and the private sector will play the remaining stages according to the profile.*

Our equilibrium concept borrows from Ljungqvist and Sargent (2018), which adapts plain game-theoretic subgame perfection to the situation in which a "large" player interacts with a mass of atomistic agents.[11] We extend this concept in two directions. First, we introduce Walrasian market interactions. Second, there are two such large players, a monetary and a fiscal authority. The former extension is the one that is conceptually most interesting. We formally treat the price in date-0 markets as an action—in the standard

[10] To alleviate notations, the strategy profile $\sigma$ does not feature the transfers between $M$ and $F$ as they will turn out to be a straightforward consequence of the other actions.

[11] See the definition of equilibrium in chapter 24.

game-theoretic sense—of the private sector modelled as a market-maker—a single player in charge of clearing the market. Thus, markets clear by assumption for all feasible fiscal and monetary policies, whether or not they are part of a Nash equilibrium—formally, conditions (1) and (2) are satisfied for all policies. Then, a Nash equilibrium must be in particular such that these market-clearing actions are consistent with the individual rationality of price-taking and atomistic private agents. Such a formalization of prices as actions by the private sector acting collectively as a market maker seems a natural way to blend a strategic setting—in which there must be market prices associated with all feasible policies in order to identify the policies that form a Nash equilibrium—and a Walrasian environment in which nobody sets a price and in which non-clearing markets are not predictable outcomes. An alternative route that we applied in an earlier working-paper version uses market games à la Shapley and Shubik (1977), and generates exactly the same result at the cost of somewhat more burdensome notations.

## 2.4 Comments

**Transfers between $F$ and $M$.** Transfers between the central bank and the Treasury are an important feature of fiscal and monetary interactions. The important assumption that we make is that both $F$ and $M$ can avoid making a positive transfer to the other authority if they do not wish to do so. In particular, $F$ cannot be forced to "recapitalize" $M$ at any date with a transfer. Given these options to turn down any transfer, it will be clear that which of the authorities gets to make the take-it-or-leave-it offer is immaterial, and giving the bargaining power to $M$ is only to fix ideas. We leave the possibility of forced recapitalizations of the central bank for future research.

**Bond trading by $M$.** Excluding $M$ from the bond market is highly unrealistic, and only meant here to derive our central result in the simplest possible model. Section 4.1 allows $M$ to purchase bonds, and shows that it leaves our results unchanged.

**Asymmetric objective functions.** The objective functions that we assume for both authorities aim to capture that the monetary authority cares more about the price level than the fiscal authority. They are also sufficiently simple to make the analysis tractable.

These objectives are exogenously given, yet fully consistent with the view that the fiscal authority benefits from the creation of an independent central bank with a price-stability objective. In our model, given its preferences, the fiscal authority faces indeed a time-consistency problem due to nominal debt. In the absence of the monetary authority, a fiscal authority that directly controls the price level would inflate away nominal debt ex-post. Ex-ante, this would prevent the government from borrowing, which may not be desirable from its point of view.[12] By contrast, a monetary authority focused on the price level is by construction not subject to the same time-inconsistency. This approach to justify the delegation of monetary policy to an independent central bank with a price stability objective in order to solve a time-inconsistency problem echoes the literature following Barro and Gordon (1983a) and Rogoff (1985).

The objective function of the fiscal authority is also stylized as only the present value of public spending matters. In particular, to the extent that public spending exceeds $\underline{g}$, there is no motive to smooth spending over time. We make this assumption for tractability and, as our analysis will make clear, any motive to smooth consumption by the fiscal authority would make fiscal dominance generically less likely than it is with these assumed linear preferences. Also, we assume for tractability that the fiscal authority does not care about the price level. Adding such a price level objective would not change the economics of our game to the extent that, for the fiscal authority, the consumption gains from fiscal dominance exceed the cost in terms of higher price levels.[13]

**Default costs.** In the pioneering paper of Sargent and Wallace (1981), the preferences of the fiscal and monetary authorities are not spelled out. Yet it is implicit and important in their approach that the monetary authority has an arbitrarily large aversion to outright sovereign default. The monetary authority would otherwise not be willing to accommodate, no matter the inflationary consequences, whichever path of debt and deficits the fiscal authority announces. The costs $\alpha^M$ and $\alpha^F$ are finite here, and are only two of the parameters that will determine whether fiscal or monetary dominance prevails.

The cost of default $\alpha^F$ may be directly interpreted as the reputation loss of the fiscal

[12] More generally, there may be other sources of costs of inflation such as those coming from nominal rigidities, but they are outside the scope of our model.

[13] Notice also that assigning a price-level objective to the fiscal authority would not make it time-consistent if it directly selected monetary policy: Unless it cares sufficiently little about consumption, the fiscal authority is still tempted to raise the price level ex-post to reduce the real value of nominal liabilities. However, as this move is anticipated by investors when debt is issued, there are no ex-ante gains, thus justifying to delegate monetary policy to an independent central bank.

authority and its exclusion from financial markets. The interpretation of $\alpha^M$ is subtler. The first interpretation of this cost is the potential collateral effects of a default due to exposures to public debt, as studied by the literature on domestic costs of sovereign default. These collateral effects, such as banking crises or more generally financial instability, are potentially costly for the central bank either directly, when the central bank has a financial-stability objective, or indirectly, when the central bank is concerned by how the financial sector may transmit its monetary policy. The second interpretation is the risk of a reversal of central bank independence in case of a country's default: to avoid a hard default, the government may reverse central bank independence – the expectation of such a reversal may be costly for the central bank, at least through the central bankers' career concerns (see Section 4.2 for an analysis of reversal of central bank independence).

An infinite-horizon extension (see the Online Appendix) endogeneizes the cost of default incurred by $M$. In this case, financial markets may run on the currency, jeopardizing price stability.

Finally, notice that, for the fiscal authority, the fact that $M$ cares about default is a form of imperfect delegation. To perfectly tie its hands, the fiscal authority would ex-ante prefer to delegate monetary policy to a monetary authority which does not care about default.

# 3 Analysis

Subgame perfection boils down to sequential rationality with a finite horizon, and so we can solve this two-date model using backwards induction. Namely, we first study the optimal final default decision of $F$ for all possible histories, and then solve for all the optimal decisions backwards given the solution to the subsequent nodes.

Before proceeding with this analysis, we first show that some histories can be ruled out because they correspond to a strictly dominated action by one of the agents at some point. These two strictly dominated strategies are consuming negatively for $M$ and ending up with reserves on hand for the private sector.

**$M$ always consumes positively.** Notice first that $M$ can always ensure that it consumes positively at every date, which it finds strictly dominant, by being passive on all markets and never proposing a strictly positive transfer to $F$. Thus we can without loss of generality restrict the analysis to histories such that $M$ consumes positively.

**Savers sell as many reserves as possible at date 1.** Price-taking savers find it optimal to offload their entire reserve holdings in the date-1 reserve market since they do not find reserves intrinsically desirable at date 1. Thus we can restrict the analysis to situations such that $X_1^H = -R_0 X_0^H \leq 0$.

## 3.1 Date-1 taxation and transfers: When does $F$ default?

Consider first the situation after the date-1 reserve market has cleared and determined the date-1 price level. Given history $(R_0, X_0^M, P_0, B_0^F, Q_0, X_1^M, X_1^H, P_1)$, $M$ has real resources with nominal value $-X_1^M$. The elimination of strictly dominated strategies and clearing of the date-1 reserve market entails that we can restrict the analysis to:

$$0 \leq -X_1^M = P_1\bar{x} + X_1^H = P_1\bar{x} - R_0 X_0^H. \tag{8}$$

At this stage, $F$ and $M$ agree that these resources must be transferred to $F$. Thus $M$ offers to $F$ to do so and $F$ accepts. This implies that pre bond-market settlement, $F$ has real resources with nominal value

$$P_1(\bar{x} + \bar{\tau}) - R_0 X_0^H, \tag{9}$$

equal to the sum of its transfer $P_1\bar{x} - R_0 X_0^H$ from $M$ and of its fiscal resources $P_1\bar{\tau}$. Thus $F$ makes good on its debt (if any) if and only if:

$$P_1(\bar{\tau} + \bar{x}) - R_0 X_0^H - B_0^H \geq \max\left\{P_1(\bar{\tau} + \bar{x}) - R_0 X_0^H - P_1\alpha^F; P_1\underline{g}\right\}. \tag{10}$$

The right-hand side of condition (10) encodes that $F$ may find default optimal either because the default cost $\alpha_F$ is sufficiently small relative to the size of the (real) repayment $B_0^H/P_1$ or because it must default in order to consume at least $\underline{g}$.[14] To simplify the analysis, we assume that only the latter motive to default matters:

**Assumption 1.** *$\alpha^F \geq \bar{x} + \bar{\tau} - \underline{g}$.*

[14]Notice that $\bar{\tau} \geq (1+r)\underline{g} > \underline{g}$ and $P_1\bar{x} \geq R_0 X_0^H$ from (8) imply both that $F$ can always consume at least $\underline{g}$ by defaulting, and that condition (10) holds if $B_0^H \leq 0$.

Assumption 1 implies that the default cost is sufficiently large other things being equal that $F$ always prefers to make good on its debt as long as it does not prevent from spending at least $\underline{g}$. Beyond simplicity, Assumption 1 also allows us to capture situations such as the one of "political dominance" described in Leeper (2023) in the case of US debt ceiling, in which new debt could not be issued and taxes and expenditures could hardly adjust. In this view, default stems from an ex-post resource constraint rather than from a preference.[15]

As a result of Assumption 1, $F$ finds it optimal to repay its debt if and only if this is compatible with spending $g_1$ above the incompressible level $\underline{g}$, and defaults otherwise. We have $g_1 \geq \underline{g}$ with full debt repayment whenever:

$$P_1(\bar{x} + \bar{\tau} - \underline{g}) \geq R_0 X_0^H + B_0^H. \tag{11}$$

Condition (11) admits a straightforward interpretation. The left-hand term is the nominal value of total public resources $\bar{x} + \bar{\tau}$ net of incompressible expenditures $\underline{g}$ at date 1. The right-hand term is the total liabilities of the public sector towards the private one at the opening of date 1.

## 3.2 Date-1 monetary policy: When does $M$ chicken out?

We now study the date-1 reserve market given that agents rationally anticipate the above subsequent events of date 1. At the outset of date 1, given history $(R_0, X_0^M, P_0, B_0^F, Q_0)$, $M$ can select $X_1^M$ so as to consume positively and set the date-1 price level at any level $P_1$ above $R_0 X_0^H / \bar{x}$. This stems from $X_1^M \leq 0$ to ensure positive consumption, $X_1^H = -R_0 X_0^H$ (strict dominance), and market clearing $P_1 \bar{x} + X_1^M + X_1^H = 0$

In particular, $M$ can always (but may not want to) set $P_1$ sufficiently large that the solvency constraint (11) holds so that $F$ does not default. A larger price level $P_1$ erodes the real value of the public sector's nominal outstanding liabilities. We denote by $P^F$ the smallest price level such that this solvency constraint (11) holds:

$$P^F \equiv \frac{R_0 X_0^H + B_0^H}{\bar{x} + \bar{\tau} - \underline{g}}. \tag{12}$$

[15] We discuss the case of strategic defaults in Section 3.5.

By definition, expenditures are at the incompressible level ($g_1 = \underline{g}$) as soon as $P_1 = P^F$ so that (11) holds with equality. The problem faced by $M$ at date 1 thus reads:

$$\max_{P_1 \geq R_0 X_0^H/\bar{x}} -\left|P_1 - P_1^M\right| - \alpha^M 1_{\{P_1 < P^F\}}. \tag{13}$$

Denoting $\underline{P}_1 \equiv \max\left\{P_1^M; R_0 X_0^H/\bar{x}\right\}$, the optimal price level results from the comparison of $\underline{P}_1$ with $P^F$. First, if $P^F \leq \underline{P}_1$, then $M$ optimally sets $P_1 = \underline{P}_1$ as it minimizes the departure from its target $\mid P_1 - P_1^M \mid$, possibly to 0 if $\underline{P}_1 = P_1^M$, without inducing default.

Alternatively, if $P^F > \underline{P}_1$, then $M$ must trade off the distance to price-level target and sovereign solvency. If $M$ lets $F$ default then it incurs a cost $\alpha^M$, but it can optimally set the date-1 price level at $\underline{P}_1$. If, conversely, $M$ seeks to avert default, then it optimally does so by setting the date-1 price at the smallest level $P^F$ at which this is possible, thereby reducing $F$'s consumption to the incompressible level $\underline{g}$. As a result, $M$ finds it optimal to prevent $F$ from defaulting by setting $P_1 = P^F$ if and only if $P^F \leq \underline{P}_1 + \alpha^M$.

The following proposition summarizes this date-1 outcome.

**Proposition 1.** ***(Terminal date 1)*** *Given history $(R_0, X_0^M, P_0, B_0^F, Q_0)$, date 1 unfolds according to one of the three following situations.*

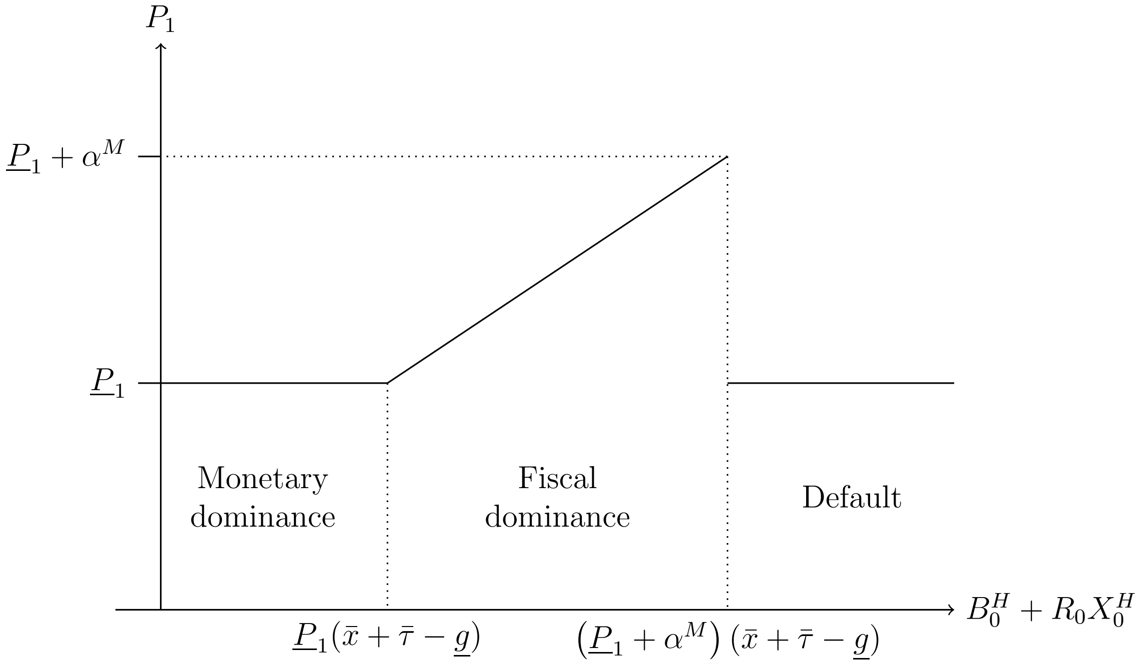
1. *Date-1 monetary dominance: If $P^F \leq \underline{P}_1$, $M$ sets the date-1 price level at $\underline{P}_1$ by setting $X_1^M = 0$ if $\underline{P}_1 > P_1^M$ and $X_1^M = R_0 X_0^H - P_1^M \bar{x}$ otherwise. $F$ fully repays maturing bonds if any: $l_1 = 0$, and consumes $g_1 \geq \underline{g}$, where the inequality is strict as soon as $P^F < \underline{P}_1$.*

2. *Date-1 fiscal dominance: If $\underline{P}_1 < P^F \leq \underline{P}_1 + \alpha^M$, $M$ sets the date-1 price level at $P^F$ by setting $X_1^M = R_0 X_0^H - P^F \bar{x}$. $F$ fully repays maturing bonds: $l_1 = 0$, and spends at the incompressible level $g_1 = \underline{g}$.*

3. *Default: Otherwise, $M$ sets the date-1 price level at $\underline{P}_1$ by setting $X_1^M$ as in 1. $F$ fully defaults on $B$: $l_1 = 1$, and spends $g_1 = \bar{x} + \bar{\tau} - R_0 X_0^H/\underline{P}_1 > \underline{g}$.*

Figure 1 illustrates how the date-1 price level $P_1$ evolves as the (nominal) public liabilities at the outset of date 1, $R_0 X_0^H + B_0^H$, increase. As soon as the monetary authority $M$ cares somewhat about sovereign solvency—that is, $\alpha^M > 0$—and the public liabilities are large enough, $M$ chickens out and ensures that the price level is such that the fiscal authority is solvent. There is however a maximum nominal amount of public liabilities beyond which $M$ prefers to let $F$ default.

Figure 1: Date-1 price level as a function of public liabilities held by the private sector.




*Note: The horizontal axis represents public liabilities held by the private sector* $(B_0^H + R_0 X_0^H)$. *The vertical axis represents the date-1 price level* $(P_1)$. *The increasing segment in the fiscal dominance zone reports the equation* $P_1 = P^F$ *where* $P^F$ *is given by equation* (12).

The key result in Proposition 1 is that the situations of fiscal dominance in which $M$ chickens out so that $P_1 = P^F > \underline{P}_1$ must be such that $F$ cannot spend in excess of the incompressible level $\underline{g}$. If this were the case that $g_1 > \underline{g}$ and $P_1 > \underline{P}_1$ simultaneously along the equilibrium path, $M$ would indeed strictly benefit from tightening monetary policy, thereby forcing $F$ to reduce spending so as to avert default, a contradiction. We will now see that this feature of the equilibrium at date 1 will shape the date-0 debt policy of the fiscal authority.

**Remark on "reserve overflow".** In the case of monetary dominance or default, $M$ might still have to set the price strictly above its date-1 target $P_1^M$ when the reserves sold by savers $R_0 X_0^H$ are strictly larger than $\bar{x} P_1^M$, so that the price level must be at least equal to $R_0 X_0^H / \bar{x} = \underline{P}_1 > P_1^M$. In this case, $M$ has manufactured its own lower bound on the date-1 price level when deciding on $(R_0, X_0^M)$ at date 0, thereby barring itself from reaching its date-1 price level target. We will see below that in the absence of a zero lower bound on the policy rate $R_0$, $M$ can ensure that this does not occur along the equilibrium path. We will also see that there exist cases in which $M$ deliberately uses this in order to commit to a date-1 price level that it finds ex-post excessive (see Proposition 4). Notice that, in this situation of reserve overflow, monetary policy may have perverse effects with a tightening (a higher $R_0$) leading to a higher price level.

We are now equipped to solve backward through the stages of date 0 when agents rationally anticipate the above date-1 consequences of any history. Notice first that at the last stage of date 0, $M$ has real resources with nominal value $-X_0^M$ from the date-0 reserve market. Strict dominance implies that they are positive, and so $M$ and $F$ agree that they should be transferred to $F$.

## 3.3 Date-0 bond market: "Sargent-Wallace" versus "price-level taking" debt levels

Suppose now that the date-0 reserve market has generated history $(R_0, X_0^M, P_0)$ and that the date-0 bond market opens. The fiscal authority $F$ selects a position $B_0^F$, and then savers clear the market with a demand $B_0^H = -B_0^F$ at the bond price $Q_0$. From Proposition 1, these actions lead to one of the following date-1 situations: monetary dominance, fiscal dominance, or default.

It is strictly dominant for $F$ to set $B_0^F = 0$ rather than issue bonds on which it defaults because it generates the same (zero) resources in the bond market and spares the disutility from default $\alpha^F$. Thus one can without loss of generality study only bond issuances that lead either to date-1 fiscal dominance or to date-1 monetary dominance. We study each of them in turn.

**Optimal debt issuance conditional on date-1 fiscal dominance.** In equilibrium, each saver is happy to take the position $B_0^H = -B_0^F$ if and only if she earns a real return $r$ on it. Conditional on date-1 fiscal dominance, she expects a date-1 price level $P_1 = P^F$ and so:

$$P_0 = rQ_0P^F, \tag{14}$$

where $P^F$ is given by (12) when $B_0^H = -B_0^F$:

$$P^F = \frac{R_0 X_0^H - B_0^F}{\bar{x} + \bar{\tau} - \underline{g}}. \tag{15}$$

Anticipating this pricing rule, the fiscal authority $F$ decides on a position $B_0^F$ that solves:

$$\max_{B_0^F} g_0 + \beta^F g_1 \tag{16}$$

$$\text{s.t. } P_0 \bar{g} \leq P_0 g_0 = -Q_0 B_0^F - X_0^M, \tag{17}$$

$$g_1 = \bar{g}, \tag{18}$$

$$(14), (15), \text{ and } \underline{P}_1 \leq P^F \leq \underline{P}_1 + \alpha^M.$$

Since $P^F$ decreases with respect to $B_0^F$ from (15), and $Q_0$ decreases with respect to $P^F$ from (14), it must be that $-Q_0 B_0^F$ and thus $g_0$ decrease with respect to $B_0^F$. Thus the solution to this program consists in selecting $B_0^F$ as small as possible, and so the largest level of debt for $F$, namely such that $P^F = \underline{P}_1 + \alpha^M$. In the remainder of the paper, we deem this optimal amount of debt conditional on date-1 fiscal dominance the "Sargent-Wallace" debt level.[16] The utility of $F$ is in this case:

$$-\frac{X_0^M}{P_0} - \frac{Q_0 B_0^F}{P_0} + \beta^F \underline{g} = -\frac{X_0^M}{P_0} + \frac{1}{r}\left(\bar{x} + \bar{\tau} - \underline{g} - \frac{R_0 X_0^H}{\underline{P}_1 + \alpha^M}\right) + \beta^F \underline{g}, \tag{19}$$

where the expression of $Q_0 B_0^F$ stems from injecting $P^F = \underline{P}_1 + \alpha^M$ in (14) and (15).

**Optimal debt issuance conditional on date-1 monetary dominance.** Conditionally on expecting a date-1 price $P_1$ equal to $\underline{P}_1$, $F$ selects the debt level $B_0^F$ so as to

[16] We use this denomination not because our model is stricto sensu the one in Sargent and Wallace (1981) but because it corresponds to a situation in which the fiscal authority forces the price level away from the central bank's objective to ensure solvency in equilibrium.

solve:

$$\max_{B_0^F} g_0 + \beta^F g_1, \tag{20}$$

$$\text{s.t. } P_0\underline{g} \leq P_0 g_0 = -X_0^M - Q_0 B_0^F, \tag{21}$$

$$\underline{P}_1\underline{g} \leq \underline{P}_1 g_1 = \underline{P}_1(\bar{x} + \bar{\tau}) + B_0^F - R_0 X_0^H, \tag{22}$$

$$P_0 = rQ_0\underline{P}_1, \tag{23}$$

$$\underline{P}_1 \leq P^F. \tag{24}$$

where (21) and (22) are date-0 and date-1 budget constraints, (23) ensure that savers are willing to post the market-clearing demand $B_0^H = -B_0^F$, and the last condition ensures that monetary dominance is the date-1 outcome.

Program (20) entails that if $\beta^F r \leq 1$, $F$ finds it optimal to set $g_1 = \underline{g}$ (strictly so if $\beta^F r < 1$). But in this case, the Sargent-Wallace debt level inducing date-1 fiscal dominance is strictly dominant for $F$ as it leads to a strictly larger $g_0$ than that resulting from Program (20) holding $g_1 = \underline{g}$ fixed. Thus, a necessary condition for monetary dominance is $\beta^F r > 1$. In this case, $F$ maximizes its utility conditional on monetary dominance by setting $B_0 = B_0^*$, the largest possible position in the bond market subject to reaching its date-0 incompressible consumption level:

$$Q_0 B_0^* \equiv -X_0^M - P_0\bar{g}. \tag{25}$$

Notice that $B_0^*$ may be positive, in which case $F$ is net saver. This happens when (unrealistically) $F$ receives more dividends from the monetary authority than its incompressible level of consumption $\bar{g}$. Overall, $F$ thus obtains utility

$$\underline{g} + \beta^F\left(\bar{x} + \bar{\tau} - r\underline{g} - r\frac{X_0^M}{P_0} - \frac{R_0 X_0^H}{\underline{P}_1}\right). \tag{26}$$

In the remainder of the paper, we deem this optimal amount of debt conditional on date-1 monetary dominance the "price-level taking" debt level.

**Comparing the two debt levels.** Comparing the utility under monetary dominance (26) with the one under fiscal dominance (19) shows that $F$ prefers the price-level taking debt level if and only if

$$\underbrace{\left(\beta^F r-1\right)}_{\text{Unit cost of frontloading } g} \times \underbrace{\left(\bar{x}+\bar{\tau}-(1+r)\underline{g}-\frac{rX_0^M}{P_0}-\frac{R_0X_0^H}{\underline{P}_1}\right)}_{\text{Net public resources}} \geq \underbrace{R_0X_0^H\left(\frac{1}{\underline{P}_1}-\frac{1}{\underline{P}_1+\alpha^M}\right)}_{\text{Fiscal-dominance gains}}. \tag{27}$$

This condition admits a simple interpretation. Relative to the price-level taking debt level, the Sargent-Wallace one generates additional resources from applying a higher price level to the reserves $R_0X_0^H$ held by savers at date 1 (right-hand side of (27)). However, generating these resources comes at the cost of frontloading the date-1 consumption of the government (left-hand side of (27)). The unit frontloading cost is $\beta^F r-1$, and is actually a unit gain if $\beta^F r \leq 1$, in which case $F$ always prefers the Sargent-Wallace debt level. This unit cost applies to the resources of the public sector $\bar{x}+\bar{\tau}$ net of the date-1 value of its liabilities, both explicit (reserves) and implicit (incompressible expenditures). $F$ prefers the price-level taking debt level if this cost from the Sargent-Wallace debt level exceeds the benefits.

The following proposition summarizes these results.

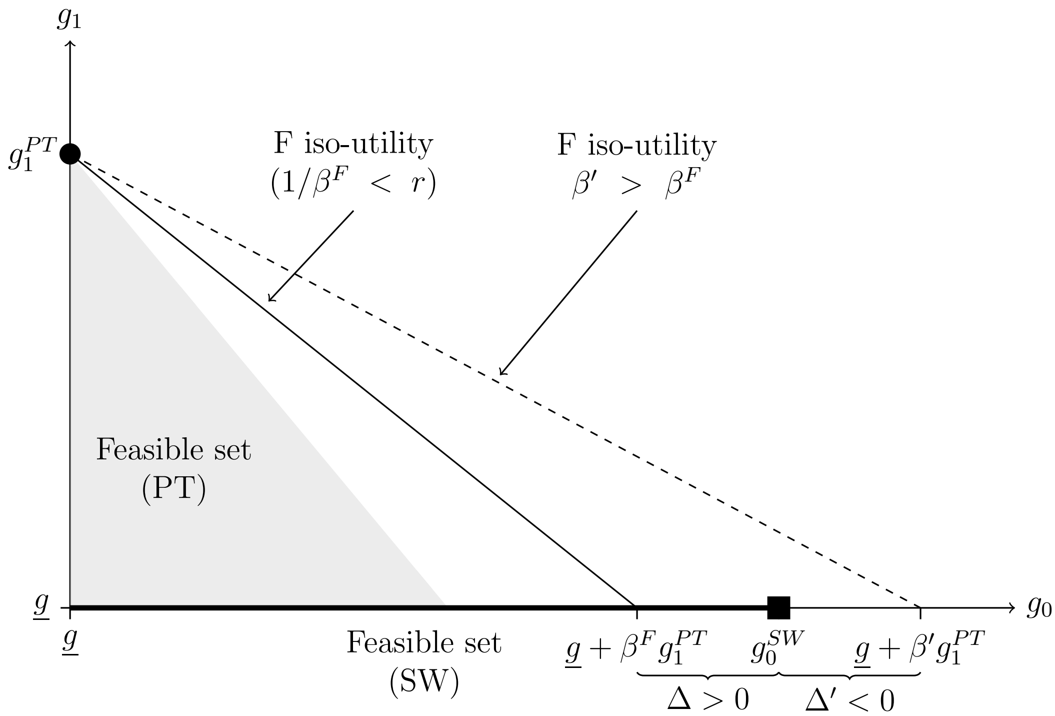
**Proposition 2.** ***(Debt issuance in the date-0 bond market)*** *Given* $(R_0, X_0^M, P_0)$, *$F$ issues one of either debt level:*

- ***Price-level taking debt level:*** *$F$ issues bonds $B_0^*$ so as to optimize its consumption pattern taking the date-1 price level $\underline{P}_1$ as given.*
- ***Sargent-Wallace debt level:*** *$F$ issues a larger amount in the bond market, front-loading consumption as much as possible ($g_1 = \underline{g}$) and issues enough debt to force a date-1 price level given by fiscal dominance. The date-1 price level is equal to $\underline{P}_1+\alpha^M$.*

*There is no default at date 1. $F$ selects the "price-level taking" debt level whenever condition* (27) *holds.*

We illustrate these results in Figure 2. The price-level taking debt level corresponds to the consumption pattern $(g_0, g_1)$ that maximizes $F$'s utility under the budget constraints (21) and (22) (the grey triangle). When $\beta^F r > 1$, the solution to this problem is at the upper left corner of the triangle (the round dot). F's utility is then given by the intersection between the iso-utility (the solid downward-sloping curve) and the x-axis. The consumption profile associated with the Sargent-Wallace debt level $(g_0^{SW}, g_1^{SW})$ is indicated by the square dot on the x-axis as $g_1^{SW} = \underline{g}$. Notice that this square dot is outside the feasible set under monetary dominance (the grey area), as the Sargent-Wallace debt level allows to reduce the real cost of already-issued reserves and hence a higher date-0 consumption level. Finally, $\Delta$ measures the gap between the payoffs associated with the two debt levels. When this gap is positive as in Figure 2, the Sargent-Wallace debt level is preferred by $F$ as the higher date-0 consumption level more than compensates the lower date-1 consumption level. On the contrary, when $\Delta$ is negative, for instance, due to $F$'s discount factor being $\beta' > \beta^F$ (dotted downward-sloping curve), $F$ prefers the price-level taking debt level over the Sargent-Wallace one.

Figure 2: Problem faced by $F$ on the date-0 debt market.




*Note: When choosing debt $B_0^F$, $F$ selects government spendings $(g_0, g_1)$. The grey area corresponds to the feasible set when $F$ takes prices as given. The dark thick segment over the x-axis corresponds to the one when $F$ forces $M$ to chicken out at date-1 (and $g_1 = \underline{g}$). The round dot on the y-axis stands for the consumption pattern associated with the price level taking debt level and the square dot on the x-axis stands for the one with the Sargent-Wallace debt level. The two downward-sloping curves correspond to $F$ iso-utility curves for two different discount factors $\beta'$ and $\beta^F$ with $\beta' > \beta^F$. Finally, $\Delta$ and $\Delta'$ show $F$'s gains from SW-debt level over PT-debt level for the two discount factors. $\Delta > 0$ means SW-debt level is preferred with the low discount factor $\beta^F$.*

The "Sargent-Wallace" debt level whereby $F$ floods the bond market with paper so as to force $M$ to "chicken out" and inflate away outstanding reserves at date 1 in order to ensure public solvency is related to that underlying the unpleasant monetarist arithmetic in Sargent and Wallace (1981). An important difference is that $F$ creates a deficit that forces $M$ to inflate away the value of public liabilities and, in particular, reserves, whereas, in Sargent and Wallace (1981), a deficit requires the monetary authority to generate seignorage income. Proposition 2 shows that issuing the Sargent-Wallace debt level need not be $F$'s favorite strategy as this may induce an excessive distortion of its optimal spending relative to the gains from inflation. We are now equipped to solve for the first stage of the game: the date-0 market for reserves.

### 3.4 Date-0 reserve market: Which authority determines the price level?

We tackle the first stage of the game—monetary policy in the date-0 reserve market—in two steps. Proposition 3 first characterizes situations in which monetary dominance prevails at both dates 0 and 1. Proposition 4 then tackles the situations in which $M$ cannot reach this outcome.

**M's problem.** To start with, if $M$ announces a rate $R_0$ and issues new reserves $X_0^M \leq 0$, savers clear the market posting $X_0^H = X_{-1} - X_0^M$ at the date-0 price level $P_0$ that solves

$$P_0 R_0 = r P_1(R_0, X_0^M, P_0), \tag{28}$$

where $P_1(R_0, X_0^M, P_0)$ is given by the continuation game summarized in Proposition 2. Thus, $P_1(R_0, X_0^M, P_0) \in \{\underline{P}_1; \underline{P}_1 + \alpha^M\}$, and condition (27) implies that $P_1$ is weakly decreasing in $P_0$, implying that there is a unique $P_0$ that solves (28).

In what follows, we want to make sure that any date-0 price-level deviation from $M$'s objective $P_0^M$ is due only to the fiscal-monetary interaction. We impose in particular that the real exogenous demand for reserves at date 1, $\bar{x}$, is sufficiently large that $M$ can set $P_0 = P_0^M$ without consuming negatively at any date, that is:

**Assumption 2.** $\frac{X_{-1}}{P_0^M} < \frac{\bar{x}}{r}$.

Assumption 2 ensures that $P_1\bar{x} - R_0 X_{-1} \geq 0$ when $P_0 = P_0^M$ so that $M$ can (but may not want to) always set the date-0 price level equal to $P_0^M$ while keeping $X_0^M, X_1^M \leq 0$

and thus consume positively at each date.

The monetary authority selects a reserve demand $X_0^M$ and a level of interest rate $R_0$ so as to solve the following problem:

$$\max_{R_0 \geq 0, X_0^M \leq 0} - \left|P_0 - P_0^M\right| - \beta^M \left|P_1 - P_1^M\right| \tag{29}$$

$$\text{s.t. } P_0 R_0 = r P_1(R_0, X_0^M, P_0) \tag{30}$$

**When monetary dominance always prevails.** Let us first characterize the situations in which $M$ achieves its price level objective both at dates 0 and 1. In these situations, it must set the rate at $R_0 = rP_1^M/P_0^M$. Assumption 2 implies that

$$\underline{P}_1 = \max\left\{P_1^M; \frac{R_0 X_0^H}{\bar{x}}\right\} = \max\left\{P_1^M; \frac{rP_1^M(X_{-1} - X_0^M)}{P_0^M \bar{x}}\right\} = P_1^M \tag{31}$$

for $X_0^M$ sufficiently close to zero. Condition (27) states that $F$ will find the price-level taking strategy optimal for such $(R_0, X_0^M)$ if and only if

$$(\beta^F r - 1)\left(\bar{x} + \bar{\tau} - (1+r)\underline{g} - \frac{rX_{-1}}{P_0^M}\right) \geq \frac{r\alpha^M(X_{-1} - X_0^M)}{P_0^M(P_1^M + \alpha^M)}, \tag{32}$$

which is most likely to hold when $X_0^M$ is maximum at $X_0^M = 0$. Thus,

**Proposition 3.** ***(Characterization of monetary dominance)*** *The equilibrium is such that price levels are on target at dates 0 and 1 ($P_0 = P_0^M$ and $P_1 = P_1^M$) if and only if*

$$(\beta^F r - 1)\left(\bar{x} + \bar{\tau} - (1+r)\underline{g} - \frac{rX_{-1}}{P_0^M}\right) \geq \frac{r\alpha^M X_{-1}}{P_0^M(P_1^M + \alpha^M)}. \tag{33}$$

*In this case, $M$ issues no or sufficiently small new reserves, and announces a rate $R = rP_1^M/P_0^M$. The game then unfolds as in the price-level taking debt level situation in Proposition 2 with $P_1 = P_1^M$.*

Condition (32) shows that $M$ must keep the quantity of reserves in the economy $X_{-1} - X_0^M$ sufficiently low if it wants to impose monetary dominance at date 1. A necessary condition for this to be feasible is that the legacy reserves $X_{-1}$ be sufficiently small other things being equal. In this case, by issuing no new reserves ($X_0^M = 0$), or a sufficiently small amount of them, $M$ makes the gains from the Sargent-Wallace debt level sufficiently small that $F$ does not issue it. $M$ is indifferent between several level of reserves below a threshold because reserves and bonds are perfect substitutes, and so the resources that $M$ raises and transfers to $F$ to fund $g_0$ can be raised by $F$ at the same cost in the bond market.

Figure 2 allows to grasp some intuition for this result: by limiting the quantity of reserves, $M$ is able to reduce the distance between the budget set when taking price levels as given (the grey triangle in the Figure) and consumption under the Sargent-Wallace debt level solution (the square dot).

In addition to low legacy public liabilities $X_{-1}$, the other interesting features that drive monetary dominance are twofold. First, the existence of a large fiscal space $\bar{x}+\bar{\tau}-(1+r)\underline{g}$ helps because in this case, $F$ needs to engineer a very large distortion of its public finances in the form of large current borrowing and spending in order to be credibly ready to default in the future. It is important at this point to recall that the analysis is carried out under Assumption 1 ensuring that $F$ does not contemplate default as long as it can consume at least $\underline{g}$. Thus the case in which $F$ has a lot of fiscal space is also implicitly one in which $F$ has a sufficiently large aversion to default.

The last driver of monetary dominance, which shows on the right-hand side of (33), is the coefficient $\alpha^M/(P_1^M+\alpha^M)$, the gain per unit of legacy liabilities that $F$ can extract from the Sargent-Wallace strategy. The magnitude of this coefficient depends on $M$'s aversion to sovereign default.

**When monetary dominance does not always prevail.** Let us now turn to situations in which condition (33) fails to hold. In this case, $M$ cannot ensure monetary dominance at one date at least. We show that the equilibrium can be of three types in this case: $M$ surrenders, $M$ creates preemptive inflation, or $M$ manufactures a date-1 lower bound on the price level with reserve overflow. We describe each outcome in turn.

$M$ **surrenders.** In this case, $M$ accepts that the date-1 price level will be $P_1^M+\alpha^M$ because $F$ will issue the Sargent-Wallace debt level, and sets the price level at $P_0^M$. More precisely, $M$ sets a rate $R_0 = r(P_1^M+\alpha^M)/P_0^M$ and a reserve demand $X_0^M \in [X_{-1}-P_0^M\bar{x}/r, 0]$. The date-0 price level is then $P_0^M$ and the economy unfolds such that $F$ issues the Sargent-Wallace debt level. The date-1 price level is $P_1^M+\alpha^M$. The utility cost for $M$ relative to monetary dominance is $\beta^M\alpha^M$.

This surrendering outcome is in particular the equilibrium when the fiscal authority is weakly more impatient than the private sector: $\beta^F r \leq 1$. In this case $F$ finds it optimal to frontload its consumption regardless of strategic concerns. Given that it borrows against all future public resources, it might as well raise the nominal value of its debt to the level that forces date-1 fiscal dominance, as this comes at no cost. If by contrast $\beta^F r > 1$, then $M$ may (or may not) find one of the two following strategies superior to surrendering and optimal.

**$M$ creates preemptive inflation.** In this strategy, $M$ raises the price level $P_0$ to the smallest level ensuring that condition (33) holds. This is the solution $P_0^*$ to

$$(\beta^F r - 1)\left(\bar{x} + \bar{\tau} - (1+r)\underline{g} - \frac{rX_{-1}}{P_0^*}\right) = \frac{r\alpha^M X_{-1}}{P_0^*(P_1^M + \alpha^M)}. \tag{34}$$

By raising $P_0$, $M$ reduces the real amount of legacy liabilities to which the rate of "seigniorage" $\alpha^M/(P_1^M + \alpha^M)$ applies, thereby also reducing the appeal of the Sargent-Wallace strategy. In terms of implementation, $M$ demands reserves $X_0^M = 0$ so as to minimize the gains from inflating reserves away, and sets the rate at $R_0 = rP_1^M/P_0^*$. The date-0 reserve market thus clears at $P_0^*$, and the game unfolds according to the price-level taking strategy in Proposition 2 with $\underline{P}_1 = P_1^M$.

**$M$ manufactures a lower bound on the date-1 price level.** The last strategy that $M$ can pursue is to set both the date-0 price level $P_0$ and the date-1 price level $P_1$ above target so that condition (33) holds. An increase in $P_0$ plays the same role as under preemptive inflation to shrink the real basis of legacy liabilities to which the seigniorage rate applies. The increase in $P_1$ serves to shrink this seigniorage rate $\alpha^M/(P_1^M + \alpha^M)$ in addition.[17]

Here there is a twist, however. $M$ cannot commit at date 0 to a date-1 price level. As a commitment device, it must use reserve overflow so as to manufacture its own lower bound on $P_1$. Namely, $M$ must demand reserves $X_0^M = X_{-1} - \bar{x}P_0/r$ in order to face a reserve overflow at date 1. More precisely, the strategy of $M$ is as follows. Let $(P_0, P_1)$

[17]Notice that the assumption of a fixed default cost $\alpha^M$ plays an important role here.

solve

$$\min_{P_0 \geq P_0^M, P_1 \geq P_1^M} P_0 + \beta^M P_1 \tag{35}$$

$$\text{s.t.} \quad \left(\beta^F r - 1\right) \left(\bar{x} + \bar{\tau} - (1+r)\underline{g} - \frac{rX_{-1}}{P_0}\right) \geq \frac{\alpha^M \bar{x}}{P_1 + \alpha^M}. \tag{36}$$

Condition (36) stems from injecting $X_0^M = X_{-1} - \bar{x}P_0/r$ and substituting $P_0^M$ and $P_1^M$ with $P_0$ and $P_1$ respectively in (32). $M$ announces an interest rate $R_0 = rP_1/P_0$, and demands reserves $X_0^M = X_{-1} - \bar{x}P_0/r$. The game then has the price-taking debt level continuation with reserve overflow.

*Remark.* Notice that the situation of reserve overflow resembles a situation deemed "stepping on a rake" by Sims (2011). In this case, as previously mentioned, any tightening in monetary policy (a higher $R_0$) would have the perverse effect of increasing the price level at date 1. Notice, however, that this is not the only situation in which monetary policy is under fiscal influence.

We can in principle derive analytical expressions for $M$'s payoff associated with each strategy and compare them with each other. The expressions are cumbersome and unfortunately not particularly instructive. There are however two cases in which the best strategy for $M$ and thus the ensuing equilibrium can be identified. The first one has been mentioned above and corresponds to $M$ surrendering for lack of an alternative when $\beta^F r \leq 1$. Second, if $\beta^F r > 1$, then preemptive inflation is the equilibrium strategy when $X_{-1}$ is sufficiently small other things being equal—that is, $X_{-1}$ sufficiently small that condition (33) is sufficiently close to being satisfied holding other parameters fixed. The reason is that in this case, preemptive inflation comes only at the cost of an arbitrarily small deviation from the date-0 price-level target. By contrast, the two other strategies come at a fixed cost. Surrendering has a fixed utility cost $\beta^M \alpha^M$. Manufacturing a lower bound also comes at a cost that is bounded away from that of preemptive inflation for $X_{-1}$ sufficiently small because it involves an increase $\bar{x}P_0/r - X_{-1} \geq \bar{x}P_0^M/r - X_{-1}$ in the reserves that $F$ may seek to inflate away.

The following proposition summarizes these possible outcomes.

**Proposition 4.** ***(Optimal monetary policy without monetary dominance)*** *Suppose that condition* (33) *in Proposition 3 does not hold. The equilibrium is one of the following:*

- *($M$ **surrenders**) $M$ announces a rate $R_0 = r(P_1^M + \alpha^M)/P_0^M$ and is indifferent between several levels of newly created reserves (including 0). The date-0 price level is $P_0^M$ and the game unfolds according to the Sargent-Wallace debt level situation with $P_1 = P_1^M + \alpha^M$.*

- *($M$ **creates preemptive inflation**) $M$ announces a rate $R_0 = rP_1^M/P_0^*$, where $P_0^* > P_0^M$, and does not issue new reserves ($X_0^M = 0$). The game unfolds according to the price-taking debt level situation. The price levels are $(P_0^*, P_1^M)$.*

- *($M$ **manufactures a lower bound on the date-1 price level**) $M$ announces a rate $R_0 = rP_1/P_0$, with $P_1 > P_1^M$ and $P_0 \geq P_0^M$, and issues reserves $-X_0^M = P_0\bar{x}/r - X_{-1} \geq 0$. The game unfolds according to the price-taking debt level situation with reserve overflow. The price levels are $(P_0, P_1)$.*

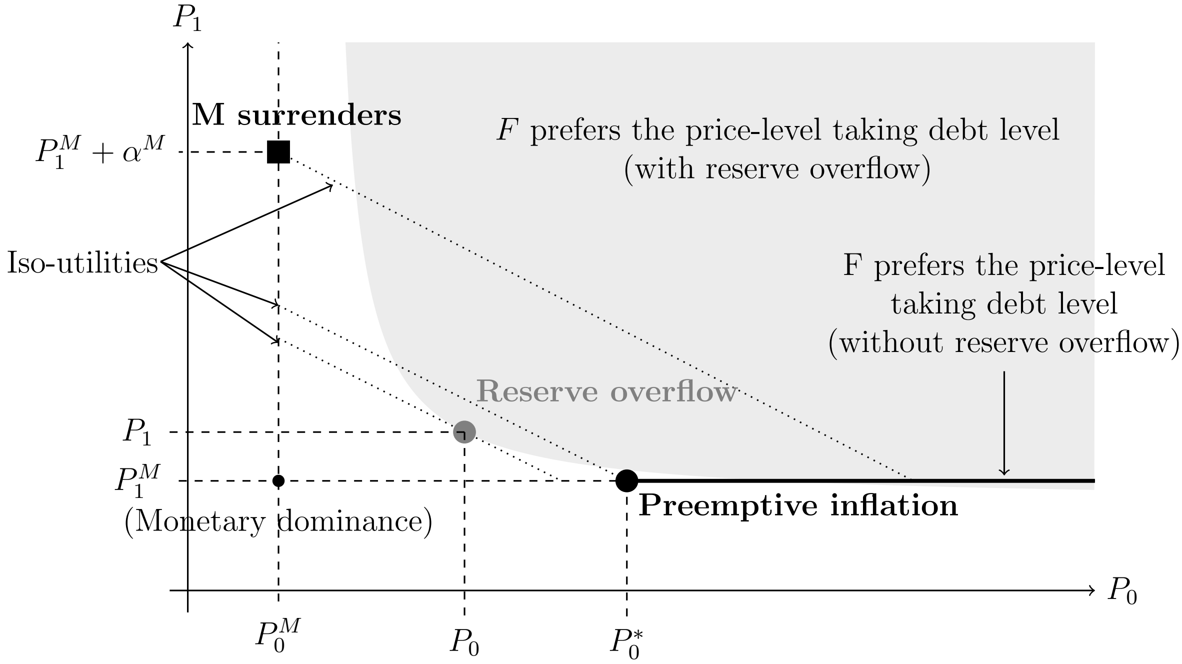
*Furthermore, $M$ surrendering is the equilibrium when $\beta^M r \leq 1$. If $\beta^M r > 1$, preemptive inflation is the equilibrium when, ceteris paribus, $X_{-1}$ is sufficiently small.*

The three options listed in Proposition 4 are different nuances of fiscal dominance: in any of them, the price levels are away from $M$'s targets at one date at least. We plot in Figure 3 how the three options perform in terms of the price levels $P_0$ and $P_1$. Date-1 fiscal dominance corresponds to the top-left square dot $(P_0^M, P_1^M + \alpha^M)$. Reserve overflow is the middle grey round dot and corresponds to the price levels at which the iso-utility line (dashed lines) is tangent to grey area where the constraint (36) is satisfied. Preemptive inflation corresponds to the bottom-right black round dot with $(P_0^*, P_1^M)$. The Figure depicts a situation in which $M$ optimally chooses reserve overflow over the two other options. Notice that the preemptive inflation dot is outside the grey area as under preemptive inflation, $M$ does not issue new reserves and hence $P_0^*$ is lower than what is necessary to deter the Sargent-Wallace debt level under reserve overflow and $P_1 = P_1^M$.

### 3.5 Discussion

**Ex-ante fiscal gains from the unpleasant arithmetic.** It is worthwhile stressing that $F$ does not derive ex-ante gains from issuing the Sargent-Wallace debt level when it does so in equilibrium. When it finds it optimal to do so ex-post, it is anticipated in

Figure 3: Problem faced by $M$ on the date-0 reserve market (when monetary dominance is out of reach).




*Note: When monetary dominance $(P_0^M, P_1^M)$ is out of reach, M selects actions whose outcomes are represented by the black square dot: M surrenders and fiscal dominance prevails at date 1; the grey round dot: M generates reserve overflow to credibly implement a higher price level at date 1 and possible higher price level at date 0 as well; and the dark round dot: M creates preemptive inflation at date 0. The grey area corresponds to the set of prices such that F prefers the price-level taking debt level given reserve overflow, while the dark thick horizontal line corresponds to the set of prices such that F prefers the price-level taking debt level without reserve overflow. Downward-sloping lines stand for M's iso-utility. In this example, M chooses reserve overflow over the two other options as it maximizes M's date-0 utility.*

the reserve and bond markets, so that all public liabilities command the same real return $r$. $F$ on the other hand incurs the costs from excessive borrowing when $\beta^F r > 1$. In this case, $F$ would be happy to avail itself of a commitment device to not issue at the Sargent-Wallace level, such as a credible fiscal requirement putting an upper bound on the amount of debt it can issue.

There are also parameter values such that $F$ derives ex-ante gains from its ex-post optimal behavior. These correspond to the equilibria in which $M$ deters the Sargent-Wallace debt level with an increase in $P_0$. This erodes the value of the legacy liabilities, thereby generating additional public resources for consumption. Furthermore, $F$ does not borrow inefficiently in this case and thus extracts these benefits at no cost.[18]

[18] This may, however, be anticipated in the unmodelled date-(-1) reserve market in which $X_{-1}$ is issued.

**Timing and connection with the Fiscal Theory of the Price Level.** Our assumptions on timing are such that the government issues new debt when the price level at date 0 is already set. As a result, fiscal policy and debt issuance in particular may have a direct effect on the price level at date 1 only. This contrasts with the fiscal theory of the price level in which fiscal policy is set ex-ante so that the debt maturing at date 0 constrains the date-0 price level $P_0$. Despite this difference, as in the fiscal theory of the price level, the date-0 price level may still be determined by fiscal policy in our setting depending on how the monetary authority responds to anticipated fiscal-dominance risk, as spelled out in Proposition 4.

We could alternatively suppose that the bond market opens and clears before that for reserves at date 0. The insights are broadly similar to that when $M$ issues reserves first. The main difference is that $F$ cannot benefit from forcing a date-1 price level above target by borrowing a lot at date 0 since this would be anticipated in both date-0 bond and reserve markets. $F$ may however still find it worthwhile forcing $M$ to set the date-0 price level at $P_0^M + \alpha^M$ so as to reduce the date-0 real value of legacy reserves $X_{-1}$. This is so again when the associated gain more than offsets the cost from excessive date-0 borrowing. But then, the interesting analysis of optimal monetary policy in anticipation of this behavior—the equivalent of Propositions 3 and 4—would have to take place in the date-(-1) reserve market at which these reserves are issued.

In sum, current debt issuance can directly affect the price-level determination that follows, whether it is within the same date or at the following one. The previous price level can also be indirectly affected by $M$'s anticipation of future fiscal dominance.

**What if default is strategic?** Assumption 1 implies that $F$ is financially unconstrained in the sense that it can borrow against its entire future resources $\bar{x} - R_0 X_0^H / P_1 + \bar{\tau} - \bar{g}$. Thus the default boundary that it must reach when entering into the Sargent-Wallace debt level is equal to the point at which it would be forced to cut expenditures below $\underline{g}$ in order to make good on its debt. This situation in which borrowing constraints play no role is a natural first step. The main insights are identical, however, if $F$ is financially constrained. Suppose that Assumption 1 is replaced with

$$r\underline{g} \leq \alpha^F < \bar{\tau} - \underline{g}, \tag{37}$$

so that $F$ cannot borrow against its entire future resources, but can borrow enough to fund date-0 incompressible expenditures $\underline{g}$. In this case, the default boundary is hit when $F$ owes real debt $\alpha^F$ at date 1, as it finds default preferable to cutting spending by $\alpha^F$. It is easy to derive the counterpart of condition (33) under which monetary dominance prevails:

$$\underbrace{\left(\beta^F r - 1\right)}_{\text{Unit cost of frontloading } g} \times \underbrace{\left(\alpha^F - r\underline{g} - \frac{rX_{-1}}{P_0^M}\right)}_{\text{Amount to be frontloaded}} \geq \underbrace{\frac{r\alpha^M X_{-1}}{P_1^M(P_1^M + \alpha^M)}}_{\text{Fiscal-dominance gains}}. \tag{38}$$

The only difference with condition (27) is that the default boundary $\bar{x} + \bar{\tau} - \underline{g}$ is replaced with $\alpha^F$. Condition (38) shows that a higher cost of default makes the Sargent-Wallace debt level more costly and thus less appealing to $F$.

**Remittances as an incentive scheme.** The lexicographic preferences of $M$, which ceteris paribus prefers to maximize the utility of $F$, are primarily meant to fix ideas. Yet this is not an entirely innocuous assumption. Paired with lack of commitment, it implies that $M$ cannot use its dividend policy to discipline $F$. If $M$ did not care about its nor $F$'s consumption, it could by contrast credibly commit to a scheme of contingent remittances, rewarding moderate debt issuance levels by the government. Such a scheme would consist in building up more central-bank equity with indefinitely retained earnings in response to fiscal expansions. This of course is impossible in institutional settings such that $F$ can dictate the central bank's dividend policy, a situation that is broadly captured by our setting with lexicographic preferences.

**Fiscal and monetary disagreement and legacy liabilities.** Suppose a less extreme formulation of the disagreement between $M$ and $F$ in which the utility of $M$ is a weighted sum of (6) and (7). In this case, interestingly, the disagreement between the two authorities would decrease in the magnitude of the legacy liabilities $X_{-1}$. It is easy to see with such linear preferences. For $X_{-1}$ sufficiently small, $M$ would always prefer to set the price level on target rather than generate small extra consumption for $F$ by inflating $X_{-1}$ away. Past a threshold for $X_{-1}$, $M$ would however find that the gains from generating fiscal space with inflation would overcome the costs of inflation.

# 4 Extensions

We discuss the following extensions of the baseline model: allowing $M$ to trade bonds, allowing $F$ to reclaim the conduct of monetary policy, endogenizing payoffs within an infinite-horizon version of the model, allowing for general costs of taxation and imperfectly elastic demand for public liabilities.

## 4.1 The central bank can trade bonds

In order to showcase the main forces driving our results in the simplest setting, the baseline model very counterfactually rules out that $M$ can purchase bonds issued by the other agents. This section relaxes this restriction. Suppose that in the date-0 bond market, after $F$ has posted a demand $B_0^F \in \mathbb{R}$, $M$ can post a demand $B_0^M \geq 0$. Then the private sector posts a bond price $Q_0$ and clears the market: $B_0^H + B_0^F + B_0^M = 0$. The rest of the model is unchanged. Here we sketch how this affects the equilibrium. Notice first that $M$ consuming positively at date 0 implies $B_0^M \in [0, -X_0^M]$.

**Monetary dominance.** Consider first the case in which condition (33) holds so that monetary dominance prevails at every date. In this case, an irrelevance result that is akin to that in Wallace (1981) applies. If $M$ has any date-0 resources ($X_0^M < 0$), whether it uses them to buy bonds or transfers them to $F$ is immaterial. Since any date-0 resources of $M$ are ultimately transferred to $F$ at date 0 or 1, $F$ can undo in the bond market whatever $M$ does.

**Fiscal dominance.** Consider then the case in which (33) fails to hold. Proposition 3 states that the equilibrium of the baseline model can be of three types. If parameters are such that $M$ optimally surrenders in the baseline model, then it is also the case when $M$ can buy bonds. The only difference is that if $M$ has any resources at date 0, then it will always find it optimal to invest them entirely in the bond market—$B_0^M = -X_0^M$—so as to minimize the amount of debt in the hands of the private sector that it will have to inflate away at date 1, and thus the date-1 price level. $F$ correctly anticipates this, however, and adjusts $B_0^F$ to ensure that the date-1 price level will be at its maximum value $P_1^M + \alpha^M$. In sum, the payoffs are unchanged relative to the baseline model. The only difference is that if $M$ decides to issue a (payoff-irrelevant) amount of reserves $-X_0^M$, it finds it strictly optimal ex-post to purchase bonds rather than to pay a remittance to $F$ at date 0.

In the two other cases spelled out in Proposition 3, the same parameter values lead to the same outcome as in the baseline model when $M$ can purchase bonds, and $M$ finds it actually dominant to not purchase bonds ($B_0^M = 0$) in equilibrium. In the preemptive inflation case, it is simply because $M$ keeps reserves at the minimum ($X_0^M = 0$) in order to minimize the date-0 price level that discourages the Sargent-Wallace strategy. Finally, in the case in which $M$ issues reserves so as to manufacture its own lower bound at date 1, it prefers to pay the proceeds to $F$ rather than invest them in bonds at date 0. This is so because any bond investment $B_0^M$ would defeat the purpose of this strategy as the lower bound that $M$ faces at date 1 would be $(R_0 X_0^H - B_0^M)/\bar{x}$ instead of $R_0 X_0^H/\bar{x}$.

**Legacy bond holdings.** Finally, notice that if $M$ starts out with bond holdings that it can market at date 0, then doing so and using the proceeds to buy back legacy reserves can help shift a situation from fiscal to monetary dominance. The reason this helps $M$ is that it amounts to modify the holdings of the private sector, swapping legacy reserves that can be inflated away to the benefit of $F$ with newly issued bonds that cannot because they price in the future equilibrium price level.

## 4.2 Reversing central-bank independence and soft default

In the benchmark model, the fiscal authority can only threaten the monetary authority with a hard default at date 1. In this section, we allow the fiscal authority to take directly control of the price level by intervening in the reserve market. Our main finding is that the fiscal authority always uses its best option between hard and soft default as a threat.

**Modified setting.** Let us slightly modify the baseline model and allow the fiscal authority to issue reserves $X_1^F \in \mathbb{R}$.[19] The market clearing condition for reserves at date 1 then reads:

$$X_1^F + X_1^H + X_1^M + P_1 \bar{x} = 0. \tag{39}$$

[19] We model the reversal of central-bank independence in this manner for tractability. However, the idea that the Treasury can print money and force this way monetary policy is not a pure abstraction and can potentially be linked to the proposal in the US to issue a trillion-dollar coin or to the one in the euro area to issue zero-coupon perpetual bonds.

Suppose that issuing reserves—$X_1^F < 0$—entails a fixed cost $\gamma^F$ to the fiscal authority and $\gamma^M$ to the monetary authority. In particular, this cost does not depend on the price level, capturing that the incumbent central banker is replaced by a government's crony and no longer cares about policy outcomes. The payoffs are thus modified as follows:

$$U^F = g_0 + \beta^F \left( g_1 - \alpha^F l_1 - \gamma^F \epsilon_1 \right), \tag{40}$$

$$U^M = - \mid P_0 - P_0^M \mid - \beta^M \left( \left( \mid P_1 - P_1^M \mid + \alpha^M l_1 \right) (1 - \epsilon_1) + \gamma^M \epsilon_1 \right), \tag{41}$$

with $\epsilon_1 = 1$ when the fiscal authority takes control of monetary policy—$X_1^F < 0$—and $\epsilon_1 = 0$ otherwise. The rest of the model remains unchanged. For simplicity, we assume $\underline{g} = 0$ and $\gamma^F \geq \bar{x} + \bar{\tau}$—that is, $F$ only intervenes in the reserve market because of resource constraints.

**Optimal soft and hard defaults.** Conditionally on issuing reserves at date 1, $F$ seeks to set the price level $P_1$ so as to maximize:

$$g_1 = \bar{\tau} + \bar{x} - \frac{(1 - l_1)B_0 + R_0 X_0^H}{P_1} - \alpha^F l_1 \tag{42}$$

The solution is $P_1 = +\infty$. A dominant strategy for the fiscal authority is to flood the market with reserves no matter what the monetary authority does. The monetary authority cannot prevent the price level to diverge this way, as this is incompatible with finite resources and positive consumption. This situation describes one of soft default—debt is fully inflated away—with full reimbursement of debt. In real terms, however, the outcome is the same as under a hard default.

As a result, $F$ floods the reserve market if and only if $\gamma^F \leq \alpha^F$ and $M$ does not issue enough reserves to prevent hard default, that is:

$$P_1 \left( \bar{\tau} + \bar{x} \right) \leq B_0^H + R_0 X_0^H. \tag{43}$$

When $\alpha^F < \gamma^F$, $F$ never takes control of the reserve market and the threat is immaterial. Otherwise, $M$ will try to implement a price level $P_1$ between $\underline{P}_1$ and $\underline{P}_1 + \gamma^M$, which does not satisfy (43). If public liabilities in the hand of the private sector are too high (that is, if inequality (43) is satisfied for $P_1 = \underline{P}_1 + \gamma^M$), a price level above $\underline{P}_1 + \gamma^M$ would be required to satisfy (43) and, thus, $M$ prefers resigning and being replaced. Overall, the outcome of this game is very similar to that in the baseline model except that what matters is $\gamma^F$ instead of $\alpha^F$ and $\gamma^M$ instead of $\alpha^M$.

The rest of the game follows Section 3 with either hard or soft default at date 1 depending on the relative values of $\alpha^F$ and $\gamma^F$.

*Remark.* Which option between a soft and a hard default is the most expensive one? This depends on the institutional context. An outright default may be easier to implement and cheaper than trying to take back control of monetary policy for countries within monetary unions, as this may mean leaving the common currency. By contrast, a hard default does typically not require a decision by the legislative branch, and may thus be decided solely by the executive branch. On the other hand, the absence of formal independence may ease the possibility to reverse central-bank independence. A political consensus against central-bank independence may have the same effect.

## 4.3 Market discipline and endogenous default costs

An online appendix develops an infinite-horizon version of the model in which infinitely lived fiscal and monetary authorities interact with a private sector populated by overlapping generations of savers each identical to that in the two-date model. The economy is dynamically inefficient and the only resources that the public sector can raise from the private one stem from the issuance of Ponzi schemes. We show that in this case, the private sector can very much impose any feasible equilibrium path for monetary and fiscal policy with contingent strategies that punish both $M$ and $F$ in case of deviation. To illustrate this, we show that the key exogenous variables $(\bar{x}, \bar{\tau}, \alpha^M, \alpha^F)$ of the two-date baseline model can be endogenized as generated by the private sector's strategy from date 2 on in this infinite-horizon model.

## 4.4 General cost of taxation and variable interest rates

Finally, let us mention two extensions of the baseline model.[20] We first open up the possibility that the (real) return that savers require on reserves and bonds depends on

[20]The interested reader may refer to an earlier working-paper version for a full-fledged treatment of these extensions.

the volume of public liabilities that they must hold. We then posit smooth convex costs of taxation.

**Variable rates.** Consider first an extension in which the interest rate is increasing in the volume of borrowing by the public sector, for example because savers have strictly concave preferences. As $F$ issues more debt to shift from the price-taking level to the Sargent-Wallace level, the marginal cost $\beta^F r - 1$ increases as so does $r$ in this case. This (out-of-equilibrium) increase in the interest rate resulting from an (out-of-equilibrium) increase in debt all the way to the Sargent-Wallace level may make fiscal dominance unpalatable. Such out-of-equilibrium rise in the interest rate implies that, unlike in the baseline model, monetary dominance may prevail even though the interest rate observed in equilibrium is arbitrarily low ($\beta^F r < 1$).

**General cost of taxation and strategic default.** Consider now a convex taxation cost: It costs $c(\tau)$ to $F$ to raise (real) taxes $\tau$, with $c(0) = 0$ and $c(.)$ increasing convex. In this case, monetary dominance always prevails provided the cost of default of the fiscal authority $\alpha_F$ is sufficiently large other things being equal. When the cost of default $\alpha_F$ is large, $F$ must also make the future marginal cost of increasing taxation large to make default credible. This implies that forcing $M$ to chicken out involves issuing debt levels corresponding to potentially much larger future taxes than under monetary dominance. $F$ may find these extra taxes and the associated cost of taxation that come with the Sargent-Wallace debt level too costly ex-ante. This contrasts with the baseline model in which taxes are equal to $\bar{\tau}$ no matter the debt level.

In sum, these extensions confirm the broad insights from the baseline model. They also suggest that the cost of inducing fiscal dominance is in general larger than in the baseline model because setting public debt at a level that induces $M$ to chicken out may come both with an increase in the interest rate and with higher taxes down the road. These effects are shut down in the baseline model for expositional simplicity.

# 5 Concluding remarks

This paper formalizes Wallace's "game of chicken" as a full-fledged model of strategic dynamic interactions between fiscal and monetary authorities, and investors in their liabilities. We find that a monetary authority that lacks both commitment power and fiscal support may still be in the position of imposing its objectives. Monetary dominance prevails when the implementation of the inflationary fiscal expansion envisioned by Sargent and Wallace (1981) is too costly to the fiscal authority. This may in turn occur because, in the absence of commitment power, inflationary fiscal expansion requires a large initial debt issuance. The benefits from future inflation may be smaller than the costs from repaying this debt if the interest on it, or/and taxation costs are sufficiently large.

We believe that our framework opens up many avenues for future research on strategic fiscal and monetary interactions, including in particular the four following ones. First, we posit in this first pass that all public liabilities are perfect substitutes. A natural extension is one in which they provide different liquidity services. Second, we restrict the analysis to a perfect-foresight environment, and a study of shocks is in order. Based on our perfect-foresight analysis, we conjecture that the fiscal authority endogenously amplifies shocks above a certain size by doubling down with a Sargent-Wallace expansion when the fiscal situation becomes sufficiently dire. The prudential management of the central bank's balance sheet in anticipation of these amplified shocks is an interesting question. Third, we focussed on the case in which the agent whose solvency the monetary authority cares about is the government. Yet, we could also consider the case in which such important borrowers belong to the private sector (e.g., financial institutions). The monetary authority would then presumably have to manage a collective moral hazard problem related to that in Farhi and Tirole (2012). The alternative to monetary dominance would in this case be the so-called financial dominance rather than the fiscal one. Fourth, to become potentially more quantitative, our model may be enriched along several additional dimensions, for example with informational or nominal frictions or a richer debt maturity structure.

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# A Online appendix: Infinite-horizon model

This appendix studies an infinite-horizon version of the model in which infinitely-lived fiscal and monetary authorities interact with a private sector populated by overlapping generations of savers each identical to that in the two-date model. The motive behind this OLG modelling choice is to show how, in a dynamically inefficient economy, market forces become a central driver of the price level. To make this point, we show that the key exogenous variables $(\bar{x}, \bar{\tau}, \alpha^M, \alpha^F)$ of the two-date model can be the endogenous consequence of the private sector's strategy in an infinite-horizon dynamically inefficient economy.[1]

## A.1 Setup

Time is discrete and indexed by $t \in \mathbb{N}$.

**Private sector.** At each date $t$, a unit mass of savers are born. They live for two dates and have preferences $c_t + c_{t+1}/r_t$, where $r_t > 0$. They each receive a large endowment of the consumption good at each date. This economy is dynamically inefficient in the sense that the endowment of cohort $t+1$ is at least $r_t$ times that of cohort $t$.[2]

**Public sector.** The public sector is populated by infinitely-lived monetary and fiscal authorities very much identical to that in the two-date model, except that the fiscal one has no taxation power (more on this below). The extensive form of the game at each date $t$ is similar to that of date 0 in the two-date game. We detail it again as follows.

**Date-$t$ market for reserves.** Old savers sell their reserves $R_{t-1}X^H_{t-1} \geq 0$.[3] $M$ announces a gross nominal interest rate $R_t \geq 0$ on reserves between dates $t$ and $t+1$, and posts a demand for reserves $X^M_t \leq R_{t-1}X^H_{t-1}$. Young savers quote a price level $P_t \geq 0$ and a market-clearing demand $X^H_t \geq 0$ such that $X^H_t + X^M_t = R_{t-1}X^H_{t-1}$.

**Date-$t$ bond market.** $F$ posts a demand for one-period nominal bonds $B^F_t \in \mathbb{R}$. The private sector quotes a bond price in terms of reserves $Q_t \geq 0$ at which it is willing to

[1]The costs in case of a soft default, as in Section 3.5 may also be endogenized following the same approach.

[2]For example, the endowment is constant across cohorts and $r_t \leq 1$.

[3]We take $R_{-1}X^H_{-1}$ as exogenously given.

clear the bond market with a demand $B_t^H = -B_t^F$.

**Date-$t$ transfer between $M$ and $F$.** $M$ makes a take-it-or leave-it offer to $F$ for a transfer of goods between them.

**Date-$t$ bond settlement.** The private sector meets its bond repayments if any. If $B_{t-1}^F < 0$, $F$ selects a haircut $l_t \in \{0,1\}$, repaying $-(1-l_t)B_{t-1}^F$.[4]

A date-$t$ strategy profile $\sigma_t = (R_t, X_t^M, P_t, B_t^F, Q_t, l_t)$ describes all the above date-$t$ actions of each agent given all possible history. A strategy profile for the game $\sigma = (\sigma_t)_{t\in\mathbb{N}}$ is the sequence of date-$t$ strategy profiles.

**Objectives of $F$ and $M$.** For all $t \in \mathbb{N}$, the respective date-$t$ objectives of $F$ and $M$ are:

$$U_t^F = \sum_{s\geq t} (\beta^F)^{s-t} v(g_s), \; U_t^M = -\sum_{s\geq t} \left(\beta^M\right)^{s-t} \mid P_s - P_s^M \mid, \tag{A.0}$$

where $g_t$ is $F$'s date-$t$ consumption, and $\beta^F, \beta^M \in (0,1)$. We suppose that there exists $\underline{g} > 0$ such that $v(g) = g$ if $g \geq \underline{g}$ and $v(g) = -\infty$ otherwise, and $P_s^M > 0$ for all $s$.

As in the two-date model, $F$ values spending and is subject to an incompressible level of expenditures $\underline{g}$, whereas $M$ values the price level being on (an exogenously given) target. Unlike in the two-date model, the public authorities incur no exogenous costs of default. We will focus on equilibria in which the private sector's strategy endogenously creates such costs.

Finally, $M$ incurs an arbitrarily large disutility if it consumes strictly negatively, and if two strategies generate the same utility for $M$, it strictly prefers the one that maximizes the utility of $F$.

**Equilibrium concept.** The equilibrium concept is the same as that in the two-date game—subgame perfection with large and small agents:

**Definition 1.** ***(Equilibrium)*** *An equilibrium is a strategy profile $\sigma$ such that:*

1. *Each action by $F$ and $M$ is optimal given history and its beliefs that the future actions are taken according to the strategy profile.*

[4] We posit that $B_{-1}^F = 0$.

*2. Each date-t young saver, taking as given history, $P_t$, and believing that the future actions of $M$, $F$, and the private sector are taken according to the profile, finds it optimal to post an individual demand for reserves equal to the market-clearing quantity $X_t^H$. Similarly, she finds it optimal to post an individual date-t bond demand equal to the market-clearing quantity $B_t^H$ given history, $Q_t$, and the beliefs that future actions by $F$, $M$ and the private sector are taken according to the profile.*

## A.2 Analysis

This infinite-horizon section focuses exclusively on situations, ruled out by a finite horizon, in which public liabilities are self-sustained Ponzi schemes. Accordingly and for analytical simplicity, we deprive the public sector from any resources other than that generated by such schemes. We abstract in particular from taxation. Our main goal is to show that the important exogenous variables of the baseline model can arise as equilibrium objects of this infinite-horizon setting. More precisely, we endogenize the respective real resources $\bar{x}$ and $\bar{\tau}$ of $M$ and $F$ at date 1 and their respective costs of default $\alpha^M$ and $\alpha^F$ as resulting from their continuation utilities in the infinite-horizon game after dates 0 and 1 have been played. Consider thus $\bar{x}, \bar{\tau}, \alpha^M, \alpha^F \geq 0$ that satisfy Assumptions 1 and 2 of the baseline model. We have:

**Proposition 1.** ***(Endogenous payoffs of the baseline model)*** *If $\beta^F r_t \leq 1$ for all $t \geq 1$, there exists an equilibrium $\sigma$ such that date 0 is strategically equivalent to date 0 in the baseline model with parameters $\bar{x}, \bar{\tau}, \alpha^M, \alpha^F \geq 0$ and interest rate $r_0$. In other words, the continuation profiles $(\sigma_t)_{t \geq 2}$ generate the same payoffs as that of the baseline model.*

*Proof.* We prove the proposition in two steps. First, we show that the private sector can impose arbitrary equilibrium sequences of price levels and bond and reserve rollover. Second, we build an equilibrium that has the properties of the proposition by selecting, from the subset of equilibria that we have constructed in the first step, continuation equilibria contingent on $F$'s date-1 default decision.

**Step 1.** *Let* $(P_t^*, X_t^*, B_t^*)_{t\geq 0}$ *such that* $P_t^* > 0$ *for all* $t$, $X_0^* \geq 0$, $X_0^* + B_0^* \geq P_0^* \underline{g} + R_{-1} X_{-1}^H$, *and for all* $t \geq 0$*:*

$$P_t^* X_{t+1}^* = r_t P_{t+1}^* X_t^*, \; B_{t+1}^* = \frac{r_t P_{t+1}^*}{P_t^*} B_t^* + P_{t+1}^* \underline{g}. \tag{A.1}$$

*There exists an equilibrium without default and such that for all* $t \geq 0$, $P_t = P_t^*$, $X_t^H = X_t^*$, *and* $B_t^H = B_t^*$*.*

**Proof.** A simple strategy profile generating this equilibrium path is the following. At each date $t \geq 0$, $M$ announces a rate $R_t = r_t P_{t+1}^* / P_t^*$, and issues $X_t^M = 0$ if $t > 0$ and $X_0^M = R_{-1} X_{-1}^H + X_0^*$. The private sector clears the reserve market at the price level $P_t = P_t^*$ if $M$ has behaved this way until date $t$ included, and $P_t = +\infty$ otherwise. $F$ issues $B_t^F = -B_t^*$. The private sector clears the bond market at $Q_t = P_t^* / (r_t P_{t+1}^*)$ if $F$ has issued this way until date $t$ and $F$ has not defaulted until $t-1$. Otherwise, it does so at $Q_t = 0$. $F$ sets $l_t = 0$ as long as this is compatible with $g_t \geq \underline{g}$, and defaults otherwise.

We now show that this strategy profile corresponds to the claimed equilibrium. First, it is easy to see that if each player acts according to its respective profile, this generates the equilibrium path. Second, we show that each agent finds its action optimal given history and the other profiles. First, $M$ and $F$ both gets utilities equal to $-\infty$ if they deviate from the profile and so they cannot find it optimal. Second, it is optimal for each saver to shun the reserve or/and bond market if $M$ or/and $F$ deviates because this triggers a self-justified burst of the Ponzi scheme on reserves or/and bonds.

**Step 2.** We now construct an equilibrium that has the properties claimed in the proposition. The broad idea is that savers' strategies from date 2 are contingent on date-1 default in a way that generates $(\bar{x}, \bar{\tau}, \alpha^M, \alpha^F)$.

In the absence of date-1 default, the date-2 continuation equilibrium is as in Step 1 with $P_t^* = P_t^M$ for all $t \geq 2$, $X_2^* = \bar{x} r_1 P_2^M$, and $B_2^* = B$, where $B$ is above a lower bound specified below. The only difference with step 1 is that we add the condition that savers from date 2 on treat as default the event that $F$ raised more than a real value $\bar{\tau}$ at date 1. This pins down the (real) date-1 debt capacity of $F$ at $\bar{\tau}$.

In case of date-1 default, the date-2 continuation equilibrium is the date-2 continuation equilibrium as above except that $P_2^* = P_2^M + \alpha^M / \beta^M$, and $B_2^* = (P_2^M + \alpha^M / \beta^M)(B / P_2^M -$

$\alpha^F/\beta^F) \geq (P_2^M + \alpha^M/\beta^M)(\underline{g} + r_1\bar{\tau})$, and this latter inequality puts a lower bound on $B$. Finally, we add again the condition that savers from date 2 on treat as default the event that $F$ raises more than a real value $\bar{\tau}$ at date 1.

This profile from date 2 on implies that $F$ always raises exactly $\bar{\tau}$ in the date-1 bond market, and faces a cost of default in the form of a loss in date-2 resources whose date-1 present value is $\alpha^F$. $M$ faces an inflationary date-2 run on its reserves in case of date-1 default, with a cost $\alpha^M$ viewed from date 1. Overall, $F$, $M$, and savers face the same date-1 payoffs viewed from date 0 as in the baseline model. $\square$

In this simple environment in which all intertemporal trade between private and public sectors takes the form of Ponzi schemes, the private sector can run the show. Its trigger strategies dictate that of monetary and fiscal authorities, as illustrated by this microfoundation for the parameters $\bar{x}, \bar{\tau}, \alpha^M, \alpha^F$ of the two-date model.

In particular, $F$'s ability to induce $M$ to inflate away public liabilities is driven by the extent to which savers run not only on bonds but also on reserves in the event of sovereign default. The monetary authority is willing to preemptively generate itself the inflation that a run on its currency would generate anyway following a credit event. Thus, in an economy in which the private sector can swiftly switch out of the local currency and "dollarize" in case of a debt crisis (high $\alpha^M$), the monetary authority would be eager to prevent such crises by monetizing sovereign debt even if this comes at a sizeable inflation cost. On the polar opposite, if the private sector has an incompressible demand for reserves whose level is not too far below that of the legacy reserves $R_{-1}X_{-1}^H$ (low $\alpha^M$), then the central bank can discourage any fiscal attempt at a Sargent-Wallace expansion. It is credible at doing so because there will be no run on its liabilities in the (out-of-equilibrium) event of a sovereign default.

We find it interesting to fully microfound our baseline model by means of the infinite-horizon one using market-discipline arguments. We offer in particular a simple formalization of the broad idea that a central bank with a pure price-stability mandate may still care about sovereign solvency because default affects the transmission of monetary policy. This is a useful contribution because such an impact of sovereign default on price stability has seldom been modelled to our knowledge. Yet, the study of fiscal and monetary interactions hinges on the assumption that sovereign solvency matters to the monetary authority, albeit often implicitly so as in the pioneering work of Sargent and Wallace.