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Shotgun Wedding: Fiscal and Monetary Policy

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Abstract

This review describes interactions between monetary and fiscal policies that affect equilibrium price levels and interest rates by critically surveying theories about (*a*) optimal anticipated inflation, (*b*) optimal unanticipated inflation, and (*c*) conditions that secure a nominal anchor in the sense of a unique price level path. We contrast incomplete theories whose inputs are budget-feasible sequences of government-issued bonds and money with complete theories whose inputs are bond/money strategies described as sequences of functions that map time t histories into time t government actions. We cite historical episodes that confirm the theoretical insight that lines of authority between a Treasury and a central bank can be ambiguous, obscure, and fragile.

The best way to defend the independence of a central bank is never to exercise it.

Anonymous Federal Reserve official

1. INTRODUCTION

A government's budget forces monetary and fiscal policies to be either coordinated or consolidated. From the point of view of sequences of government IOUs called bonds and money, institutional arrangements that delegate decisions about bonds and money to people who work in different agencies are details. Central bank independence is a convention or a fiction.

Episodes from nineteenth- and early-twentieth-century US monetary/fiscal history illustrate our theme that a government budget does not sharply separate monetary from fiscal policy. When the United States had no central bank before 1914, Secretary of Treasury Leslie M. Shaw leaned against the wind by depositing federal funds in temporarily distressed commercial banks and afterwards returning them to the Independent Treasury vaults where, according to the Independent Treasury Act of 1846, they belonged (see Friedman & Schwartz 1963, chap. 4). Shaw (US Dep. Treas. 1906, p. 49) wrote that "no central bank or government bank in the world can so readily influence financial conditions throughout the world as can the Secretary under the authority with which he is now clothed."[1] Shaw's landmark 1906 Treasury report culminated more than 50 years of extralegal actions by Secretaries of Treasury and compliant Congresses that by 1906 had subverted the 1830s and 1840s Jacksonian intentions to separate US fiscal and monetary activities from all banks, public and private (see Hofstadter 1948, chap. 3; Rothbard 2002, pp. 90–104).

The Independent Treasury Act that governed US cash-management practices from 1846 until the founding of the Federal Reserve in 1914 banned the Secretary of Treasury from depositing federal funds in banks, a rule that had eroded so much by 1906 that Secretary Shaw could write openly about ignoring it. Prospective profits from issuing paper bank notes fueled that erosion process. After Andrew Jackson's Democrats in the 1830s and 1840s had forced the federal government to forgo them, state governments quickly moved to gather some of those profits by chartering state banks that issued low-denomination circulating notes backed by state bonds as collateral. States issued those charters on the condition that the banks would share profits with the state governments. During the Civil War, the US government nationalized those profit-sharing arrangements by imposing a tax that put state banks out of the note-issuing business and by establishing a national banking system whose member banks were authorized to issue National Bank Notes collateralized by a list of federal bonds. With that nationalization and other measures, Congress abandoned the Jacksonian hands-off, hard-money policy and put Congress in charge of day-to-day running of US monetary policy. In 1862, Congress issued an inconvertible currency called the greenback that was made legal tender for almost all debts, public and private, and whose value soon dropped to 40 or 50 cents in terms of the gold dollar that continued to be used for international trade and customs duties. That set off years of Congressional debates about how many greenbacks Congress should issue or withdraw and whether Congress should service interest-bearing federal bonds with gold dollars or depreciated greenbacks. Congress resolved that dispute, though only temporarily as it eventually turned out, when on January 1, 1879 it made greenbacks convertible into gold dollars one for one.

From the Civil War until the founding of the Federal Reserve in 1914, monetary policy gave headaches and heartaches to US Congresses. Congresses authorized various paper monies—greenbacks, silver certificates, National Bank Notes—and, against the background of a declining

[1]In the same report, Shaw asked Congress for even more power: "$100,000,000 to be deposited with banks or withdrawn as he might deem expedient, . . . [and] authority over the reserves of the several banks with power to contract the national-bank circulation at pleasure" (US Dep. Treas. 1906, p. 49).

price level from 1865 to 1896, they confronted political pressures to issue more money and to broaden the collateral behind the National Bank Notes, which had been confined to a list of federal bonds. For example, in 1889 the Farmer's Alliance called for issuing low-denomination Treasury notes in exchange for collateral in the form of farmers' crops that would be stored in government warehouses to be called subtreasuries (see Malin 1944; White 2017, p. 830). Silver producers and inflation proponents advocated coining silver or issuing federal notes collateralized by silver at an exchange rate that, relative to market prices, overvalued silver by a factor of two or three. In his 1906 report, Secretary Shaw lamented that his ability to conduct open-market operations was limited by the accumulated cash (i.e., greenbacks, National Bank Notes, silver certificates, gold coins) that he held in independent Treasury vaults. To relax that constraint, during financial crises clearing houses issued collateralized certificates that temporarily served as cash substitutes. To expand what counted as cash, the 1902 Fowler Bill and other unsuccessful proposals would have authorized banks to issue notes backed by railroad bonds, municipal securities, and other assets. The force behind those proposals eventually led Congress in 1908 to pass the Aldrich-Vreeland Act, which, among other things, authorized the Comptroller of Currency to issue emergency currency collateralized by various types of private securities to coalitions of banks organized in national currency associations. Congress delegated these and other monetary management headaches when in December 1913 it passed the Federal Reserve Act.[2]

In this review we mostly ignore institutional details and focus instead on the arithmetic that binds monetary to fiscal policy.[3] Only when we discuss theories of nominal anchors for a price-level sequence in worlds with only fiat paper money shall we be forced to study how a polity assigns budgets and actions to separate decision makers called a Treasury and a central bank.

Section 2 uses a baseline model to describe how a gold standard secures a nominal anchor, then tells how the addition of a paper currency can improve outcomes but leaves the exchange rate between paper and gold indeterminate. That indeterminacy is our first encounter with difficulties in securing a unique nominal anchor for a paper currency. Section 3 extends our baseline model to include an intertemporal consolidated government budget within which we can study theories of an optimal quantity of money under flexible prices. Here we study normative theories of both anticipated and unanticipated inflation. Section 4 uses irrelevance theorems for open-market operations to frame difficulties in distinguishing between monetary and fiscal policies when considering quantitative easing and to analyze the debate on the relevance of the government budget constraint when the interest rate is smaller than the growth rate of the economy. While Sections 2–4 naturally cast monetary/fiscal policies in terms of sequences of settings of monetary and fiscal policy variables—e.g., government taxes and expenditures, and bonds and money supplies—we must proceed differently when, in Section 5, we study a fiscal theory of the price level in terms of government strategies (i.e., sequences of functions that map time t histories into time t actions) that are sufficient to deliver a unique price-level path and thereby secure a nominal anchor. Section 6 extends our discussion of fiscal theories of nominal anchors by describing how separate budget constraints and strategies can be assigned to a central bank and Treasury. We relate the two-budget analysis to recent manifestations of in-house fiscal policies conducted by central banks in the United States and other countries since the 2007–2008 financial crisis.

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[2] To divorce monetary from fiscal policy, the Federal Reserve Act constrained the Federal Reserve to issue notes and reserves backed only by "real bills"—evidences of low-risk, short-term commercial debts. World War I fiscal exigencies soon led Congress to look the other way when the Federal Reserve's "borrow and buy" for Liberty bonds evaded the real bills restriction.

[3] We also limit our discussion of the closely related fragile line that separates monetary from credit policies.

2. A GOLD STANDARD

A fiscal/monetary authority interacts with a continuum of identical households. Time is discrete and indexed by $t = 0, 1, 2, \ldots$. At the beginning of a period, each household sends one buyer and one seller to distinct decentralized markets where a seller from one household can use his/her labor to produce a single consumption good and a buyer from another household can purchase that consumption good for a perfectly storable asset called cash.[4] After decentralized markets close, a single centralized market opens in which all household members can trade the nonstorable good and labor for cash and interest-bearing assets. We depart from the bilateral bargaining in decentralized markets described by Lagos & Wright (2005) and instead assume that enough participants attend decentralized markets to make them competitive.[5] This renders our setup equivalent to the cash-in-advance model of Lucas & Stokey (1987).[6] Agents are anonymous in decentralized markets, so that trade is possible there only if a medium of exchange called cash is present. Accordingly, we refer to the consumption good exchanged in decentralized markets as the cash good.

After producing and exchanging goods for cash in decentralized markets, households reunite and go to the centralized market where they can use additional labor to produce more of a consumption good that they can also purchase from other households. Then they consume what they have purchased in the two markets they have attended this period. In the centralized market, households interact with a monetary/fiscal authority that can tax, trade, and issue paper currency. In the centralized market, three assets are traded, namely, token money, bonds, and a perfectly durable, costlessly storable object called gold. Following Sargent & Smith (1997), we assume that there is a reversible linear technology that yields ϕ ounces of gold per unit of the consumption good and one unit of consumption from ϕ^{-1} ounces of gold.[7] Gold is costlessly recognizable, making it usable as cash in decentralized trade.[8]

Distinctions between fiscal and monetary policies rest partly on how differences between money and bonds are modeled. We assume that paper money can be used in the decentralized market but bonds cannot.[9] A story that supports this outcome is that bonds can be recognized and traded only in the centralized market. Households cannot hold negative amounts of gold or money, but they can hold negative bonds by borrowing up to an exogenous real bound $\underline{B}$ denominated in units of the consumption good.

Households order consumption and labor streams $\{c_t, x_t, \ell_t\}_{t=0}^{\infty}$ by

$$E_0 \sum_{t=0}^{\infty} \beta^t [u(c_t) + v(x_t) - \ell_t], \qquad 1.$$

where c_t is consumption of the credit good that is traded in the centralized market, x_t is consumption of the cash good that is traded in the decentralized market, and ℓ_t is the sum of labor supplied in decentralized and centralized markets. We assume that u and v are strictly increasing and concave and continuously differentiable. Linearity of utility in labor is not essential

4 We will use "cash" and "money" as synonyms.

5 We assume symmetry across markets so that, while each household cannot consume the good it produces and is required to send its buyer and seller to different markets, equilibrium prices and quantities are the same in all decentralized markets.

6 In discussing interactions between monetary and fiscal policies, it is important to describe precisely how households interact with the government. The Lagos–Wright model is more explicit about this than are many other cash-in-advance models, which is our reason for adopting it here. We refrain from following Bassetto (2002) in completely describing a monetary economy as a game.

7 Barro (1979) and Sargent & Wallace (1983) propose related settings in which adopting a gold standard sets a nominal anchor.

8 We ignore Sargent & Smith's (1997) tax on minting.

9 Record-keeping facilities are not available there, opening a role for gold or paper money.

for our results about monetary and fiscal policies but helps tractability.[10] E_0 denotes a mathematical expectation conditioned on time 0 information. Uncertainty can be about different things in different applications. We introduce uncertainty mostly as stochastic processes for government spending and possibly as an exogenous component of tax revenues. We can also include a sunspot process that has no direct effects on preferences or technologies but only indexes multiple equilibria that emerge purely as shifts in expectations about the nominal price level that are identical across households.

2.1. Gold as Medium of Exchange

Consider a situation in which there are no taxes, government-issued bonds, or government-issued money. To carry out decentralized trade, households can use only gold as cash. In an equilibrium in which the cash good and credit good are both produced and consumed, their prices in terms of gold are equal, and households are indifferent about supplying labor in the decentralized market now in order to earn money for buying the cash good next period or supplying labor in the centralized market to produce the credit good. Let P_t be the common price of both the cash good and the credit good in terms of gold. Since gold can be freely converted from or into the credit good at a rate of ϕ ounces of gold per unit of the consumption good, we must have $P_t = \phi$. A feasible consumption/labor plan satisfies the following conditions.

Condition 1. Let z_{t-1} be gold carried by a household into the decentralized market. Because gold is the only cash, a buyer must start a period with enough gold to purchase the cash goods that the household wants to consume that period.[11] Therefore, we have

$$\phi x_t \leq z_{t-1}. \qquad 2.$$

Condition 2. Let B_{t+1} be nominal bonds purchased by the household in period t, to be repaid in period $t+1$. The payoff of these bonds can depend on time $t+1$ shock realizations. Households trade in (dynamically) complete markets. We will often restrict the government to issue nominally risk-free bonds, in which case all state-contingent claims must be in zero net supply. Let S_{t+1} be the time-t equilibrium one-period stochastic discount factor, so that the value at time t of a portfolio B_{t+1} is $E_t S_{t+1} B_{t+1}$. Then the household budget constraint in the asset market in period 0 is given by

$$B_t + \phi(\ell_t - x_t - c_t) + z_{t-1} \geq z_t + E_t[S_{t+1}B_{t+1}]. \qquad 3.$$

A household starts a period owning maturing nominal bonds and gold carried over from the previous period, earns wages from working in either market, and buys consumption goods. What is not spent on consumption is allocated between gold and (possibly state-contingent) bonds to be carried into the next period.

Condition 3. A no-Ponzi condition ensures that households cannot finance consumption by borrowing each period and forever rolling over maturing debts;[12] that is, we have

$$\lim_{s\to\infty} E_t\left[q_s(B_{s+1} + z_s)\right] \geq 0, \quad t \geq 0, \qquad 4.$$

[10]We also assume that parameter values are such that the nonnegativity constraint on labor never binds.

[11]At the beginning of a period, it is optimal for the household to allocate all of the gold to the buyer since a seller does not need it in a decentralized market.

[12]We express a no-Ponzi condition as the limit of an expectation that must hold almost surely at any time t. For a more complete discussion of the no-Ponzi condition and the resulting transversality condition, the reader is referred to Weitzman (1973) for deterministic problems and Kamihigashi (2003) and Coşar & Green (2016) for stochastic problems. Because we have assumed that disutility is linear in labor, in principle a household could repay any amount of debt by working sufficiently many hours. In our applications, we implicitly assume that there is an upper bound on hours worked that is sufficiently loose to never bind in finite time; its role

where E_t is a mathematical expectation conditional on information available at time t and q_s is the cumulated stochastic discount factor between period 0 and period s:

$$q_0 = 1, \qquad 5.$$

$$q_s = \prod_{t=1}^{s} S_t, \quad s > 0. \qquad 6.$$

Optimal household decisions are characterized by:

- Intratemporal optimality between leisure and credit goods:

$$u'(c_t) = 1; \qquad 7.$$

- Intertemporal optimality via the Euler equation:[13]

$$S_{t+1} \equiv \beta; \qquad 8.$$

- Optimality of cash goods:[14]

$$v'(x_t) = 1/\beta; \qquad 9.$$

- Optimal gold holdings:

$$z_t = \phi x_{t-1}; \qquad 10.$$

- The budget constraint (Equation 3) and the transversality condition (Equation 4) must hold as equalities.

Households are indifferent about when they work, so a household's bond position is indeterminate. In the aggregate, bonds are in zero net supply, and therefore in a symmetric equilibrium $B_t = 0$. The labor supply is determined as a residual either from the household budget constraint or from the production function.[15] The use of gold as cash fixes the price level over time and thus provides a nominal anchor.[16]

2.2. More Efficient Equilibria

The equilibrium of Section 2.1 anchors the nominal price level at the social cost of requiring households to carry gold as cash. In our reference model, households hold gold not because it gives them utility directly (see Equation 1) but because trading arrangements give gold utility indirectly by enabling decentralized trade. More efficient equilibria exist if it is feasible to replace gold as

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is to imply that a strategy of rolling over debt indefinitely would eventually make it impossible to repay the accumulated balance.

[13] Utility is linear in leisure and the price level is constant over time, so the stochastic discount factor is constant over time.

[14] Time 0 is special, as the household may inherit an exogenous level of gold that does not correspond to Equations 9 and 10. For that period, we have $v'(x_0) = \max\{1, v'(z_{-1}/\phi)\}$, and the cash-in-advance constraint may be slack.

[15] These yield the same solution by Walras's law.

[16] We have fixed the relative price of gold and goods by setting the linear technology parameter ϕ to be a constant. In practice, a gold standard imperfectly stabilizes the price level, as analyzed, for example, by Cogley & Sargent (2015). We could capture such observed outcomes mechanically by letting ϕ vary over time either predictably or unpredictably.

cash with a costlessly produced paper money whose supply can be limited by society. Then paper money can be used as cash, and all gold can be converted into the consumption good. Adopting the paper dollar as the unit in which prices are denominated, the household budget constraint now becomes

$$B_t + P_t(\ell_t - x_t) \geq M_t - M_{t-1} + \frac{(z_t - z_{t-1})P_t}{\phi} + P_t c_t + E_t[B_{t+1}S_{t+1}] + T_t, \qquad 11.$$

where T_t are nominal taxes or transfers (if negative) from the government. As a simple first experiment, assume that the government distributes to each household M_0 paper dollars before the start of period 0, after which no subsequent transactions occur between government and households, so that $T_0 = -M_0$ and $T_t = 0$ in all subsequent periods. In period 0, we have that $B_0 = M_{-1} = 0$, and $z_{-1} > 0$ is exogenously given, as before.[17] The cash-in-advance constraint and the no-Ponzi condition now include paper money:

$$M_{t-1} + \frac{P_t}{\phi} z_{t-1} \geq P_t x_t, \qquad 12.$$

$$\lim_{s\to\infty} E_t\left[q_{s+1}\left(B_{s+1} + \frac{z_s P_{s+1}}{\phi} + M_s\right)\right] \geq 0. \qquad 13.$$

There exists a paper-money-only equilibrium in which Equations 7–9 are satisfied and $z_t = 0$ and $M_t/P_t = x_t$ for $t \geq 0$. In this equilibrium, consumption is the same as in the economy with only gold as cash, but households use only paper money to trade. They convert all of their gold into the consumption good at the start of period zero. That increases their utility by reducing their labor supply at $t = 0$.[18]

However, once the nominal anchor provided by gold is weakened or removed, many other types of equilibria exist. Paper money and gold may coexist as cash while the value of total cash in terms of consumption goods equals its value in the cash-must-be-gold equilibrium. In a stochastic environment, the price level (the inverse of the value of money) may fluctuate over time in response to sunspots. In such equilibria, the logic that underlies Kareken & Wallace's (1981) exchange rate indeterminacy finding renders the initial value of money indeterminate.[19] The original cash-must-be-gold equilibrium also survives: If households expect paper money to be worthless tomorrow, they will accept only gold as cash today.[20] In pure paper money equilibria in which $z_t = 0$, equilibria other than the steady state described above can emerge. Before we return to the question of uniqueness and nominal anchors in Section 5, we explore the implications of paper money for the government budget and for equilibrium.

We have assumed that the government simply gives the entire money stock to the representative household. There are various alternative ways for a government to spend paper money, many of which have been studied by monetary theorists and tried in practice. A government can sell

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[17]This experiment sheds light on the end of the Hungarian hyperinflation after World War II described by Paal (2000). Hyperinflation drove real money balances nearly to zero. The government reformed fiscal/monetary policy so that it would no longer print currency to finance government expenditures. To supply new currency, the central bank extended loans to favored clients. Many of these loans were not repaid, so that the central bank remonetized the Hungarian economy partly by gift giving.

[18]Households reap all of the benefit in the form of leisure in period zero because we assumed linear preferences in leisure. In a richer model, the real interest rate would change, consumption in period zero would increase, and, depending on parameter values, the benefit could be spread over multiple periods.

[19]The evolution of the price level is also indeterminate, but we know that it must be a submartingale.

[20]To represent this no-value equilibrium would require adjusting our notation, because money cannot be taken as the numeraire when it is worthless.

paper money to households in exchange for either goods or private-sector IOUs that the government can later use to finance government purchases. Furthermore, economic fundamentals do not require a government to issue the paper currency. Instead, a private bank could do that.

3. GOVERNMENT BUDGET AND OPTIMAL INFLATION

In Section 2.2, we posited that the government acts only at time 0, when it distributes fiat money. We now consider what happens when the government and private households both act repeatedly. In this case, interactions between monetary and fiscal policy actions over time become more complicated. To simplify (and modernize), we drop gold from the analysis and also assume that the government is a monopoly provider of money.[21]

The evolution of the government budget is thus given by

$$B_t^g + P_t g_t + M_{t-1}^g \leq T_t + M_t^g + E_t S_{t+1} B_{t+1}^g. \tag{14}$$

In Equation 14, B_t^g are bonds issued by the government (i.e., liabilities on the government accounts) and g_t is government spending in goods (purchased in the centralized market). Initial holdings of money and bonds are exogenous and must satisfy the consistency conditions $B_0^g = B_0$ and $M_{-1}^g = M_{-1}$.

Market clearing requires

$$c_t + x_t + g_t = \ell_t,$$

$$B_t^g = B_t,$$

and

$$M_t^g = M_t.$$

Whether the government is also subject to a no-Ponzi condition that constrains monetary/fiscal policy sequences or whether this condition prevails only in equilibrium as a consequence of households' transversality conditions hinges on how monetary and fiscal policies are assumed to be conducted. Thus, it matters whether the Treasury and the central bank together freely print money to service maturing bonds, or whether the paper money supply is rigidly set independently of households' preferences about rolling over their portfolios of government bonds. It also matters whether the government runs permanent primary surpluses or there are times in which public spending temporarily exceeds tax revenues, so that, in addition to rolling over preexisting claims, bonds are issued to cover temporary revenue shortfalls. Different authors use the distinct terms "government budget constraint" or "government debt valuation equation" (see Cochrane 2018) to refer to the same equation, using labels that occur in formulations of the fiscal theory of the price level that we shall discuss in Section 5. Here we sidestep the naming issue and simply refer to the government budget balance, which holds in any sequence of allocations, prices, and policies that constitute a competitive equilibrium.

[21] When used as cash, gold puts a lower bound on the return of money, limiting a government's ability to pursue inflationary policies. Governments intent on pursuing high-inflation policies have circumvented this constraint by imposing legal restrictions that make it costly to hold gold or to use it for trades. Edwards (2018) describes and interprets actions taken by the US Roosevelt administration in the 1930s to raise the US price level. Sargent & Velde (1995) describe draconian restrictions that the Jacobins imposed during the 1794 Terror in France to lower the price level.

Compared to the previous case of a commodity-backed standard, household optimality conditions still require Equation 7 to hold but are otherwise modified to allow prices to vary over time:

$$S_{t+1} = \beta \frac{P_t}{P_{t+1}}, \quad 15.$$

$$1 = \beta E_t \left[\frac{P_t}{P_{t+1}} v'(x_{t+1}) \right], \quad 16.$$

$$M_{t-1} \geq P_t x_t, \quad 17.$$

and

$$\lim_{s\to\infty} E_t \left[q_s \left(B_s + M_{s-1} \right) \right] = 0, \quad t \geq 0. \quad 18.$$

Next, we sum the household budget constraint forward and substitute market clearing and household optimality conditions. For convenience, we also define the (gross) risk-free nominal interest rate between periods t and $t+1$ to be $R_t := (E_t S_{t+1})^{-1}$. We obtain a key equation that links monetary and fiscal policy actions:

$$\frac{B_t + M_{t-1}}{P_t} = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[\frac{T_s}{P_s} - g_s + \frac{M_s}{P_s} \left(1 - \frac{1}{R_s} \right) \right]. \quad 19.$$

Another representation of Equation 19 is

$$\frac{B_t}{P_t} = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[\frac{T_s}{P_s} - g_s + \frac{M_s - M_{s-1}}{P_s} \right]. \quad 20.$$

In both versions (Equations 19 and 20), at every time t the present value of the government liabilities must equal the present value of primary surpluses $\frac{T_s}{P_s} - g_s$ augmented by revenues from seigniorage, defined as revenues that the government raises by issuing paper money that bears a net nominal interest rate of zero.

3.1. Seigniorage

The representations in Equations 19 and 20 express seigniorage—that is, government revenues from printing money—in different ways. Equation 19 emphasizes that money is a government liability, a standard accounting practice in many countries today;[22] the fact that paper money pays zero interest leads to recording positive seigniorage earnings on real money balances when $R_s > 1$, so that the net nominal interest rate exceeds zero. In contrast, Equation 20 implicitly treats only interest-bearing government bonds as government liabilities and treats new issues of fiat money as seigniorage. Notice that the accounting scheme based on Equation 20 records seigniorage as being negative when a government reduces its paper money supply.

Equations 19 and 20 tie together equilibrium sequences of taxes, government spending, interest-bearing debt, and paper money. In models with a single government decision maker, giving names to separate monetary and fiscal policy decisions is arbitrary and without consequence. A

[22]In practice, money is usually a liability of the central bank, which is a distinct entity from the Treasury, and seigniorage profits are a transfer from the central bank to the Treasury. We will return to this point in Section 6.

distinction between monetary and fiscal policies comes to life only when we assign decisions about particular actions exclusively to either a Treasury or a central bank, as we do in Sections 5 and 6.

A stochastic process for inflation interacts with the government budget in distinct ways: (*a*) An anticipated part of inflation acts as a tax rate on real money balances, and (*b*) an unanticipated part of inflation (i.e., an innovation in inflation) revalues the entire stock of nominal government liabilities (fiat money plus nominal interest-bearing debt).

3.2. Anticipated Inflation

To study anticipated inflation, we shut down uncertainty. Define $\pi_{t+1} := P_{t+1}/P_t$ to be the gross inflation rate between periods $t+1$ and t. Equilibrium conditions imply that seigniorage revenues $L(\pi_{t+1})$ satisfy[23]

$$L(\pi_{t+1}) := \frac{M_s}{P_s}\left(1-\frac{1}{R_s}\right) = v'^{-1}\left(\frac{\pi_{s+1}}{\beta}\right)\left(1-\frac{\pi_{s+1}}{\beta}\right). \qquad 21.$$

Equation 21 states that in equilibrium, seigniorage revenues from one-period inflation anticipated in period s can be represented as a function of anticipated inflation that is unambiguously increasing when inflation is negative or in a neighborhood of zero inflation. At higher inflation rates, countervailing forces contend: Higher inflation increases revenues directly but decreases them indirectly by depressing households' demand for real money balances. In settings where government-issued money competes with imperfect substitutes issued by other borrowers, the second force is likely to dominate at higher levels of inflation, implying that there is a maximum amount of revenues that can be raised each period.[24] To keep things simple, we assume that preferences are such that L is strictly increasing up to some inflation $\pi_{\max}$ and strictly decreasing afterwards.

A manifold of equilibria share the same sequence of real primary deficits/surpluses $\{\frac{T_s}{P_s} - g_s\}_{s=0}^{\infty}$ and the same time-0 real government obligations $(B_0^g + M_{-1}^g)/P_0$. If we consider only equilibria in which inflation stays in the range in which the function L is increasing, then Equations 19 and 21 imply that all equilibria in the manifold share the same present value of revenues from seigniorage:

$$\bar{L} \equiv \sum_{s=0}^{\infty} \beta^s L(\pi_s). \qquad 22.$$

The invariant object defined in Equation 22 provides a concise representation of Sargent & Wallace's (1981) unpleasant monetarist arithmetic. Given initial real liabilities and a fixed profile of real primary deficits/surpluses, a lower inflation rate in some period t must necessarily be compensated by higher inflation in some other period t' in order to keep the present value of seigniorage revenues constant. Associated with Equation 22 is a natural notion of an intertemporal average of future inflation rates, in particular, the constant $\bar{\pi}$ that satisfies[25]

$$\bar{L} \equiv \sum_{s=0}^{\infty} \beta^s L(\bar{\pi}), \qquad 23.$$

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[23] Note that this is true even when $R_s = 1$, so that the cash-in-advance constraint may not be binding and real money balances are not uniquely defined in equilibrium: In this case, the argument of v'^{-1} may not correctly represent real money balances, but the second factor is zero anyway.

[24] As an example, in the case of Section 2.2, gold is perfectly durable and a perfect substitute for government-issued paper, and the demand for money drops to zero as soon as $P_{t+1} > P_t$.

[25] If there exists an equilibrium that raises $\bar{L}$, our assumptions about preferences imply that $\bar{\pi}$ exists and is unique.

which is the Chisini (1929) mean of the sum in Equation 22. According to Equation 23, Chisini mean inflation is uniquely pinned down by initial debt and prospective primary government surpluses.[26] If we assume an exogenous and fixed sequence of primary surpluses, then Chisini mean inflation is determined by fiscal policy, and monetary policy determines only the distribution of inflation over time. Notice how this analysis takes exogenous sequences of fiscal actions as given and does not model how they have been chosen. The analysis simply derives implications from the budget equations that link monetary and fiscal policy action sequences together with the inequalities describing private agents' optimal decisions that determine an equilibrium allocation and price system.

A second and equally valid use of the very same equilibrium conditions would instead take the sequence of gross inflation rates $\{\pi_t\}_{t=0}^{\infty}$ to be given exogenously, find the implied $\bar{L}$ from Equation 22, and deduce a required present value of taxes net of spending from Equation 19. In this second interpretation monetary policy goes first, and fiscal policy then adjusts.

These two uses of the same equilibrium conditions delineate an irreconcilable hypothetical conflict between a fiscal authority intent on reducing taxes and a monetary authority intent on reining in inflation. Thus, in our first scenario, a monetary authority is forced to adjust to choices made first (and once and for all) by a fiscal authority. The second interpretation instead envisions a monetary authority as choosing first, forcing the fiscal authority then to adjust. Sargent (1986) refers to this as "Wallace's game of chicken."[27]

While perhaps helping us to make sense of contending forces that break loose during big inflations, the hostile relationship between monetary and fiscal policy envisioned in a game of chicken differs markedly from the well-aligned monetary and fiscal policies embedded in an optimal taxation theory in which coordinated monetary/fiscal policy actions implement a Friedman rule that drives the net nominal interest rate to zero. In the context of our reference model, optimality of a Friedman rule follows immediately because we assumed that the government can impose lump-sum taxes. When $R_t > 0$, competitive equilibria are distorted, since the marginal rate of substitution in preferences between cash goods and leisure exceeds the marginal rate of transformation in production, which equals 1 in our model. There exist monetary/fiscal policies consistent with an equilibrium that undo this distortion and render the equilibrium allocation efficient by setting $R_t = 0$ and hence $P_{t+1}/P_t = \beta$. Under a policy that supports that outcome, Equation 19 then requires that the present value of taxes must equal the value of initial money and debt plus the present value of government spending. To deliver the required deflation, the government taxes the households and uses the proceeds to retire money over time.[28]

The Friedman rule remains optimal in some economies in which lump-sum taxes are not available. As an example, if we replaced lump-sum taxes with proportional taxes on labor income, the results described by Chari et al. (1991) imply that the Friedman rule is optimal in our simple model whenever u and v exhibit constant and equal relative risk aversions.[29] This follows from the uniform commodity taxation result found by Atkinson & Stiglitz (1972): With homothetic preferences between cash and credit goods, it is optimal to tax both goods at the same rate. To do

[26]Here we take initial real government liabilities $(B_0 + M_{-1})/P_0$ as exogenous. We discuss the role of initial inflation in Section 3.3.

[27]For recent formalizations of the game of chicken, the reader is referred to Barthélemy & Plantin (2018) and Camous & Matveev (2020).

[28]Cole & Kocherlakota (1998) emphasize that a government has wide latitude in choosing a path of repurchases, because when $R_t = 0$ the cash-in-advance constraint does not bind, so households are happy to hold excess money balances as a good savings vehicle.

[29]The rule is optimal if the constant relative risk aversion of v is lower than that for u. In this case, it would be optimal for the government to tax cash goods less than credit goods, but this cannot be achieved when the only instrument available is the inflation tax.

this, the production of both goods must be distorted by the same labor tax. Adopting the Friedman rule equates the unit marginal rate of substitution between cash and credit goods to the marginal rate of transformation in production. Da Costa & Werning (2008) extend Chari and colleagues' result to allow for nonlinear income taxes.[30]

Up to now, we have distinguished sharply between bonds that are held purely as stores of value and money that also serves as a means of payment. However, Treasury bonds can also serve as transactions vehicles, as became especially apparent after the financial crisis of 2008. Interest rates on Treasury bonds are below the rates on bank reserves (and below zero rates of return on cash) in a number of countries today. It would be straightforward to extend our reference model to account for such a situation. We could add two types of anonymous transactions: one in which central-bank money (currency) is required, and another in which Treasury bonds can be used, leaving private bonds in zero net supply as a residual category that can be held as a pure store of value. In this situation, the wedge between the interest on private and on government debt (beyond the part that is driven by risk) is another source of seigniorage revenues for the Treasury.[31] Since in most countries government debt is much higher than the monetary base, this second source of seigniorage can also be bigger.[32]

3.3. Surprise Inflations

Having discussed the role of expected inflation in Equation 19, we now study inflation surprises. Here we are concerned with responses of inflation to unanticipated shocks to government spending or tax revenues. Suppose that the government issues only nominally risk-free debt, so that B_t is predetermined and known at time $t-1$. Then, Equation 19 implies that

$$(B_t + M_{t-1})\left(\frac{1}{P_t} - E_{t-1}\frac{1}{P_t}\right)$$
$$= E_t \sum_{s=t}^{\infty} \beta^{s-t}\left[\frac{T_s}{P_s} - g_s + \frac{M_s}{P_s}\left(1 - \frac{1}{R_s}\right)\right] - E_{t-1}\sum_{s=t}^{\infty}\beta^{s-t}\left[\frac{T_s}{P_s} - g_s + \frac{M_s}{P_s}\left(1-\frac{1}{R_s}\right)\right]. \quad 24.$$

Equation 24 links surprises in future government surpluses, inclusive of seigniorage revenues, to surprises in inflation. In response to an adverse fiscal shock—for example, a war that reduces anticipated future real tax collections relative to prospective government expenditures—fiscal balance can be restored in one of three ways:[33]

1. Taxes and spending can be adjusted to restore the present value of net-of-interest government surpluses $\frac{T_s}{P_s} - g_s$ to its initial value;
2. Future seigniorage revenues can be increased by raising prospective inflation rates; or

[30] To break this result, Albanesi (2007) explores a model in which cash goods are disproportionately purchased by low-income households, and inflation arises from the conflict among heterogeneous households. In her paper, low-wage households prefer greater reliance on labor taxes, while high-wage earners favor the inflation tax.

[31] van Binsbergen et al. (2019) estimate this wedge to be 40 basis points (see also Lagos 2010).

[32] Notwithstanding many discussions about the demise of cash, currency in circulation in the United States is almost 8% of GDP, still as high as it has been since the early 1950s.

[33] Our discussion of inflation as a shock absorber mirrors the one by Sims (2001). Building on work by Aiyagari et al. (2002), Sargent (2001) draws connections between precautionary saving in models with limited idiosyncratic insurance and tax smoothing when full insurance through inflation or state-contingent debt is impossible.

3. The price level can be allowed to jump immediately in order to lower the value of liabilities previously issued by the government.

When lump-sum taxes are available as they are in the model above, the first option is optimal. However, when the government can levy only distorting taxes on labor supplied, a result of Chari et al. (1991) shows that it is optimal to use inflation as the primary shock absorber. Unanticipated inflation turns out to be an excellent way of insuring the government against unfavorable fiscal shocks. Because the timing assumptions about cash holdings made by Chari and colleagues as well as by Lucas & Stokey (1983, 1987) allow households to readjust their cash after observing the shock, unexpected inflation is not distortionary. Therefore, volatility of unexpected inflation has no direct adverse welfare consequences. In contrast, our reference model adopts Svensson's (1985) timing assumption that makes cash holdings predetermined relative to the arrival of the fiscal shock. This makes unanticipated inflation depress consumption of cash goods via the constraint in Equation 17 and diminishes the reliance of optimal policy on unanticipated inflation.[34] An alternative way to introduce costs from unexpected inflation is to assume sticky prices, an avenue first pursued in this context by Siu (2004) and Schmitt-Grohe & Uribe (2004).

Equation 24 opens the door to a hedging theory of an optimal level of government debt that activates a new avenue by which fiscal and monetary policies interact. Thus, let the government spending process $\{g_s\}_{s=0}^{\infty}$ be given. Break taxes into two parts, an exogenous real component represented by the stochastic process $\{\tau_s\}_{s=0}^{\infty}$ and a residual component $\{T_t/P_t - \tau_t\}_{t=0}^{\infty}$ that the government adjusts to ensure that Equation 19 is always satisfied. Also take as given the stochastic process of inflation. We can then rewrite Equation 24 as

$$\begin{aligned}\frac{B_t + M_{t-1}}{P_{t-1}}\left(\frac{1}{\pi_t} - E_{t-1}\frac{1}{\pi_t}\right) = {} & \mathrm{PV}_t(\tau) - E_{t-1}[\mathrm{PV}_t(\tau)] + \mathrm{PV}_t(T/P - \tau) \\ & - E_{t-1}[\mathrm{PV}_t(T/P - \tau)] + \mathrm{PV}_t(g) - E_{t-1}[\mathrm{PV}_t(g)], \end{aligned} \qquad 25.$$

where PV represents a present-value operator that for our economy with quasilinear preferences is

$$\mathrm{PV}_t(g) := E_t \sum_{s=t}^{\infty} \beta^{s-t} g_s,$$

and similarly for the other stochastic processes. We can compute that the level of government liabilities to be issued at $t-1$ that minimizes the conditional variance of the residual component of taxes is

$$\frac{B_t + M_{t-1}}{P_{t-1}} = \frac{\mathrm{Cov}_{t-1}\left(\pi_t^{-1}, \mathrm{PV}_t(\tau - g)\right)}{\mathrm{Var}_{t-1}(\pi_t^{-1})} = \mathrm{Corr}_{t-1}\left(\pi_t^{-1}, \mathrm{PV}_t(\tau - g)\right)\sqrt{\frac{\mathrm{Var}_{t-1}(\mathrm{PV}_t(\tau - g))}{\mathrm{Var}_{t-1}(\pi_t^{-1})}}, \qquad 26.$$

an equation that summarizes the responses to hedging motives implied by the object being minimized. If inflation and the present value of the exogenous component of surpluses are negatively correlated [that is, if $\mathrm{Corr}_{t-1}(\pi_t^{-1}, \mathrm{PV}_t(\tau - g)) > 0$], then the quantity of government debt that achieves the best hedge is larger (*a*) the more correlated are inflation and the present value of the surplus, (*b*) the more variable is the exogenous component of the surplus, and (*c*) the smaller is the volatility of inflation.

[34]The Svensson timing has been used to guarantee existence of an interior solution in models in which optimal government policy is subject to time inconsistency and to moderate a temptation to default ex post on all nominal liabilities (see Albanesi et al. 2003).

In our reference model, setting nominal liabilities at the optimal hedging solution of Equation 26 is not urgent, because taxes are lump sum and can be adjusted at no cost. However, in a model with only distorting labor taxes, Bhandari et al. (2016) show that an optimal fiscal policy eventually drives government debt to the value shown in Equation 26. Their result reflects the balancing of two forces. First, the fact that labor tax distortions are typically convex in the tax rate creates a reason to use debt to hedge fiscal risks.[35] Second, as in work by Lucas & Stokey (1983), debt would remain constant in the absence of shocks. The envelope condition then implies that the cost of deviating from a constant path and tilting it slightly is of second order. In the presence of shocks, the hedging benefits of moving debt slowly toward the optimal hedging value more than compensate for the losses from deviating from a constant tax rate.[36]

The next step is to consider both inflation and tax rates as jointly determined. Two aspects of this problem are worth further consideration.[37]

1. If unanticipated inflation is costly, there is a reason to limit the conditional variability of inflation. However, from Equation 26, we know that hedging fiscal risk then requires higher values of debt. Depending on the initial value, this may require more costly deviations from tax smoothing. It might also imply that a level of debt that achieves an optimal hedge is above the peak of the Laffer curve.[38]
2. The more correlated are inflation and government fiscal needs, the better nominal debt is as a hedge. Forces ignored by our model would reduce this correlation, including shocks beyond government control that buffet nominal variables. Such shocks would have important implications for the joint conduct of monetary and fiscal policy.

Since our model includes just short-term debt, only an unanticipated jump in the price level has any effect on the real value of debt. With long-term debt, ongoing inflation depreciates the real value of future promised repayments, as discussed for instance by Cochrane (2001) and Sims (2013). This would allow spreading the costs of inflation over a longer time span; but even with long-term debt, it is only the arrival of inflation surprises after debt has been issued that affects the government budget constraint.[39]

Berndt et al. (2012) assess the fiscal hedging delivered by government debt in the United States after World War II. They find that innovations in defense spending were mostly absorbed by future increases in taxes, but about 10% of them were absorbed by abnormally low returns on government debt. Hall & Sargent (2014) infer that during the eighteenth and nineteenth centuries the federal government of the United States earned a reputation for repaying its debts in gold and did not often use state-contingent inflation as a major hedge against its fiscal needs.[40] An

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[35] We can interpret the exogenous component τ_t as the revenues associated with a constant tax rate.

[36] Bhandari et al. (2016) study a real economy in which the state-contingent payoff of debt one period ahead is exogenously given. This corresponds to our assumption of exogenous inflation, since we have assumed that debt is nominally risk free.

[37] The first consideration below implicitly appeared in Siu's (2004) analysis, but he did not analyze the asymptotic level of debt in depth. Bhandari et al. (2018) analyze economies in which distortionary taxes are desirable for social insurance purposes; since they allow for lump-sum taxes, a representative-agent version of their economy does not feature a need for the government to hedge fiscal risk.

[38] Bhandari et al. (2016) do not characterize the solution for this case. Since they consider cases in which the real payoff of debt is exogenous, they simply assume it to be such that the optimal hedging value is interior.

[39] An empirical analysis of the degree by which inflation surprises would affect the balance sheet of the federal government in the United States is undertaken by Hilscher et al. (2014).

[40] It is worth noting that convertibility of greenbacks into gold was suspended at critical junctures, and that the United States did not lose any of the wars in which it was engaged; it is thus possible that the states of nature in which the hedge would have been exercised did not materialize.

interesting aspect of the analysis of Berndt and colleagues is that low returns on government debt were realized in the years that followed the shocks, contrary to the theory described above, which stresses a contemporaneous correlation. This is consistent with the argument made by Reinhart & Sbrancia (2015) that debt erosion after World War II occurred primarily through financial repressions that delivered low real interest rates. This finding is confirmed by Hall & Sargent's (2011) decomposition of the evolution of US federal debt after World War II.

4. MODIGLIANI–MILLER LOGIC IN MONETARY ECONOMIES

Since both of these financial claims have the same zero nominal net rate of return at the Friedman rule, households regard money and nominally risk-free bonds as perfect substitutes. When real money balances exceed the satiation level $v'^{-1}(1)$, open-market operations that swap money for bonds do not affect equilibrium consumption, leisure, or prices. Thus, starting from an equilibrium in which $R_t = 1$, an increase in money balances M_t^g by ΔM and a corresponding reduction in nominal bond issuance B_{t+1} by the same (uncontingent) amount ΔM affect neither household nor government budget constraints (Equations 11, 14, and 18). Furthermore, the cash-in-advance constraint (Equation 12) is slack when $R_t = 1$ and continues to be satisfied if households accept the extra money injected by the policy maker. With no change in asset or goods prices, a household's optimal choice of sequences of consumption and labor also remains the same. It follows that the consumption-leisure allocation, the asset-pricing kernel, and the nominal price sequence $\{P_t\}$ that formed the original equilibrium remain an equilibrium after the open-market operation.

Such irrelevance results obscure the lines between monetary and fiscal policies: The classical tool of monetary policy, open-market operations, has no effects, and the price level is governed exclusively by the present value of primary surpluses, an object typically viewed as being determined by fiscal policy. Wallace (1981b) and Chamley & Polemarchakis (1984) show that open-market operations are irrelevant in many settings in which money is held purely as a store of value and provides no special transaction services. A tell-tale sign that an irrelevance theorem is at work is that money is not dominated in rate of return by other stores of value. Examples of such settings include ones in which a monetary/fiscal policy implements the Friedman rule.

Irrelevance theorems extend to operations in which the government does not simply swap one risk-free nominal liability for another one but instead issues money to buy state-contingent securities. For example, in our reference model, starting from a competitive equilibrium in which the Friedman rule applies, let the government issue money ΔM in period t and buy an arbitrary portfolio of state-contingent bonds ΔB_{t+1} of equal value at asset prices prevailing in the original equilibrium:[41]

$$\Delta M_t = -E_t[S_{t+1}\Delta B_{t+1}].$$

As of time $t+1$, this open-market operation yields profits $\Delta M_t - \Delta B_{t+1}$. If the government distributes these profits by adjusting lump-sum taxes in period $t+1$ by $\Delta T_{t+1} = \Delta B_{t+1} - \Delta M_t$, government and household budget sets remain unchanged at the original sequence of goods and asset prices, so the original equilibrium allocation continues to form a competitive equilibrium at those prices. Wallace (1981b) connects this result to the Modigliani–Miller neutrality theorem in corporate finance: The government resembles a corporation that issues nominal claims (money)

[41]Our convention is that B_{t+1} is a liability for the government, so a purchase of assets implies that $E_t[S_{t+1}\Delta B_{t+1}] < 0$.

in order to acquire new assets (state-contingent securities) at market prices and then increases its future dividends (reductions in lump-sum taxes) by the payouts from these purchased assets, an operation that has no effects on the firm's total net present value.[42] Chamley & Polemarchakis (1984) consider another purchase that leaves taxes fixed and instead makes the net present value of surpluses change by the amount $\Delta M_t - \Delta B_{t+1}$ at time $t + 1$ and lets prices jump just enough to restore Equation 19.

A general lesson from irrelevance theorems is that alterations in the central bank's balance sheet that indicate the same open-market exchange can be associated with markedly different equilibrium outcomes, depending on the subsequent fiscal policy adjustments triggered by that exchange.[43]

So far, we have associated the Friedman rule with a zero nominal interest rate in models in which the nominal interest rate is the relevant cost of holding cash. However, the last decade has witnessed large increases in fractions of the monetary base being held as bank reserves that sometimes pay interest. We can easily adjust our reference model to let money pay a nominal interest rate $\tilde{R}_t$. A Friedman rule then calls for supplying sufficient real balances to eradicate any gap between rates of return on money and debt so that $\tilde{R}_t = R_t$.[44] An irrelevance result under this more general Friedman rule provides a useful tool for understanding the quantitative easing of the last decade. Under such an interest-on-reserves Friedman rule, quantitative easing will have real effects only if frictions in addition to those underlying a cash-in-advance constraint are present. Indeed, in this spirit, recall that Wallace (1981b) mentioned having some agents be credit constrained as a way to overturn his Modigliani–Miller theorem for open-market operations.

Various devices have been used to disarm the irrelevance of open-market operations. A common approach recently has been to assume that heterogeneous households trade financial assets with each other as well as with the government. Cúrdia & Woodford (2011) require all private transactions to go through intermediaries that bear a cost to transfer funds from savers to borrowers. Gertler & Kiyotaki (2010) and Gertler & Karadi (2013) introduce agency costs that limit intermediaries' sizes. Cui & Sterk (2018) follow Kaplan & Violante (2014) by assuming that households are subject to idiosyncratic shocks and that they face costs when rebalancing their portfolios between liquid assets (in our case, money) and illiquid assets (bonds). In all of these settings, open-market operations that swap money for bonds relax some agents' credit constraints. This affects their consumption decisions and thereby sets off other general-equilibrium effects. But even in such settings, the line between monetary and fiscal policy is still tenuous. Sargent & Smith (1987) show that even when some agents' asset holdings are constrained, open-market operations can be neutral when type-dependent fiscal transfers are made. To reinstate the irrelevance of open-market operations, they adjust the timing and amounts of type-specific transfers so that the budget-feasible set of each type of agent remains unchanged at the preintervention prices when the mix of government-issued assets is altered. With such a policy, private agents' original choices

[42] In the case of the government, the net present value is the present value of future primary surpluses, which is unchanged in this experiment as of time t, since, at the Friedman rule, $E_t[S_{t+1}(\Delta M_t - \Delta B_{t+1})] = 0$.

[43] In assessing their macroeconomic impact, Bhattarai et al. (2015) emphasize the signaling role of quantitative easing policies.

[44] Without uncertainty, Equation 15 implies $P_{t+1}/P_t = \beta R_t$. By setting $\tilde{R}_t = R_t > 0$, a monetary authority can decouple the Friedman rule prescription from a requirement to generate a deflation. Doing that would be desirable in models with nominal frictions that make deflations costly, or in new Keynesian models where a zero lower bound on nominal interest rates prevents the implementation of an optimal policy. These observations are relevant for assessing papers that have argued that persistently low-interest-rate policies are responsible for the inflation recently undershooting central banks' targets in many developed countries; Williamson (2019) reviews the argument.

remain optimal after the open-market operation, so no general-equilibrium effects are triggered. Thus, even when enough of these frictions are present to render open-market operations relevant, the boundary between monetary and fiscal policies remains fuzzy: Open-market exchanges by the central bank can be regarded as having real effects only when they serve as substitutes for alternative fiscal actions.[45]

Williamson (2012) analyzes open-market operations in a model in which both money and bonds have transaction roles.[46] In this context, open-market operations affect relative scarcities of the two payment instruments. To implement a Friedman rule, the real values of money and bonds must both be sufficiently high that they do not constrain opportunities to trade that would be present if perfect credit markets were to exist. However, the government's present-value budget constraint inextricably links the real value of its total liabilities to the present value of fiscal surpluses.[47] Yet again, a government's ability to facilitate private sector transactions cannot be separated from its choices of taxes, transfers, and spending.

4.1. Real Bills Doctrine and Manufactured Liquid Assets Scarcities

In Section 3.1 we discussed the optimality of the Friedman rule when money plays a special transaction role relative to either government or private bonds and the Friedman rule calls for equalizing rates of return on money and bonds. As discussed by Sims (2019), a Friedman rule prescription requires that there be room for the government to lower a wedge between returns on money and bonds by exchanging money for bonds. In the setting studied by Sims, it is optimal for the government to inflate away all government bonds outstanding at the beginning of time 0, all of which are denominated in dollars. But at time 0, the government is not allowed to accumulate private assets. This renders inapplicable the Modigliani–Miller equivalence discussed above, because there are no outstanding government bonds for the government to purchase with currency issues after time 0. In this setting, it turns out that driving the opportunity cost of money to zero is not optimal.[48] However, most governments today have outstanding (large) stocks of nominal bonds, so for them the option of reducing the bond supply and increasing the money supply remains open.

When other government-issued liabilities—say, both money and bonds—play special roles in providing transaction services, a rule in the spirit of Friedman's calls for equating the returns of both money and government-issued bonds to the return on privately issued, nominally risk-free assets.[49] To attain this outcome, a government may have to purchase private assets; Sims's analysis is especially pertinent here. As an example, in the model of Sargent & Wallace (1982) the Friedman rule is a requirement for Pareto optimality: It can be implemented by having the monetary authority open a discount window and offer freely to exchange money for private bonds. After a sufficient quantity of private securities have been discounted by the monetary authority to equate returns on

[45]In addition to the assumption of missing fiscal instruments, this avenue of research needs to explain why it is not optimal for the government to flood the market with money by purchasing enough public or private bonds, thereby restoring the irrelevance theorem, as in Sargent & Wallace's (1982) work.

[46]In Williamson's (2012) model, bonds are not used directly in decentralized trade but rather are needed to back bank deposits that are used by households for payments.

[47]Note, however, that the present value is now taken with respect to an interest rate that is below the interest rate for private credit transactions.

[48]In this work, driving the opportunity cost of money to zero is impossible because money demand becomes infinite (Sims 2019). This is not the case if a satiation point exists, as in our reference model.

[49]More precisely, a Friedman rule would require that government-issued liabilities and private securities should be priced by the same stochastic discount factor. This is relevant because in practice only the government has ultimate control of the money printing press and is thus able to issue nominally risk-free assets.

money and private risk-free bonds (or to eliminate other rate-of-return dominations), any further discounting of private indebtedness has no effects on asset or goods prices. This is an instance of a real bills doctrine stating that central bank purchases of high-quality private indebtedness have no effects on an equilibrium price-level path. This interpretation of the real bills doctrine stands as another manifestation of a Modigliani–Miller irrelevance result. Sargent & Wallace (1982) also remark that, in their environment, equilibria resulting from policies that restrict the provision of liquidity need not be Pareto inferior to those arising from the Friedman rule: While less desirable from a pure efficiency perspective, those equilibria can redistribute wealth to favor some groups at the expense of others. In the absence of direct nondistorting fiscal instruments for achieving these redistribution aims, it may be optimal for the government to rely on policies that artificially drive wedges between prices of different classes of assets, even when buying private assets is possible.

With heterogeneous endowments, owners with similar endowments want to collude to drive up the relative prices of their wares. Government tax policy can substitute for collusion. Because this insight applies to intertemporal prices as much as it does to apples or milk, different agents will have incentives to lobby for an intertemporal distribution of taxes that distorts asset prices in their favor, as emphasized by Bassetto (2014). Several recent papers have rationalized policies that restrict supplies of government debt on those grounds. Common to these papers is the idea that some agents are constrained in their abilities to borrow, so that (as in Woodford 1990) the government can relax their borrowing constraint by lowering current taxes and issuing government debt, then raising them later. Such a policy effectively allows the government to borrow on behalf of some private agents. In such an economy, a characteristic of borrowers that are to be helped is that they are well endowed in the future relative to their preference for future consumption. To act as a cartel, borrowers would need to collectively restrict their demands for loans enough to lower the equilibrium interest rate. Borrowers do not favor a policy under which the government issues so much public debt that private borrowing constraints become slack. Rather, the optimal level of public debt from a borrower's perspective keeps borrowing constraints binding. Different papers supplement this same idea with different reasons the government may wish to favor borrowers over savers. Bhandari et al. (2017) make this point for a general case. In Azzimonti & Yared's (2017, 2019) work, borrowers are poorer than savers, and a government that is utilitarian and wishes to redistribute is prevented from doing so by using type-specific taxes. Yared (2013) considers a Diamond & Dybvig (1983) setup in which, in the absence of private insurance markets, it is optimal for the government to redistribute in favor of some agents who ex post are revealed to be impatient and want to borrow. Bhandari et al. (2017) push these forces one step further: Rather than taking borrowing constraints as given, a government can deliberately limit the enforcement of private contracts to restrict the demand for loans and thereby move the interest rate. Such a policy can remain optimal even when a government has access to nonlinear income taxes so long as information frictions prevent full redistribution by fiscal policy alone.[50]

[50]The transaction role of government debt in work by Sargent & Wallace (1982) and Azzimonti & Yared (2017, 2019) differs from the role of money in our reference model. In our model, money permits trade in anonymous transactions in which record keeping is impossible. In Azzimonti & Yared's model, public debt alleviates a limited commitment problem that arises when agents are tempted to default on previous private obligations ex post. The force arising here remains valid in alternative environments in which public debt plays a money-like role that private debt cannot serve, so long as government debt is disproportionately purchased by agents from whom the government wishes to redistribute. The key difference between cash and government bonds is that poor agents' portfolios are relatively concentrated in cash and away from bonds. It is for this reason that a utilitarian government with no direct instruments for redistribution would find it optimal to pursue the Friedman rule for cash, but not for bonds.

In the competitive equilibria of our simple reference model, the present value of household consumption,

$$E_t \sum_{s=0}^{\infty} q_s P_s (c_s + x_s) = E_t \sum_{s=0}^{\infty} \beta^s (c_s + x_s), \qquad 27.$$

is always well defined. If the economy is deterministic, this equation means that the real interest rate is asymptotically greater than the growth rate of consumption. The present value of household consumption continues to be well defined in more general models so long as households trade in complete markets and borrowing is constrained only by a no-Ponzi condition like the one in Equation 13. However, the situation changes when households have finite planning horizons. This can happen either because their lifetimes are finite, or because they might eventually face binding borrowing constraints that (at the margin) will make choices of variables at the date of the binding borrowing constraint insensitive to what will happen in subsequent periods.

Darby (1984) argues that Sargent & Wallace's (1981) unpleasant monetarist arithmetic does not apply when the economy's growth rate exceeds the interest rate on government debt. Similarly, Blanchard (2019) refines arguments from Diamond (1965) and shows that the cost of issuing extra government debt may be small or null if his historical estimates of US risk-free rates of return relative to growth rates prevail in the future. By way of assessing Darby's and Blanchard's analysis, and inspired by Sargent & Wallace (1982), Yared (2013), and especially Azzimonti & Yared (2017), we now present a simple example that shows that budget balance still imposes limits on fiscal policy. We also show how the line between monetary and fiscal policy becomes potentially even more tenuous in an environment in which the growth rate exceeds the interest rate. We consider a deterministic economy populated by overlapping generations of two period–lived people with constant size total population. We abstract from cash and credit goods but impose that no household can borrow. In this model, government debt and transfers can at least partially substitute for missing credit markets.

We depart from Blanchard (2019) by introducing equal numbers of two types of agents for each cohort. Savers receive endowments $(e_{\mathrm{y}}^{\mathrm{S}}, e_{\mathrm{o}}^{\mathrm{S}}) = (\alpha, \epsilon)$ when young and old, respectively, while borrowers receive $(e_{\mathrm{y}}^{\mathrm{B}}, e_{\mathrm{o}}^{\mathrm{B}}) = (\epsilon, \gamma)$. We abstract from labor supply. We assume that ϵ is small and study the limit of equilibria as $\epsilon \to 0$.[51] Households of type $i = \mathrm{B}, \mathrm{S}$ born in period t have utility

$$\log c_{\mathrm{y}t}^{i} + \log c_{\mathrm{o}t+1}^{i},$$

where $c_{\mathrm{y}t}^{i}$ is consumption when young, and $c_{\mathrm{o}t+1}^{i}$ is consumption when old. We assume that no durable goods exist.[52]

The government is not allowed to redistribute directly between generations or between borrowers and savers; rather, it is restricted to applying equal lump-sum taxes and transfers to every living household. Since young borrowers have an $\epsilon \approx 0$ endowment, the government is effectively prevented from taxing, but it can implement transfers. The government can also issue debt and/or money, which are equivalent here since there is no separate transaction role for one instrument relative to the other. We consider two alternative specifications of policy, one that more closely resembles monetary policy, and another that looks more like fiscal policy. We then show that the two policies implement the same allocations; however, contrasts between two implementations of the same allocations bring insights.

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[51]Having $\epsilon > 0$ ensures that household utility is well defined even in autarky.
[52]Our results can survive the introduction of a durable reproducible good such as capital, but depending on the production function they may no longer apply if there is a factor in fixed supply (see Rhee 1991).

In the monetary implementation, at the beginning of each period t there is a stock of government-issued money M_{t-1} per capita, and the government makes a transfer (a negative tax)

$$-T_t = M_t - M_{t-1} \geq 0. \tag{28}$$

Budget constraints for a household of type i born in period t are

$$m_t^i = P_t(e_{yt}^i - c_{yt}^i) - T_t, \tag{29}$$

$$P_{t+1}(c_{ot+1}^i - e_{ot+1}^i) = m_t^i - T_{t+1}, \tag{30}$$

where m_t^i is the choice of money holdings for a household of type i born in period t, and the borrowing constraint imposes $m_t^i \geq 0$. The initial old cohort in period 0 faces just Equation 30, taking m_{-1}^i as exogenously given. In each period, market clearing for money balances requires[53]

$$m_t^S + m_t^B = 4M_t. \tag{31}$$

In the fiscal implementation, we use real quantities as numeraire. The government starts a period owing b_t units of goods per capita. It then sells debt b_{t+1} payable in period $t+1$ at a real gross interest rate ρ_{t+1} and uses the proceeds to repay existing debt obligations and make real transfers $-\tau_t$. Government policy must be such that

$$-\tau_t = b_{t+1}/\rho_{t+1} - b_t \geq 0. \tag{32}$$

The budget constraint for a household of type i born in period t is

$$\frac{b_{t+1}^i}{\rho_{t+1}} = e_{yt}^i - c_{yt}^i - \tau_t, \tag{33}$$

$$c_{ot+1}^i - e_{ot+1}^i = b_{t+1}^i - \tau_{t+1}, \tag{34}$$

with b_t^i being real debt purchased in period t, which must be nonnegative due to the borrowing constraint. As before, the initial old cohort starts with an exogenous amount b_0^i. Market clearing for debt requires that

$$b_{t+1}^S + b_{t+1}^B = 4b_{t+1}. \tag{35}$$

To verify that our monetary and fiscal implementations correspond to the same economic fundamentals, take any allocation $(c_{yt}^i, c_{ot}^i, m_{t-1}^i)_{t=0}^{\infty}$, price system $\{P_t\}_{t=0}^{\infty}$, and monetary policy $(T_t, M_{t-1})_{t=0}^{\infty}$ that satisfy Equations 28–31. We then construct an allocation $(c_{yt}^i, c_{ot}^i, b_t^i)_{t=0}^{\infty}$, asset price system $\{\rho_{t+1}\}_{t=0}^{\infty}$, and fiscal policy $(\tau_t, b_t)_{t=0}^{\infty}$ that satisfy Equations 32–35 as follows: Take the same consumption allocation, and set $b_t^i = M_{t-1}^i P_t$, $b_t = M_{t-1}P_t$, $\rho_{t+1} = P_t/P_{t+1}$, and $\tau_t = T_t P_t$. The same process works in reverse, starting from a fiscal policy specification and going back to a monetary policy specification. Since the households and the government face the same budget constraints in the two specifications (after prices have been appropriately transformed as above), the set of consumption allocations that are part of a competitive equilibrium is the same in the two implementations. Yet again, a distinction between monetary and fiscal policy is tenuous and arbitrary.

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[53] The number 4 in Equation 31 appears because in each period there is an equal number of young savers, old savers, young borrowers, and old borrowers.

We now study which equilibria are preferred by different households. For brevity, we restrict the investigation by considering only consumption allocations that converge to a steady state and by focusing on the welfare of generations born far into the future, at dates at which allocations have nearly converged.

As a first step, we show that in a steady state, borrowers always consume their posttransfer endowments, while savers buy all government bonds: Borrowing and saving are intermediated through the government. We use our fiscal notation, which is expressed in real terms, and denote by subscript SS a steady-state value. In a steady state, since $\tau_{SS} \leq 0$, the government budget constraint of Equation 32 requires either $b_{SS} = 0$ or $\rho_{SS} \leq 1$. If $b_{SS} = 0$, no intertemporal trade can take place among households: Young borrowers would indeed like to borrow from savers, but they are prevented from doing so by the borrowing constraint, while savers have no other people to whom they can lend. Since bonds are in zero net supply, the interest rate must be such that savers find it optimal not to demand any bonds, which requires $\rho_{SS} = \epsilon/\alpha < 1$.[54] When $b_{SS} > 0$, the after-transfer endowment of the borrowers is $(\epsilon + \tau_{SS}, \alpha + \tau_{SS})$. With $\rho_{SS} < 1$, their optimal choice is not to save but rather to consume their endowments, verifying our claim.

Having established that all bonds will be acquired by young savers, we characterize a steady state. In the limit as $\epsilon \to 0$, savers' bond demand is

$$b^S_{SS} = \frac{1}{2}\,[\alpha - \tau_{SS}(\rho_{SS} - 1)]. \qquad 36.$$

Combining Equations 32 and 36 along with the market-clearing condition $b^S_{SS} = 4b_{SS}$ yields a quadratic equation in τ_{SS} and b^S_{SS}. Keeping in mind that positive taxes are ruled out by the borrowing constraints, the quadratic expression yields

$$\tau_{SS} = b^S_{SS} - \frac{\sqrt{b^S_{SS}(\alpha + 2b^S_{SS})}}{2}. \qquad 37.$$

The range of debt that yields a negative tax (a positive transfer) is $(0, \alpha/2)$ per each saver [or $(0, \alpha/8)$ in per capita terms]. In this range, the government earns seigniorage revenues by providing an asset that savers are willing to hold to smooth consumption over time even at a negative net real interest rate. The government transfers the revenues to all households alive, benefiting the borrowers as well.[55] Over this range, τ_{SS} is a convex function with a unique minimum $b_{\min}$. As pointed out by Miller & Sargent (1984) in their reply to Darby (1984), when the quantity of government debt affects interest rates, the observation that the interest rate is below the growth rate of the economy for the levels of debt that we historically observed does not imply that an arbitrary net-of-interest deficit is sustainable.

Since borrowers consume their after-transfer endowments, when the government acts in their interest, it chooses the level of debt that maximizes transfers, namely, $b_{\min}$. At this point, the negative net real interest rate is strictly below the growth rate of the economy, which is zero in our case. In contrast, savers' welfare is strictly increasing in b all the way to $\alpha/2$, the point at which the real interest rate becomes zero. We obtain results similar to those found by Diamond (1965) and Blanchard (2019) only for the savers: So long as $b^S_t < \alpha/2$, cutting taxes and issuing extra debt allows making some transfers to an initial generation without making future savers worse off. This is because, unlike borrowers, future savers benefit from the higher interest rates more than they suffer from smaller transfers.

[54]Any value of $\rho_{SS} \leq \epsilon/\alpha$ would also work, but the same consumption allocation would prevail.

[55]As emphasized by Bhandari et al. (2017), a similar allocation could be achieved if the government enforced a limited amount of private borrowing. It is in this sense that the government borrows on behalf of private agents.

A lesson from this example is that it would be misleading to conclude that the government budget constraint is disarmed whenever the government pays interest rates that fall short of the growth rate. First, even when the interest rate is lower than the growth rate, higher debt and the correspondingly higher interest rates may reduce the government funds that in our example finance redistributive transfers; this is because the marginal cost of debt can be positive even when the average is negative. Second, to the extent that direct redistribution channels are limited, an increase in interest rates benefits some groups at the expense of others. It is thus possible that a government could choose to limit its debt in order to accomplish a desired redistribution.

In the monetary interpretation of our overlapping-generations economy, a constant real rate of return is achieved by setting money growth, and therefore inflation, to the common constant rate $1/\rho_{SS}$. The equivalence that we proved earlier lets us still use Equation 37 to establish the policies preferred by different groups among cohorts that are born after the economy has (nearly) converged to steady state. Borrowers prefer the rate of money growth that maximizes the real value of the monetary transfers, the rate that prevails when real balances per young saver equal $b_{\min}$. We can derive the implied (positive) rate of money growth by solving Equations 32 and 37 for the steady-state value of ρ_{SS}. Not surprisingly, savers' utility is decreasing in money growth:[56] They prefer to forgo transfers in exchange for being able to save with money that retains a constant value.

Forces underlying our results also prevail in environments with richer sources of household heterogeneity. For example, it would be tempting to carry out similar experiments in Bewley models of idiosyncratic uninsurable income shocks. It would also be worthwhile to analyze what happens when a low rate of return on government debt coexists with higher returns on private assets driven by discrepancies in assets' transaction roles, like the differences that arise between money and debt in the cash-in-advance model discussed above. In those models, an increase in debt implies a lower convenience yield, i.e., a lower spread between government debt and private assets that reduces seigniorage revenues in ways similar to those analyzed here. Interactions between household heterogeneity, convenience yields, and rates of return on private assets add extra dimensions that are worth exploring.[57]

Our model is silent about whether monetary or fiscal authorities should be in charge of managing public liabilities. It is tempting to relate our model's silence to the troubles, to which we alluded in the Introduction, that nineteenth-century US statesmen confronted in designing institutions that could draw sustainable lines between monetary and fiscal policies.

5. FISCAL POLICY AS NOMINAL ANCHOR

So far we have studied the consequences of alternative arbitrary sequences of monetary/fiscal policy actions and have discussed how disputes about what should be considered fiscal versus monetary policy can boil over into conflicts among the institutions that are deemed responsible for setting the different components of a government's intertemporal budget. In this section, we turn to questions about price-level determinacy that force us to cast monetary and fiscal policies in terms of mechanical rules that relate actions to past and present outcomes. This will naturally

[56] Savers would want to push money growth to an interior negative value; however, in our environment money growth cannot go below zero because young borrowers would be unable to pay the taxes required to reduce the money supply.

[57] A recent literature emphasizes how heterogeneity across households shapes macroeconomic responses to monetary and fiscal policy shocks. Kaplan et al. (2018) show that the effects of interest rate movements depend on how taxes and spending react to these shocks. Other examples are discussed by Auclert et al. (2018) and Auclert (2019).

lead us to discuss versions of a fiscal theory of the price level (FTPL) that generates a determinate price level (aka a nominal anchor) by fostering complementarities between particular monetary and fiscal policy rules.

Section 2.2 told how the absence of a nominal anchor for unbacked paper money leads to a multiplicity of equilibrium price levels at time 0 and to indeterminacies in the form of sunspot equilibria in all subsequent periods. As an example, going back to the reference model of Section 2.2 without gold, consider a monetary/fiscal policy in which the government trades no bonds and spends nothing, but at each period $t \geq 0$ makes a proportional transfer of money to households in the amount μM^S_{t-1}, so that money grows at the geometric rate μ. We consider settings in which $\mu > 0$ and equilibria in which the cash-in-advance constraint binds.[58] Combining Equations 16 and 17 and imposing market clearing, we conclude that in any equilibrium the following difference equation for consumption of the cash good x_t is satisfied:[59]

$$1 = \frac{\beta}{\mu}\left[\frac{x_{t+1}v'(x_{t+1})}{x_t}\right]. \qquad 38.$$

Brock (1974, 1975), Matsuyama (1990, 1991), and Woodford (1994) analyze a similar difference equation and show that for many interesting preference specifications it has many solutions. The lack of a nominal anchor comes from the lack of a boundary condition for Equation 38. The only candidate for such a boundary condition is the government budget balance; however, for the rule that we just specified, Equation 20 always holds, since in each period $B_t = g_t \equiv 0$ and $T_t \equiv M_s - M_{s-1}$.

To rule out equilibria with $x_t \to 0$, Wallace (1981a) and Obstfeld & Rogoff (1983) add a "fiscal backstop" in which at every time t the government offers to exchange money for goods at a price $\mu^t \bar{P}$ and promises to raise the revenues required to do so by levying lump-sum taxes on households.[60] The government sets $\bar{P}$ high enough that it need not use the fiscal backstop along an equilibrium path, so that real tax revenues required by the policy would be small even off an equilibrium path. This policy puts a floor under the real value of money and rules out self-fulfilling high-inflation equilibria in which the household expects real money balances to approach zero as time passes without limit.

Although Wallace's and Obstfeld & Rogoff's backstop excludes some equilibria, it does not necessarily assure a unique equilibrium. It excludes equilibria having real money balances that approach zero asymptotically but it possibly leaves intact multiple equilibria with strictly positive real balances that remain bounded both from above and from below. An example is provided by Sargent & Wallace (1975), who analyze a set of equilibria in an economy in which the monetary/fiscal authority sets a fixed nominal interest rate R_t at which it is willing to exchange money for one-period, risk-free nominal bonds maturing in period $t + 1$, appropriately adjusting taxes and transfers to ensure that the present-value budget balance holds. In our reference model, taking the conditional expectations of Equation 15, we obtain

$$\frac{1}{R_t} = \beta E_t\left[\frac{P_t}{P_{t+1}}\right]. \qquad 39.$$

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[58]Woodford (1994) considers other assumptions about money growth rates, as well as more general preferences.

[59]The equilibrium is then completely characterized by obtaining S_{t+1} from Equation 15 and the price level from the cash-in-advance constraint.

[60]Cochrane (2011) asserts that Obstfeld & Rogoff's (1983) analysis does not explain how equilibria with eventual demonetization are ruled out. Obstfeld & Rogoff (2017) fill in important details about this.

Starting from any P_t, there exist multiple stochastic solutions that make P_{t+1} and x_{t+1} functions of a sunspot and that satisfy Equations 16 and 39.[61] There are infinitely many solutions arbitrarily close to the nonstochastic solution given by

$$P_{t+1} = \beta R_t P_t, \quad x_{t+1} = v'^{-1}(\beta R_t). \qquad 40.$$

Thus, for a given price P_t, a Wallace–Obstfeld–Rogoff backstop policy higher than $\beta R_t P_t$ fails to rule out multiple equilibria.

Leeper (1991), Sims (1994), and Woodford (1994) describe a policy that does guarantee a unique equilibrium. Shift Equation 19 forward one period. Since the government trades only one-period, risk-free nominal bonds, both B_{t+1} and M_t on the left-hand side are predetermined. A candidate sunspot equilibrium would imply a change in P_{t+1} in the denominator of the left-hand side that would exactly offset movements in the seigniorage term on the right-hand side. This would require either taxes or government spending to be adjusted to ensure that the equilibrium condition of Equation 19 holds. Leeper, Sims, and Woodford consider fiscal policies that prohibit any such adjustment and that thereby deliver a unique equilibrium price-level path. An example of such a policy is one in which government spending and nominal interest rates are constant at $\bar{g}$ and $\bar{R} > 1$, respectively, and in which taxes in period t satisfy[62]

$$T_t = \bar{\tau} P_{t-1} - (M_t - M_{t-1}), \qquad 41.$$

with $\bar{\tau}$ being exogenous.[63] When fiscal policy obeys this rule, substituting Equations 15 and 41 into Equation 20 implies

$$\frac{B_t - \bar{\tau} P_{t-1}}{P_t} = \frac{1}{1-\beta}\left(\frac{\bar{\tau}}{\bar{R}} - \bar{g}\right). \qquad 42.$$

In period 0, the only endogenous variable in Equation 42 is the price level P_0. It follows that in any equilibrium, the initial price level P_0 is uniquely determined by Equation 42. In all subsequent periods, since the government only trades nominally risk-free bonds, B_t is predetermined as of time t. Equation 42 then implies that P_t must also be predetermined and so cannot depend on the realization of a time t sunspot variable. It is then straightforward to prove that there exist a unique allocation, price sequence, and stochastic discount factor that satisfy Equations 15–17 and 42. Here, a fiscal policy provides the nominal anchor in the sense that it delivers and shapes a unique price-level path.

Uniqueness is attained by mechanics well explained by Cochrane (2005). Our nominal anchoring fiscal policy effectively turns holders of nominal government claims into residual claimants to the stream of real payments described by the right-hand side of Equation 42.[64] The price level is thus determined by an equilibrium condition requiring that the real value of nominal claims issued by the government should equal the present value of fiscal primary surpluses.

The preceding discussion forgets that the government issues two claims, namely, bonds and money; it leaves open how total claims are divided between these two components; and it does

[61] When an allocation, policy, and price system satisfy Equations 16 and 39, Equation 17 also holds, since the government is supplying any amount of real balances demanded by households, and Equation 19 holds by the assumption that transfers are adjusted to make it hold.

[62] The tax policy in Equation 41 is written so that the government need not observe P_t when it sets T_t.

[63] In period 0, we can equivalently specify an arbitrary initial condition P_{-1}, or set $T_0 = \bar{T}_0 - (M_0 - M_{-1})$. We take the first option in the text for simplicity.

[64] Because P_{-1} is given, and from the details of our timing protocols, the first-period tax receives a special treatment on the left-hand side.

not explain how a relative price between the two would affect the analysis. To remedy this deficiency, Buiter (2002) includes a "debt revaluation factor" that allows a dollar of maturing nominal bonds to be different from a dollar of paper money. A justification for ignoring Buiter's revaluation factor could be that maturing bonds will be redeemed for paper money at par, a justification that automatically implies that the FTPL substantially limits the independence of whatever monetary authority is assigned to control the money supply. It also rules out monetary/fiscal rules in which the government sets an unconditional supply of money independent of the amount of bonds that households might wish to redeem.[65]

The credibility of an FTPL hinges on the plausibility attached to the particular fiscal-monetary rules on which it rests. Whether these rules are stated explicitly or left implicit, an FTPL analysis is not just about competitive equilibrium sequences of allocations, prices, and monetary/fiscal policy actions, but also about an equilibrium collection of strategies—sequences of functions that map information at time t into actions at time t—that are essential components of a theory not only about household and government behavior along an equilibrium path, but also about how everyone would behave under a vast number of alternative scenarios, most of which will never happen. As an example, Cochrane (2020) studies a model in which "surpluses do not respond to arbitrary unexpected inflation and deflation, so fiscal policy remains active" and shows how such an assumption selects appealing equilibria in a new Keynesian framework (see also Cochrane 2019). What the government can and will do during such off-equilibrium path scenarios decisively shapes outcomes along an equilibrium path, but it cannot be coherently analyzed by looking only at competitive equilibria in which unexpected inflation in the sense of Cochrane never materializes. Modeling an equilibrium collection of strategies in the rigorous fashion accomplished in game theory is challenging to carry out in an environment with competitive markets and large numbers of anonymous private decision makers who take prices as given: The presence of a single large player called the government prevents us from treating prices as being set by that convenient deus ex machina called the Walrasian auctioneer. Instead, we are forced explicitly to model how prices are set as the government and the private sector interact[66] and to specify precisely the information the government has and the actions it can take when setting taxes and the money supply. This avenue of research is pursued by Bassetto (2002, 2005).[67] Two important conclusions emerge from Bassetto (2002), who describes an economy as a game in which equilibria emerge from fully specified strategies for households and the government.

1. There exist government strategies that defend a unique price level even when the government (or central bank) pursues a policy of a constant interest rate like the one that led to indeterminacy in Sargent & Wallace's (1975) model. This nominal anchor outcome substantiates an FTPL.
2. Strategies that sustain a nominal anchor are associated with outcomes that confront the government with confidence crises triggered by private households' occasional refusals to make new loans to the government. At times when government spending exceeds planned tax revenues, these crises can require the government to adjust its tax plans to guarantee that real tax revenues are at least as large as government spending. Details about how the

[65]Regime changes in interactions between monetary and fiscal policies are the subject of a literature that promises to improve accounts of the relationship between output and inflation in new Keynesian models. Examples are provided by Chung et al. (2007), Davig & Leeper (2007), and Bianchi & Melosi (2014, 2018, 2019).

[66]Shapley & Shubik (1969) provide one framework in which this is possible.

[67]Other papers that have grappled with this question are by Kocherlakota & Phelan (1999), Christiano & Fitzgerald (2000), Niepelt (2004), and Daniel (2007).

government makes this adjustment determine whether fiscal policy indeed acts as a nominal anchor.

Even when monetary and fiscal policy coordinate as the theory instructs, the FTPL cannot cure all indeterminacies. Thus, when it provides additional liquidity services, the interest rate on government debt can be below the economy's growth rate. Then, even though, as required for the FTPL, the intertemporal balance in the government budget continues to matter, as we discussed in Section 4.1, Bassetto & Cui (2018) and Berentsen & Waller (2018) show that the FTPL is able only to select a range of possible equilibrium price levels, not a unique one.

6. TWO GOVERNMENT BUDGET CONSTRAINTS

Unconventional monetary policies deployed after the 2007–2008 financial crises have attracted attention to the relationships between monetary and fiscal policies, as events have taught policy makers that setting interest rates in the fashion codified by Woodford (1995) or Clarida et al. (1999) may not suffice to attain inflation targets. Sims (2004, 2005) sets the stage for analyzing such policies when he studies the consequences of endowing a Treasury and a central bank with separate budget constraints.[68] To the extent that we are only interested in describing the set of equilibria consistent with a given sequence of monetary/fiscal actions, there is no reason to distinguish between different government agencies sharing a common budget constraint. Recall, however, how in Section 5 we moved forward from simple descriptions of sequences of actions to studying the government strategies that generate those sequences. In that context, if the government is not a monolith but rather a set of distinct decision makers, how these decision makers manage their own budgets can affect all outcomes, including the monetary/fiscal policy sequence. For these reasons, we now split Equation 14 into one equation for the Treasury and another for the central bank. To keep things simple, we assume that only the Treasury is allowed to levy taxes on the households and to spend resources, while only the central bank is allowed to issue noninterest-bearing claims in the form of paper money. While this assignment is arbitrary from the point of view of much macroeconomic theory, as highlighted in the previous sections, it does a good job of approximating the institutions observed in many countries.

Define B_t^{T} as (potentially state-contingent) nominal bonds that the Treasury issues in period $t-1$ and repays in t, and define H_t as nominal transfers from the central bank to the Treasury. The Treasury's budget constraint at time t is

$$B_t^{\mathrm{T}} + P_t g_t \leq T_t + E_t S_{t+1} B_{t+1}^{\mathrm{T}} + H_t. \qquad 43.$$

Define B_t^{CB} as net holdings of nominal state-contingent bonds held by the central bank; B_t^{CB} counts as positive the central bank's holdings of Treasury-issued securities as well as nominal claims issued by the private sector, while it subtracts interest-bearing claims issued by the central bank, which in practice are comprised of reserves held by banks and short-term borrowing effected through repurchase agreements. We also reintroduce gold as a real asset, but unlike in Section 2, we assume that gold's only role is as a store of value and that it cannot be used as a medium of exchange.

[68]Though it is natural to think that the two main agencies in charge are the government (especially the Treasury) and the central bank, in reality things can be more complicated, as our Introduction attests. The distinction between a Treasury and central bank itself can be obscure, and decision makers from other agencies may enter the scene. Good examples are Fannie Mae and Freddy Mac in the United States, private corporations that were able to issue government-backed claims. We have limited our distinctions among government agencies to the Treasury and the central bank to emphasize the obscure boundaries between monetary and fiscal policy.

Letting z_t^{CB} be central bank holdings of gold at the beginning of period t, it follows that

$$B_t^{CB} - M_{t-1}^g \geq H_t - M_t^g + E_t S_{t+1} B_{t+1}^{CB} + \frac{P_t}{\phi}\left(z_t^{CB} - z_{t-1}^{CB}\right). \qquad 44.$$

If we aggregate Equations 43 and 44, we obtain Equation 19, except that gold now appears as an additional government asset.[69]

If we solve these difference equations forward, we obtain two intertemporal balance equations: the Treasury's,

$$\frac{B_t^T}{P_t} = E_t \sum_{s=t}^{\infty} \beta^{s-t}\left(\frac{T_s + H_s}{P_s} - g_s\right), \qquad 45.$$

and the central bank's,[70]

$$\frac{B_t^{CB} - M_{t-1}}{P_t} = E_t \sum_{s=t}^{\infty} \beta^{s-t}\left[\frac{H_s}{P_s} - \frac{M_s}{P_s}\left(1 - \frac{1}{R_s}\right) - \frac{z_t^{CB} - z_{t-1}^{CB}}{\phi}\right]. \qquad 46.$$

Notice that gold counts as an asset only to the extent that it is sold and converted into goods. Since we assume gold not to be productive, if it forever remains in central bank vaults it is considered wasted from the perspective of present-value budget balance.

Sims (2004) distinguishes two models of central bank operations: model F and model E. A model F central bank resembles the US Federal Reserve System or the Bank of England, while a model E central bank looks more like the European Central Bank or the Hong Kong Monetary Authority. In model F, the central bank invests exclusively in government debt. In normal times (at least in the past), the nominal interest rate R_s is always positive. This implies that the seigniorage term on the right-hand side of Equation 46 is also positive: Revenues accrue to the central bank from issuing paper money bearing no interest and from investing the proceeds in bonds paying positive interest. If we assume in addition that the central bank only invests in short-term securities and that it does not pay to the Treasury more than its net interest income, then Equation 46 ensures that a central bank that starts with positive net worth on the left-hand side will continue to have positive net worth into the indefinite future. It is easy to imagine that, if and when the central bank and the Treasury bargain over policy, the central bank is in a stronger position if its balance sheet is such that a recapitalization in the form of $H_s < 0$ is never required, as is the case here. But while a central bank in this position may look to be independent in the short run, the fact that its assets are purely nominal implies that the central bank alone cannot provide a nominal anchor for the price level. From Equation 46, the central bank can easily control nominal transfers H_s, but it cannot control real transfers.[71] If money supply and/or interest rate rules potentially lead to multiple equilibria, only the Treasury can provide fiscal backstop by levying appropriate real taxes.

In extensions of this model to long-term debt (Sims 2005), if a model F central bank invests in long-term securities, then the mismatch in the duration of its asset (long-term debt) and money (a zero-maturity claim) can lead to fluctuations in the central bank's net worth, even becoming

[69]In the aggregation, $B_t^g = B_t^T - B_t^{CB}$.
[70]We use market clearing to substitute $M_s^g = M_s$ in equilibrium.
[71]To make this argument precise requires describing an economy in more detail along the lines followed by Bassetto (2002). The reason the central bank cannot commit to a sequence of real transfer payments to the Treasury is that the real value of its profits is driven by the willingness of households to accept its money and its bonds. However, the Treasury can force households to pay a quantity of real goods through taxes.

negative. Nonetheless, we can rewrite Equation 46 as

$$\frac{B_t^{\mathrm{CB}}}{P_t} = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[\frac{H_s}{P_s} - \frac{M_s - M_{s-1}}{P_s} - \frac{z_t^{\mathrm{CB}} - z_{t-1}^{\mathrm{CB}}}{\phi} \right]. \quad 47.$$

In a richer model with long-term debt, the left-hand side term represents the real value of the central bank's portfolio of bonds. Bassetto & Messer (2013) remark that, so long as all of the central bank's liabilities are in the form of paper money and the bank pursues a policy of always expanding the money supply, fluctuations in the real value of bonds do not threaten the central bank's ability to deliver $H_s > 0$ every period. However, the central bank's ability to do this deteriorates markedly if the central bank issues reserves that are held by banks uniquely as a store of value and that are remunerated at the market interest rate. In this case, the mismatch between short-term interest-bearing liabilities and long-term bonds can imply that the left-hand side of Equation 47 turns negative in an adverse scenario, forcing the central bank either to ask for fiscal help from the Treasury or to pursue more monetary expansion, with its inflationary implications.[72]

In contrast to his model F central bank, Sims's model E central bank holds substantial reserves in the form of real assets. In our equation above, these assets are represented by gold, but in practice they could be other real claims such as hard-currency reserves.[73] In this case, the required fiscal backstop that puts a lower bound on the real value of money can happen "in-house": At any point in time t, the central bank can offer to redeem all of the money balances for its current gold holdings at a price given by $M_{t-1}/z_{t-1}^{\mathrm{CB}}$. This is a natural model for the European Central Bank, since its fiscal counterpart is represented by a heterogeneous collection of national governments, with a correspondingly weaker link between fiscal and monetary authorities. However, as Sims points out, risks arising from fluctuations in the value of the central bank portfolio may be of greater consequence in a world of weak links, because help from the fiscal authorities may not be forthcoming ultimately.[74]

7. CONCLUDING REMARKS

We began this review by reciting examples of challenges that statesmen confronted in separating monetary from fiscal policy. Promises written on paper and metal monies on display in collections of US coins and bank notes testify to the fiscal and and monetary policy decisions that the Congress and President sometimes delegated to the Treasury Department and Comptroller of the Currency before 1914, and after 1914 divided sometimes ambiguously between the Treasury and the Federal Reserve System. While this goal can be accomplished in various ways, government budget arithmetic asserts that, one way or another, monetary and fiscal policies must be coordinated or consolidated.

[72] Carpenter et al. (2013) and Greenlaw et al. (2013) analyze in detail the magnitude of the interest-rate risk created by the quantitative easing policies undertaken by the US Federal Reserve after 2008. They conclude that it would take extreme swings in long-term rates to turn the net value of interest-bearing assets and liabilities into a negative number. A similar conclusion arises in the complete dynamic stochastic general equilibrium model analyzed by Del Negro & Sims (2015). Hall & Reis (2015) extend the discussion to other sources of risk for the balance sheet of the central bank, such as exchange risk and, in the case of the Eurozone, outright default by national Treasuries. In contrast, the position of the Bank of Japan is more precarious.

[73] Of course, with foreign-currency reserves, questions about ultimate fiscal backing become questions about what ensures the real value of foreign currencies.

[74] Our equations rule out fluctuations by imposing a constant real value of gold. Also note that, as was the case for a model F central bank, fluctuations in the price of central bank assets require no outside intervention so long as the desired policy path involves an ever-increasing money supply, as discussed by Schmitt-Grohé (2005).

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