THE FISCAL MYTH OF THE PRICE LEVEL*

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I examine the "fiscal theory of the price level" according to which "non-Ricardian" policy and predetermined nominal government debt fiscally determine prices. I argue that the non-Ricardian policy assumption and, by implication, fiscal price level determination are inconsistent with an equilibrium in which all asset holdings reflect optimal household choices. In such an equilibrium, policy must be Ricardian even if, in some states of nature, the government defaults or commits to an arbitrary real primary surplus sequence.

I propose an alternative to the fiscal theory of the price level, based on nominal flows instead of nominal stocks. While this alternative framework establishes a consistent link between fiscal policy and the price level, it does not introduce inflationary fiscal effects beyond those suggested by Sargent and Wallace.

I. INTRODUCTION

The government's intertemporal budget constraint has several unpleasant implications. One of these concerns the interaction of fiscal and monetary policy in the determination of equilibrium inflation, as highlighted by Sargent and Wallace's [1981] "unpleasant monetarist arithmetic." Decentralized policy implies a "game of chicken" [Sargent 1987] where the first mover constrains the policy options of the follower. If the fiscal authority moves first and commits to a time path of preseignorage primary deficits, it forces the monetary authority to generate enough seignorage revenue to satisfy the government's intertemporal budget constraint. The central bank thus loses the ability to control inflation.

Concerned about this threat to price stability, economists have argued that an institutional first mover advantage— central bank independence—should be assigned to the monetary authority. If the central bank can commit to its preferred monetary policy, the treasury should bear full responsibility for balancing the budget. In a series of papers Woodford [1995, 1998, 1999, 2001] has challenged this conventional wisdom with its emphasis on seignorage revenue. According to Woodford, even a strictly

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independent and committed monetary authority is unable to achieve price stability if no additional constraints are imposed on fiscal policy makers. Woodford's argument relies on two assumptions: first, some government debt is issued in nominal terms; second, policy is "non-Ricardian" [Woodford 1995] in the sense that the fiscal policy rule specifies a path of surpluses that satisfies the government's intertemporal budget constraint not as an identity but only in equilibrium. In other words, Woodford introduces a game of chicken between the government as a whole and the Walrasian auctioneer [Christiano and Fitzgerald 2000]. By turning the government's intertemporal budget constraint into an equilibrium condition, non-Ricardian policy imposes additional constraints on the endogenous variables. In particular, it constrains the price level since that must, in equilibrium, coincide with the ratio of outstanding nominal government liabilities and the present discounted value of real primary surpluses (net of outstanding indexed debt)—thus, the "*fiscal* theory of the price level" (FTPL).

To the extent that non-Ricardian policy imposes more constraints on the endogenous variables than standard "Ricardian" policy, an interest rate peg need not—contrary to conventional wisdom—result in price level indeterminacy.[1] This appealing feature of the FTPL in the context of one specific monetary framework becomes problematic under different, equally plausible, circumstances. In a cash-in-advance (CIA) constraint model with positive interest rates and a money supply target, for example, the price-level path is already uniquely pinned down under a conventional Ricardian policy; a non-Ricardian policy then implies that the equilibrium price level is overdetermined.[2] Moreover, even if the FTPL does not overdetermine the price level, it may still predict the latter to be negative, for instance if the government owns a positive stock of nominal assets and is expected to run real primary surpluses [Buiter 2000]. In spite of this quite limited domain, there has been a predominantly favorable reception of the FTPL.[3] The debate has mainly focused on

1. Contributions by Leeper [1991], Sims [1994], and Woodford [1994] that preceded the FTPL analyze the determinacy properties of money and interest rate pegs. See also Kocherlakota and Phelan [1999] who interpret the FTPL as an equilibrium selection device.

2. For a different example, see Buiter [2000]. See also Christiano and Fitzgerald [2000, p. 18].

3. FTPL related contributions, extensions and discussions include Bassetto [2002], Bergin [2000], Buiter [1998, 1999, 2000, 2002], Christiano and Fitzgerald

whether it is conceivable that the government satisfies its intertemporal budget constraint only in equilibrium (by pursuing a non-Ricardian policy). Disapproval by Buiter [1998, 1999, 2000, 2002] contrasts with approval by Cochrane [2000] and Sims [1999a, 2001] who propose the residual claim analogy between nominal government debt and privately issued equity.

In this paper I offer a resolution to this debate. The fundamental problem of the FTPL is that the feasibility of non-Ricardian policy hinges on the assumption of nonzero initial nominal government liabilities. This assumption is not well founded, since the FTPL link between non-Ricardian policy and the price level essentially constitutes a surprise asset revaluation. In a rational expectations equilibrium, such a surprise revaluation cannot occur; households would not have bought (as much) nominal debt in the first place if they could not expect it to yield the required (average) rate of return. I show that once the model encompasses a debt issuance stage, existence of equilibrium requires fiscal policy to be standard Ricardian: fiscal policy has to identically satisfy the government's intertemporal budget constraint, even if, in some states of nature, the government defaults or commits to an arbitrary real primary surplus sequence. Accounting for the issuance of government debt also eliminates the alleged nominal anchor in the model; the notion of fiscal price level determination therefore collapses.[4]

Section II clarifies the main argument within a deterministic two-period setting. Section III extends the argument to a Lucas [1978]-type stochastic infinite horizon economy with a broad set of financial assets and a transactions role for money, similar to Svensson [1985] or Sargent [1987].[5] The section also addresses,

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[2000], Cochrane [1999, 2000, 2001], Cushing [1999], Daniel [2001], Dupor [2000], Leeper [1991], Loyo [1999], McCallum [2001], Schmitt-Grohé and Uribe [2000], Sims [1994, 1999a, 1999b, 2001], and Woodford [1994, 1995, 1998, 1999, 2001]. See also the references given in Buiter [2002].

4. The argument can be related to Bassetto [2002] who revisits the assumption of government commitment and proposes to explicitly model out of equilibrium behavior. I argue that the preconditions of the FTPL—outstanding nominal debt and non-Ricardian policy—*generally* do not arise in equilibrium. My critique differs from Buiter's [2002] in that it isolates a fundamental problem at the heart of the FTPL instead of focusing on context-dependent anomalies. Buiter maintains the assumption of predetermined nominal debt that most of my critique is about.

5. I deviate from Svensson in that I model maturing nominal government debt and money balances as perfect substitutes, and from Sargent in that I allow dividends to be partly paid out at the beginning of a period (these are timing conventions).

and refutes, potential objections. Section IV proposes a modification to the FTPL that shifts the focus from nominal stocks to nominal flows. While it is now possible to establish a link between fiscal policy and the price level even under rational expectations, the modified framework does not introduce any effects on equilibrium *inflation* beyond those already existent in Sargent and Wallace's [1981] model. Section V concludes.

II. The Argument

Consider an economy in its final period, $t = 0$, say. The representative household enters that period with a real endowment of y_0 units of the good and a nominal endowment of W_0 units (dollars) of government debt. The household's demand for the consumption good equals real household wealth, conditional on real taxes τ_0 and the equilibrium price level p_0: $c_0^d = y_0 + W_0/p_0 - \tau_0$. Supply of the good is determined by the resource constraint, $y_0 = c_0 + g_0$, with g denoting the exogenous level of real government spending. In equilibrium, consumption demand equals supply. Equivalently, the government's budget as of time zero is balanced: $W_0/p_0 = \tau_0 - g_0$.

Which variables adjust in equilibrium? According to the conventional (Ricardian) view, the intertemporal budget constraint forces fiscal policy makers to set taxes equal to real government debt plus government spending. According to the non-Ricardian view, in contrast, fiscal policy makers face no intertemporal budget constraint. Instead, they can fix taxes at some *arbitrary* level. For an equilibrium to exist, the price level p_0 must then adjust; non-Ricardian policy fiscally determines the price level.

The problem with this reasoning is that for the household to hold any nominal debt, the latter must have been issued in an earlier period. Without loss of generality, assume that all debt was issued in the previous period, $t = -1$. In that period, the household paid d_{-1} units of the good to acquire the debt. Since the household *chose* to purchase the debt, d_{-1} must satisfy an asset pricing equation,

$$d_{-1} = \frac{1}{1 + r_{-1}} \frac{W_0}{p_0},$$

with r_{-1} being the real interest rate between $t = -1$ and $t = 0$. (The real interest rate is pinned down by the Euler equation and the resource constraint. It does not depend on nominal values or the set of available assets; cf. the next section.) We can therefore write the government's dynamic budget constraint in period $t = -1$ as

$$g_{-1} = \tau_{-1} + d_{-1} = \tau_{-1} + \frac{1}{1 + r_{-1}} \frac{W_0}{p_0} = \tau_{-1} + \frac{c_0 + \tau_0 - y_0}{1 + r_{-1}} = \tau_{-1} + \frac{\tau_0 - g_0}{1 + r_{-1}},$$

where the last equality follows from the resource constraint and the last equality but one from market clearing. Equality of the left- and rightmost expressions implies that the existence of equilibrium requires the government's intertemporal budget constraint to be satisfied for *any* price level: *fiscal policy must be Ricardian.* (Introducing uncertainty about fiscal policy does not alter this conclusion; cf. the next section. The right-hand side of the above equation then features an average of discounted real primary surpluses; price levels still play no role.) Since fiscal policy must satisfy the intertemporal budget constraint as of $t = -1$, it also satisfies the intertemporal budget constraint as of $t = 0$, independent of the price level. Moreover, since fiscal policy must satisfy the intertemporal budget constraint for any price level, *it cannot pin down p_{-1} or p_0.*

More specifically, the FTPL's central proposition—fiscal price level determination—rests on two assumptions.

(a) $W_0 \neq 0$: the FTPL assumes the presence of a nominal anchor in the form of predetermined nominal debt, outstanding at the beginning of period 0.

(b) Non-Ricardian fiscal policy: the FTPL assumes that fiscal policy in period 0 can "move before" the price level and therefore independent of W_0/p_0.

To see the necessity of both (a) and (b), note that non-Ricardian policy has no lever to affect the price level if $W_0 = 0$ and that the intertemporal budget constraint of the government does not pin down the price level but rather constrains fiscal policy if the latter is Ricardian. The FTPL is internally inconsistent because, while necessary for the theory's central proposition, assumptions (a) and (b) imply that the investor's expectation formation before period 0 is inconsistent with the expectation formation in period 0, or that government bond markets did not clear. Either implication contradicts the standard notion of a rational expectations equilibrium.

To see how the FTPL drives a wedge between investor's expectation formation before and in period 0, note that predetermined nominal debt and arbitrarily set taxes imply that the return on government debt,

$$\frac{W_0/p_0}{d_{-1}} = \frac{\tau_0 - g_0}{d_{-1}},$$

differs generically from the required rate of return, $1 + r_{-1}$. The required return is only attained if the actual primary surplus $\tau_0 - g_0$ equals $d_{-1}(1 + r_{-1})$; i.e., if it satisfies the government's intertemporal budget constraint conditional on the level of real debt in $t = 0$ corresponding to what investors anticipated when investing d_{-1}. The equilibrium condition that investors held internally consistent expectations when buying government debt in $t = -1$ is therefore equivalent to the restriction that, conditional on the predetermined investment choices, actual policy in $t = 0$ be Ricardian. Assumption (a) and rational expectations equilibrium are thus incompatible with assumption (b) and therefore, as shown earlier, with the notion of fiscal price level determination.

Non-Ricardian policy subject to predetermined outstanding nominal debt amounts to "surprising" households that bought government debt under the impression that such a surprise was not possible. The important difference between the FTPL and other theories also involving surprises in perfect foresight settings (or, more generally, states of nature deemed impossible ex ante) is that the latter use the surprise assumption as a convenient shortcut of no importance for the main results, whereas the FTPL's main proposition *is* just the mirror image of the surprise assumption. Take the well-known example of a surprising helicopter drop of money: households demand real balances expecting a constant money supply, say; suddenly, money supply surprisingly increases, prices rise, and outstanding real balances are devalued. In this thought experiment, the notion of an unanticipated change in money supply is clearly at odds with the fact that money demand had been derived under the assumption of perfect foresight. But this is not particularly worrisome, because the main implications of the helicopter drop experiment do not rely on the surprise assumption. The result, for example, that after a helicopter drop the price level is higher than expected survives a consistent treatment of expectation formation.[6]

The case of the FTPL is starkly different. The theory's main proposition—fiscal price level determination—only follows under assumptions (a) and (b) which, as we saw, are directly linked to the feature of a surprise capital levy. An internally consistent modeling of expectation formation leads to the immediate collapse of the notion of fiscal price level determination and eliminates all novel implications of the FTPL. To see this, assume, for example, that taxes in period 0 can take two values: τ_0 with probability $1 - \alpha$, or $\hat{\tau}_0$ with probability α. If investors anticipated that taxes can take these two values, the real deficit they were willing to finance amounts to $\bar{d}_{-1} = ((1 - \alpha)\tau_0 + \alpha\hat{\tau}_0 - g_0)/(1 + r_{-1})$[7] such that the average realized return on government debt equals the required rate. Substitutions parallel to those above imply again that policy must be Ricardian. Fiscal policy in this stochastic environment must still, on average, deliver the required rate of return, but it can affect the *distribution* of returns, and therefore *relative* price levels, across states of nature: under the above assumptions we have[8]

$$p_0 = \frac{(1 + i_{-1})p_{-1}}{\tau_0 - g_0} \frac{(1 - \alpha)\tau_0 + \alpha\hat{\tau}_0 - g_0}{1 + r_{-1}},$$

$$\hat{p}_0 = \frac{(1 + i_{-1})p_{-1}}{\hat{\tau}_0 - g_0} \frac{(1 - \alpha)\tau_0 + \alpha\hat{\tau}_0 - g_0}{1 + r_{-1}}.$$

Two fiscal regimes collecting the same expected tax revenue in period 0, but distinct revenues in the two states, therefore have different relative price levels, $\hat{p}_0/p_0$. It is important to note that this feature is entirely unrelated to the FTPL (it arises both under Ricardian and non-Ricardian policy). It rather confirms

6. Households anticipating the possibility of a money drop base their decisions on the expected price level, which equals a weighted average of the price levels with and without a helicopter drop. If the helicopter drop actually occurs, the realized price level is higher than the expected price level. In contrast, the capital levy feature is not robust. Households anticipating the possibility of a money drop hold less real balances, but on average these balances yield the required return.

7. Without loss of generality, I assume that $y_{-1} - g_{-1} = y_0 - g_0$. This implies constant equilibrium consumption and therefore, discount factors for the two states equal to $(1 - \alpha)/(1 + r_{-1})$ and $\alpha/(1 + r_{-1})$, respectively.

8. Here, i_{-1} denotes the nominal interest rate between $t = -1$ and $t = 0$. By definition, W_0 equals the product of $\bar{d}_{-1}$, p_{-1}, and $1 + i_{-1}$.

what we already knew from Sargent and Wallace [1981] and Sargent [1987], namely, that the interaction of fiscal and monetary policy determines state-contingent *inflation* rates, but not price levels. Note that there is no nominal anchor in the two equations: if the triple $(p_{-1}, p_0, \hat{p}_0)$ satisfies the equations, they are also satisfied by any other triple $(\nu p_{-1}, \nu p_0, \nu \hat{p}_0)$, $\nu > 0$.

The discussion above shows that assumptions (a) and (b) are incompatible with the government *issuing* its debt to investors who anticipate the true characteristics of fiscal policy. This very feature, the FTPL's inability to explain the issuance of government debt, can also be seen more directly. The argument has two steps: (1) Assumption (b)—non-Ricardian policy—directly contradicts the existence of equilibrium, unless Assumption (a) is satisfied. For if $W_0 = 0$, fiscal policy must identically satisfy the government's intertemporal budget constraint for any price level, or an equilibrium does not exist. (2) Assumption (a) cannot always be satisfied if the model is to explain the issuance of all government debt.

The discussion also shows that assumptions (a) and (b) are incompatible with equilibrium, because they give rise to a surprise capital levy on outstanding debt. This suggests that non-Ricardian policy may be consistent with rational expectations equilibrium if the assumption of predetermined nominal debt can be replaced by an alternative assumption establishing a nominal anchor without giving rise to the surprise-capital-levy feature. Section IV proposes an alternative to the FTPL along these lines. Even in this alternative model, non-Ricardian policy pins down the price level only once. After the initial period, inflation is determined in a standard fashion.

Up to now, money has not yet been introduced in the model, nor has it been shown how the real and nominal interest rates are determined in equilibrium. The next section takes up these issues and generalizes the argument to a stochastic infinite horizon economy with a broad set of potentially state-contingent financial assets.

III. The FTPL: Revaluing Nominal Stocks

The infinitely lived representative household has the objective, as of time s, to

$$\max E_s \sum_{t=s}^{\infty} \beta^{t-s} u(c_t), \tag{1}$$

where $0 < \beta < 1$ and $u(\cdot)$ is increasing, concave, and satisfies the Inada conditions. c_t denotes consumption.

The state of the economy is captured by the stochastic process $\{\epsilon_t\}$. A specific history up to time t is denoted ϵ^t. Conditional on the history ϵ^s, $s \leq t$, the probability (density) of ϵ^t equals $f(\epsilon^t|\epsilon^s)$. Equilibrium values of the endogenous variables at time t will generally be functions of ϵ^t. To save on notation, I suppress this argument unless there is danger of confusion.

After observing the current state ϵ_t, households enter period t with real (goods denominated) financial wealth w_t, and nominal (dollar denominated) financial wealth W_t. (Both w_t and W_t are state-contingent if households chose to hold assets with state-contingent payoffs.) Households then sell goods of the amount g_t to the government,[9] pay lump sum taxes τ_t, and trade assets on the asset market. For convenience, and without affecting the generality of the argument, I only consider short-term maturities. At the beginning of period t, state ϵ^t, the household's dynamic budget constraint is

$$w_t + \frac{W_t}{p_t} + g_t - \tau_t - \left(\frac{M_t}{p_t} + \int_{\epsilon^{t+1}|\epsilon^t} \left[\frac{Q_t n_t}{p_t} + q_t m_t \right] d\epsilon^{t+1} \right) = 0, \tag{2}$$

with m_t and n_t denoting the prices of real and nominal Arrow-Debreu securities, respectively. That is, $m_t(\epsilon^{t+1}|\epsilon^t)$ denotes the goods denominated price as of time t, state ϵ^t, of one unit of the good at time $t + 1$, state ϵ^{t+1}; and $n_t(\epsilon^{t+1}|\epsilon^t)$ denotes the dollar-denominated price as of time t, state ϵ^t, of one dollar at time t + 1, state ϵ^{t+1}. The quantities of real and nominal Arrow-Debreu securities purchased by the household are denoted $q_t(\epsilon^{t+1}|\epsilon^t)$ and $Q_t(\epsilon^{t+1}|\epsilon^t)$, respectively. M_t and p_t denote nominal balances and the price level, respectively. Each household owns a tree generating state-contingent real dividends y_t. Households are prohibited from consuming dividends of their own tree. They must

9. More precisely, households commit to deliver g_t units of the dividend harvested in the period (see below) and, in exchange, receive an immediate credit. This timing convention is not important for the results but helps keep the relevant expressions simple. In particular, it implies that money demand depends on c_t and not on y_t. In each period and state of nature, $g_t < y_t$ by assumption.

therefore interact with other producers/consumers to sell their own production (net of sales to the government) and to buy consumption goods. These purchases must be made in cash. Consumers must therefore satisfy a CIA constraint requiring velocity not to exceed unity:

$$p_t c_t - M_t \leq 0. \tag{3}$$

(For a more general analysis involving both a CIA constraint and money in the utility function, see the working paper version [Niepelt 2002].) The contingent claims bought at the beginning of period t, money balances not used for consumption in period t, and revenues from sales to other households constitute next period's initial household wealth:

$$q_t + \frac{Q_t + (M_t - p_t c_t) + p_t(y_t - g_t)}{p_{t+1}} - \left(w_{t+1} + \frac{W_{t+1}}{p_{t+1}}\right) = 0, \quad \forall\, \epsilon^{t+1}|\epsilon^t. \tag{4}$$

At the beginning of period $t = 0$, households observe ϵ^0 as well as the state-contingent price and tax sequences $\{m_t, n_t, p_t, \tau_t\}_{t=0}^{\infty}$. Given those and w_0, W_0, households maximize expected utility subject to (2), (3), (4), and a no-Ponzi-game condition that prohibits explosive debt schemes. Assigning multipliers $\lambda_t(\epsilon^t)\beta^t f(\epsilon^t|\epsilon^0)$, $-\mu_t(\epsilon^t)\beta^t f(\epsilon^t|\epsilon^0)$, and $\tilde{\lambda}_{t+1}(\epsilon^{t+1})\beta^{t+1} f(\epsilon^{t+1}|\epsilon^0)$ to (2), (3), and (4), respectively, we find that $\lambda_t(\epsilon^t) = \tilde{\lambda}_t(\epsilon^t)$ as well as the following first-order conditions (omitting arguments of functions):

$$u_{c,t} = E_t \frac{\beta \lambda_{t+1} p_t}{p_{t+1}} + \mu_t p_t, \tag{5}$$

$$E_t \frac{\beta \lambda_{t+1}}{p_{t+1}} + \mu_t = \frac{\lambda_t}{p_t}, \tag{6}$$

$$m_t = \beta \frac{\lambda_{t+1}}{\lambda_t} f(\epsilon^{t+1}|\epsilon^t), \tag{7}$$

$$n_t = \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{p_t}{p_{t+1}} f(\epsilon^{t+1}|\epsilon^t). \tag{8}$$

Equation (5) equalizes the marginal benefit and cost of spending an additional unit of cash on consumption: the former is given by the marginal utility of consumption; the latter by the expected reduction in next period's wealth (evaluated at marginal utility) and the cost of a more tightly binding CIA constraint. Equation

(6) equalizes the marginal benefit and cost from investing an additional unit of wealth in real balances: the value of easing the CIA constraint equals the opportunity cost of holding money. Finally, conditions (7) and (8) are familiar representations of the asset pricing kernel.

The risk-free real and nominal interest rates, r_t and i_t, respectively, are defined by

$$(1 + r_t)^{-1} \equiv \int_{\epsilon^{t+1}|\epsilon^t} m_t d\epsilon^{t+1}, \tag{9}$$

$$(1 + i_t)^{-1} \equiv \int_{\epsilon^{t+1}|\epsilon^t} n_t d\epsilon^{t+1}. \tag{10}$$

We can thus rewrite (5) and (6) as

$$u_{c,t} = \lambda_t(1 + i_t)^{-1} + \mu_t p_t, \tag{5'}$$

$$\mu_t p_t = \lambda_t(1 - (1 + i_t)^{-1}). \tag{6'}$$

Combined, these two conditions imply that $\lambda_t = u_{c,t}$: the marginal utility of wealth equals the marginal utility from consumption. Substituting out λ_t instead of i_t, we find that $i_t = \mu_t p_t / (u_{c,t} - \mu_t p_t)$.

The government faces an exogenous state-contingent stream of resource requirements, $\{g_t\}$. This expenditure stream as well as the interest payments on previously issued liabilities are financed out of lump sum taxes, seignorage, and deficits. In line with the FTPL literature, I model monetary policy as following a nominal interest rate peg. (Whereas the FTPL literature often *needs* to make this assumption,[10] it is of no significance for my argument.) In particular, I assume this peg to be an exogenous, bounded, strictly positive sequence.[11] Lump sum taxes are collected in either a Ricardian or a non-Ricardian fashion. Both Ricardian and non-Ricardian policies identically satisfy the government's dynamic budget constraint linking debt accumulation to the budget deficit. Only Ricardian policies identically satisfy the government's intertemporal budget constraint that ties the

10. A money supply target, for example, will directly determine the price level if the CIA constraint binds. The FTPL link would then overdetermine the price level.

11. Generalizations are possible; see below.

initial debt to the market value of the stream of real primary surpluses.

DEFINITION 1. A *Ricardian policy* under $\{g_t, i_t\}$ consists of sequences $\{\tau_t, q_t, Q_t, M_t\}$ that satisfy the government's dynamic and intertemporal budget constraints for any sequence of prices. A *non-Ricardian policy* under $\{g_t, i_t\}$ consists of sequences $\{\tau_t, q_t, Q_t, M_t\}$ that satisfy the government's dynamic budget constraint for any sequence of prices and its intertemporal budget constraint for some, but not all, sequences of prices.

In equilibrium, g_t must equal the amount of resources not consumed by the private sector,

$$y_t = c_t + g_t. \tag{11}$$

Using (11), the sequence of intertemporal budget constraints of the private sector (which incorporate (2), (4), and the no-Ponzi-game condition) can be expressed as a sequence of intertemporal budget constraints for the government:[12]

$$\omega_s \equiv w_s + \frac{W_s}{p_s} = \sum_{t=s}^{\infty} \int_{\epsilon^t|\epsilon^s} \left(\tau_t + \frac{M_t}{p_t}\frac{i_t}{1+i_t} - g_t\right)\left(\prod_{j=s,\epsilon^s}^{t-1,\epsilon^{t-1}} m_j\right) d\epsilon^t. \tag{12}$$

Condition (12) states that, in equilibrium, initial government liabilities in real terms equal the market value of future tax revenue (lump sum taxes plus seignorage) minus the market value of future government expenditures.

DEFINITION 2. A *rational expectations equilibrium* (*REE*) under $\{g_t, i_t\}$ consists of a Ricardian or non-Ricardian policy $\{\tau_t, \tilde{q}_t, \tilde{Q}_t, \tilde{M}_t\}$; prices $\{m_t, n_t, p_t, r_t\}$; endowments $\{y_t\}$, w_0, W_0; and household choices $\{c_t, q_t, Q_t, M_t\}$ and multipliers $\{\lambda_t, \mu_t\}$, that solve (3), (4), (5′), (6′), (7), (8), (12) and satisfy (9), (10), (11), $\{\tilde{q}_t\} = \{q_t\}$, $\{\tilde{Q}_t\} = \{Q_t\}$, $\{\tilde{M}_t\} = \{M_t\}$.

In the following, to avoid unnecessary repetition, I impose

12. Using (7) and (8), the household's dynamic budget constraint, (2) and (4), can be expressed as

$$\omega_t = \tau_t - g_t + \frac{M_t}{p_t}\frac{i_t}{1+i_t} + (c_t + g_t - y_t)\frac{1}{1+i_t} + \int_{\epsilon^{t+1}|\epsilon^t} \omega_{t+1} m_t d\epsilon^{t+1}.$$

Recursive substitution, application of the resource constraint, and the no-Ponzi-game condition yield (12).

the market clearing conditions for asset markets by no longer distinguishing between $\tilde{x}_t$ and x_t for $x = q$, Q, M.

To characterize equilibrium, the following lemmas prove useful.

LEMMA 1. In an REE, $c_t = y_t - g_t$ and $M_t/p_t = y_t - g_t$.

LEMMA 2. In an REE, the state-contingent equilibrium sequences $\{i_t, c_t, M_t/p_t, \mu_t p_t, \lambda_t, m_t, r_t, \omega_t\}$ are unique.

Lemma 1 follows immediately from the resource constraint and the binding CIA constraint. With regard to Lemma 2, note that from Lemma 1 and the monetary policy rule, i_t, c_t, and M_t/p_t are uniquely determined; (5′) and (6′) pin down λ_t and $\mu_t p_t$; m_t and r_t follow from (7) and (9); and ω_t follows from (12).

LEMMA 3. In an REE, the state-contingent inflation rates are indeterminate unless the economy is deterministic or the set of marketed assets is sufficiently small. The portfolio allocation (q, Q) is indeterminate, unless the set of marketed assets is sufficiently small.

Lemma 3 follows from the fact, that the inflation rates and the portfolio allocation are only constrained (from (4), (8), and (10)) by

$$(1 + i_{t-1})^{-1} = \int_{\epsilon^t|\epsilon^{t-1}} m_{t-1} \frac{p_{t-1}}{p_t} \, d\epsilon^t,$$

$$\omega_t = q_{t-1}(\epsilon^t|\epsilon^{t-1}) + \frac{Q_{t-1}(\epsilon^t|\epsilon^{t-1})}{p_t} + \frac{M_{t-1}}{p_{t-1}} \frac{p_{t-1}}{p_t}, \quad \forall\, \epsilon^t|\epsilon^{t-1}.$$

i_{t-1}, m_{t-1}, M_{t-1}/p_{t-1}, and ω_t are uniquely determined (cf. Lemma 2). It is evident that under uncertainty and without restrictions on (q_{t-1}, Q_{t-1}), the distribution of inflation across states is indeterminate. Even conditional on a particular cross section of state-contingent inflation rates that satisfy the first equation, only the state-contingent real value of government debt, $q_{t-1} + Q_{t-1}/p_t$, is fixed. Its composition generally remains indeterminate.

Several remarks on Lemma 3 are in order. First, the lemma applies under both Ricardian and non-Ricardian policy. Second, in a perfect foresight setting, the initial price level completely determines the equilibrium price level sequence. This is not the case under uncertainty, since the interest rate peg only fixes a weighted average of the inflation rates. Third, conditional on some state-contingent equilibrium price level sequence and the associated money supply sequence, the portfolio allocation (q,Q) remains indeterminate (cf. Sargent [1987, Proposition 5.2]).[13] Fourth, the portfolio allocation and the inflation rates are interdependent: suppose that the government only issues dollar-denominated, "risk-free" claims: $q_{t-1} \equiv 0$, $Q_{t-1}(\epsilon^t|\epsilon^{t-1}) \equiv \bar{Q}_{t-1}$, $\forall \epsilon^t|\epsilon^{t-1}$. Inflation rates and nominal claims must then satisfy

$$1 = \int_{\epsilon^t|\epsilon^{t-1}} \frac{m_{t-1}}{p_t}\, d\epsilon^t (1 + i_{t-1}) p_{t-1},$$

$$\omega_t = \frac{\bar{Q}_{t-1} + M_{t-1}}{p_t}.$$

If ω_t differs across states, so must prices: the existence of an equilibrium is inconsistent with truly risk-free nominal claims (i.e., claims that pay a safe real return) and a stochastic fiscal policy necessarily implies price level instability.[14] In such an economy with nominal, "risk-free," one-period bonds, the price level is recursively pinned down by

$$p_t = \left(\omega_{t-1} + g_{t-1} - \tau_{t-1} - \frac{M_{t-1}}{p_{t-1}} \frac{i_{t-1}}{1 + i_{t-1}} \right) \frac{(1 + i_{t-1}) p_{t-1}}{\omega_t}$$

once an initial price level is fixed.[15] Cochrane [2001] shows that the inflation rate sequence remains uniquely determined under general maturities, although its stochastic properties are strongly affected by the specific choice of maturity structure.[16]

With these preliminary findings, we can now characterize equilibrium under the different policy regimes. Consider first the case of a Ricardian policy. Lemmas 1 and 2 incorporate all restrictions imposed by an REE except (4), (8), (10), and (12). From Lemma 3, (q,Q) and the inflation rates can be chosen to satisfy (4), (8), and (10). We can therefore focus on the remaining equi-

13. Similarly, a Ricardian equivalence result applies.

14. Christiano and Fitzgerald [2000] label this result "Woodford's really unpleasant arithmetic."

State-contingent government debt, explicit or due to state-contingent inflation, need not be detrimental from a welfare point of view. See Lucas and Stokey [1983] for an analysis under the assumption of distorting taxation.

15. This follows from the equation in footnote 12.

16. Cochrane's model involves no monetary frictions and has $M_{t-1} \equiv 0$.

librium condition (12) in the initial period. Under a Ricardian regime, (12) is satisfied by assumption such that the intertemporal budget constraint imposes no restrictions on the endogenous variables; it only constrains fiscal policy. An REE therefore exists. The price level sequence is indeterminate because the equilibrium restrictions are homogeneous of degree 0 in (M_t, p_t, μ_t^{-1}). This is the standard price level indeterminacy result under a nominal interest rate peg. Moreover, as discussed in Lemma 3, there exists a multiplicity of equilibrium assignments of stochastic inflation rates (cf. Woodford [1994]). We thus have

PROPOSITION 1. Suppose that policy is Ricardian. Then an REE exists. The state-contingent equilibrium sequences $\{i_t, c_t, M_t/p_t, \mu_t p_t, \lambda_t, m_t, r_t, \omega_t\}$ are uniquely determined. The initial price level is indeterminate. The state-contingent inflation rates are indeterminate unless the economy is deterministic or the set of marketed assets sufficiently small.

Consider next the case of a non-Ricardian policy. Under such a regime, the government is not committed to identically satisfying (12), and the intertemporal budget constraint imposes an additional restriction on the endogenous variables. Whether an REE exists crucially hinges on the amount of nominal government liabilities. If the initial nominal liabilities differ from zero, the initial price level is determinate. Unconstrained by any other equilibrium condition, it can adjust to the unique level satisfying (12).[17] An REE therefore exists. The intuition for this FTPL link between non-Ricardian policy and the price level is straightforward: the interest rate peg and the non-Ricardian policy render the dynamics of government liabilities inherently unstable. Condition (12), on the other hand, requires that a transversality condition be satisfied in equilibrium. The existence of equilibrium therefore hinges on the initial condition of the system. The FTPL link allows to manipulate this initial condition by letting the price

17. As mentioned earlier, an REE under a non-Ricardian policy rule might result in a negative price level. Note also that the existence of an REE hinges on whether the equilibrium conditions without (12) leave the price level indeterminate. Whenever this is not the case (for example, with a CIA constraint, a money supply rule, and positive nominal interest rates), the equilibrium price level under a non-Ricardian policy is overdetermined.

The same result holds under more general assumptions about the nominal interest rate rule; for example, i_t might depend on lagged price levels.

level appropriately revalue outstanding government liabilities.[18] Summarizing, we have

PROPOSITION 2. Suppose that policy is non-Ricardian and the level of initial nominal government liabilities differs from zero. Then an REE exists. The state-contingent equilibrium sequences $\{i_t, c_t, M_t/p_t, \mu_t p_t, \lambda_t, m_t, r_t, \omega_t\}$ and the initial price level are uniquely determined. The state-contingent inflation rates are indeterminate unless the economy is deterministic or the set of marketed assets is sufficiently small.

In a non-Ricardian regime *without* initial nominal government liabilities, all variables in (12) are either predetermined or fixed by other equilibrium conditions (cf. Lemma 2). An REE exists only if (12) happens to be satisfied at those values. In that case, the non-Ricardian policy exactly replicates a Ricardian policy.

PROPOSITION 3. Suppose that policy is non-Ricardian and the level of initial nominal government liabilities equals zero. Then, an REE only exists if the initial real government debt happens to satisfy (12), subject to the equilibrium values $\{M_t/p_t, m_t\}$ implied by Lemmas 1 and 2. In that case, the implications of Proposition 1 follow.

Propositions 1–3 show that the specification of the policy rule and the initial level of nominal government liabilities crucially determine whether an REE exists and whether the price level is determinate: (i) under a Ricardian policy, the Walrasian auctioneer (or other forces outside the model) is free to pick the initial equilibrium price level; (ii) under a non-Ricardian policy with nonzero initial nominal liabilities, the auctioneer is restricted in this choice—only the specific price level that equilibrates the government's intertemporal budget constraint results in an REE; finally (iii) under a non-Ricardian policy with zero initial nominal liabilities, the auctioneer has no influence on the existence of an REE: everything hinges on whether the policy happens to replicate a Ricardian rule in which case an REE exists.

Proposition 2 replicates the argument of the FTPL supporters who focus on (ii) when arguing that the price level is fiscally determined. But even if (ii) were the relevant case to consider,

18. Cf. Leeper's [1991] discussion of "active" and "passive" policies and their implications for stability.

this interpretation would only be valid with respect to the initial price level, since the equilibrium inflation rates remain indeterminate even under a non-Ricardian policy (cf. Lemma 3). The reason for this inflation indeterminacy is that once the FTPL link has pinned down the initial price level, there is neither a need nor scope for it to operate again: no need, because the real value of outstanding government liabilities is then fixed at a level guaranteeing that (12) is satisfied in the current and all future periods.[19] The equilibrium conditions are therefore identical to those under a Ricardian policy, where the initial price level has been fixed by the auctioneer. No scope, because the FTPL link in the initial period operates through a *surprise.* Since such surprises are inconsistent with rational expectations, the FTPL link cannot operate in any period other than the initial one. It is exactly this feature that calls into question whether the FTPL link is still consistent with a rational expectations equilibrium, once the *issuance* of government debt is properly accounted for.

Modeling the issuance of government debt is also advisable for another reason. Supporters of the FTPL rationalize their assumption of a non-Ricardian policy by stressing that (12) should be interpreted as a "government valuation equation" instead of a budget constraint.[20] However, whereas the stock analogy describes the pricing of an asset to be issued, the interpretation of (12) as a government valuation equation implicitly introduces the *re*valuation of an asset issued in an earlier period. But under rational expectations, asset prices evolve along their state-contingent equilibrium paths, without such unanticipated revaluations. An "initial" revaluation via the FTPL link is therefore inconsistent with a rational expectations equilibrium in a slightly extended model stretching one period further into the past. Put differently, if the FTPL link operates in some "initial" period, then the model cannot explain how (as much) nominal government debt could have been issued before that period. Only the Ricardian policy assumption allows a meaningful discussion of the issuance of all government debt.

I now formalize this intuition.

19. This follows from the equation in footnote 12.

20. Cochrane [2000], for example, compares the FTPL link in (12) with the pricing of privately issued equity: "First, the issuer decides how many shares . . . he will sell, pledging to divide the state-contingent profit stream . . . among the shareholders. . . . The equilibrium price . . . of securities is then determined (by an expression parallel to (12))" [p. 16].

DEFINITION 3. *A rational expectations equilibrium with issued assets (REEI) under* $\{g_t,i_t\}$ *is an REE with no nominal asset holdings at the beginning of the initial period.*

To check whether non-Ricardian policies and the FTPL link are consistent with an REEI, we simply need to go back further in time than for our previous discussion, up to a period $k < 0$, say, where W_k equals zero such that all nominal assets are issued in or after period k. Since an REEI as of period k is the same as an REE with $W_k = 0$, it directly follows that the existence of an REEI is consistent with a Ricardian policy, but in general not consistent with a non-Ricardian policy.

PROPOSITION 4. (i) Suppose that policy is Ricardian. Then an REEI exists and the implications of Proposition 1 apply. (ii) Suppose that policy is non-Ricardian. Then an REEI only exists if the initial real government debt happens to satisfy (12), subject to the equilibrium values $\{M_t/p_t,m_t\}$ implied by Lemmas 1 and 2. In that case, the implications of Proposition 1 apply.

Proposition 4 makes it clear that the feasibility of non-Ricardian policies as well as the FTPL link between such policies and the price level is an artifact of an incompletely specified model: the FTPL relies on an asset revaluation occurring immediately at the beginning of the initial period; this revaluation only works in the presence of nonzero outstanding nominal liabilities; but the model cannot rationalize how these liabilities could have been issued (in that amount) in the first place. Non-Ricardian policies are not feasible because households cannot be cheated or forced to hold government debt if they must expect the latter to yield returns below the market clearing rate.

III.A. Objections

At this point, several questions or objections might arise. I discuss them in turn.

Government default. Does the requirement that policy be Ricardian exclude the possibility of government default? No. Default is just a special case of W_t (or w_t), the dollar value (or real value) of debt at maturity, stochastically varying with ϵ^t. Partial or full default in some state(s) of nature is consistent with an REEI, as long as the payoffs in other states are high enough to ex ante compensate investors for the potential losses.

State-contingent policy regimes. Consider an economy that started with zero initial nominal debt and assume that the policy regime is state contingent in the following sense: in period t, state $\hat{\epsilon}^t$, the government fixes the real primary surplus sequence from then on at some arbitrary level while policy in all other states of nature is Ricardian. One might suspect that, whatever level of nominal debt is carried into period t, state $\hat{\epsilon}^t$, together with the surplus sequence from then on, constrains the equilibrium value of $p_t(\hat{\epsilon}^t)$ and thus fiscally determines the price level in this particular branch of the event tree. But this is not the case. A policy regime cannot be Ricardian in some states of nature and non-Ricardian in others. What might appear as a non-Ricardian "subregime" as of $\hat{\epsilon}^t$, is truly one contingency within a broader Ricardian scheme. In this broader scheme the branch of the event tree from $\hat{\epsilon}^t$ onwards is consistent with an REEI, as long as the surpluses along that branch are balanced ex ante by surpluses in the other periods and contingencies. As shown earlier, price levels and $p_t(\hat{\epsilon}^t)$ in particular are not fiscally determined. Instead, they are chosen by the Walrasian auctioneer, subject to the conditions discussed in Lemma 3. It is not the amount of nominal debt, together with the surplus sequence, that determines the price level in $\hat{\epsilon}_t$; the price level sequence, together with the portfolio allocation, rather determines the amount of nominal debt issued in period $t-1$ and carried into state $\hat{\epsilon}_t$.

What comes first: nominal deficits or the price level? The REEI conditions fix the real deficit d_k in the initial period. The "timing" can then be either way:[21] (1) the fiscal authority moves before the auctioneer and issues nominal debt in the amount D_k, say. This determines the bond market clearing price level as $p_k = D_k/d_k$. Note that this is not the FTPL because policy is Ricardian. (2) The auctioneer moves first and fixes p_k. The government then issues nominal debt to the point, where $D_k = p_k d_k$. It cannot issue more than that amount because households would not willingly hold more, knowing that only d_k can be sustained in real terms.

Both variants (1) and (2) are internally consistent. Their implications, e.g., for inflation, are identical. In both cases, policy is Ricardian.

Expectations about future policy. The result that policy must be Ricardian relies on the assumption that households

21. I disregard uncertainty here and assume no monetary frictions.

rationally anticipate the possible surplus sequences. While this assumption is strong, it is certainly standard, especially in the context of (i) asset pricing and (ii) the evaluation of policy regimes [Lucas 1976]. Moreover, note that this paper does not impose the rational expectations assumption on the FTPL—the FTPL itself assumes rational expectations. This paper rather stresses that the rational expectations assumption should be *consistently* applied, and not only from some arbitrary period onwards. In effect, the crucial postulate here is that expectation formation in any period be consistent with expectation formation in the preceding period, not that expectations be formed rationally in the sense that subjective and objective probabilities of policy regimes exactly coincide.

IV. An Alternative: Valuing Nominal Flows

Is it possible to construct a modified theory that generates a link between non-Ricardian fiscal policy and the price level without suffering from the consistency problems of the FTPL? In principle, yes. To that end, the revaluation of nominal stocks needs to be replaced by the valuation of nominal flows. Consider a fiscal authority imposing real *and nominal* taxes and transfers—both in a non-Ricardian fashion. With nominal transfers T_t and no outstanding government liabilities in the initial period k, the equilibrium conditions are unchanged except that (2) and (12) are replaced by

$$(2') \qquad \omega_t + \frac{T_t}{p_t} + g_t - \tau_t - \left(\frac{M_t}{p_t} + \int_{\epsilon^{t+1}|\epsilon^t} \left[\frac{Q_t n_t}{p_t} + q_t m_t \right] d\epsilon^{t+1} \right) = 0,$$

$$(12') \qquad \omega_s = \sum_{t=s}^{\infty} \int_{\epsilon^t|\epsilon^s} \left(\tau_t - \frac{T_t}{p_t} + \frac{M_t}{p_t} \frac{i_t}{1+i_t} - g_t \right) \left(\prod_{j=s,\epsilon^s}^{t-1,\epsilon^{t-1}} m_j \right) d\epsilon^t, \quad \omega_k = 0.$$

As before, $\{g_t, \tau_t, T_t, i_t, M_t/p_t, m_t\}$ are uniquely determined in equilibrium. Under a non-Ricardian policy, (12′) and the equilibrium inflation rates therefore constrain the initial price level p_k. Nominal transfers thereby play the same role as outstanding nominal government debt in the FTPL: they establish a lever allowing the initial price level to equilibrate the government's intertemporal budget constraint, despite the non-Ricardian policy specification. However, whereas this lever is associated with a surprise revaluation of previously issued assets in the FTPL, this is not the case here. The assumption of nominal flows therefore avoids the problems discussed in Section III.

An alternative representation of (12′) further highlights the parallels between the two setups. Define $\tilde{W}_s$ as the time s dollar value of the nominal transfer stream $\{T_t\}_{t=s}^{\infty}$, $\tilde{W}_s \equiv \sum_{t=s}^{\infty} \int_{\epsilon^t|\epsilon^s} T_t (\prod_{j=s,\epsilon^s}^{t-1,\epsilon^{t-1}} n_j) d\epsilon^t$. As of time k, equation (12′) can then be expressed as

$$\text{(12}''\text{)} \qquad \frac{\tilde{W}_k}{p_k} = \sum_{t=k}^{\infty} \int_{\epsilon^t|\epsilon^k} \left(\tau_t + \frac{M_t}{p_t} \frac{i_t}{1+i_t} - g_t \right) \left(\prod_{j=k,\epsilon^k}^{t-1,\epsilon^{t-1}} m_j \right) d\epsilon^t.$$

Any equilibrium assignment of inflation across states of nature fixes the nominal value of $\tilde{W}_k$.[22] Since the real value of this "promise" of future transfer payments must satisfy (12″) in equilibrium, non-Ricardian policy pins down the initial price level in exactly the same manner as in the FTPL.[23]

Does this partial restoration of the FTPL link then imply that we need to update Sargent and Wallace's [1981] result on how monetary and fiscal policy interact in determining the equilibrium rate of inflation? No. The Ricardian or non-Ricardian character of the policy regime only determines how the *initial* price level is fixed: either by the auctioneer, or by the equilibrium condition (12″). It does not affect equilibrium *inflation* which is determined by equilibrium conditions other than (12″) that apply under any regime.[24] In particular, it is influenced by the surplus

22. If the economy is deterministic or the transfer stream is not state dependent, then this nominal value is pinned down independent of the cross-sectional distribution of inflation across states.

23. In developed economies, $\tilde{W}_k$ typically is large, due to pension entitlements and other government promises in nominal terms.

24. This interpretation contrasts with the "tight money paradox" in the FTPL literature (see Christiano and Fitzgerald [2000], Loyo [1999], and Woodford [2001]) according to which an aggressive Taylor rule (in the sense that the monetary authority elastically adjusts the nominal interest rate to an increase in inflation) paired with a non-Ricardian fiscal policy results in an inflationary or deflationary spiral. The argument is the following: under a non-Ricardian policy, (12) determines the initial price level. Given the previous period's price level, this pins down the initial inflation rate. Due to the central bank's aggressive reaction function, inflation above (below) the desired stationary rate results in a high (low) nominal interest rate and therefore in even higher (lower) future inflation. Under a Ricardian policy, in contrast, (12) does not pin down the initial price level and the desired inflation rate can be attained. The problem with this argument is the assumption of a given price level in the "period before the initial period." It is

sequence, the maturity structure of government debt, and the portfolio allocation between real and nominal claims (cf. Lemma 3).

V. Conclusions

The FTPL assumes that sometimes in the past, the government issued nominal liabilities. In addition, it implicitly postulates that the (average) return on these liabilities differs from the market clearing rate. These two assumptions are not consistent with standard notions of equilibrium. If households had expected the government not to live up to the terms of its commitment, they would not have bought (as much) government debt in the first place.

What makes the FTPL so different from many other theories that also involve the assumption of a surprise, is that the FTPL necessarily hinges on that assumption, whereas other theories use the surprise assumption as a shortcut that is not crucial for the main results. The FTPL is the rare example of a theory whose implications collapse once the seemingly innocuous assumption of a surprise is relaxed.

While the FTPL thus leads to a contradiction, fiscal price level determination is nevertheless possible. It requires the government to simultaneously commit to real and nominal flows. The price level then plays the same role of a lever between real and nominal values as in the FTPL, but without having to induce an ex post revaluation of assets with a market-determined return. Although theoretically consistent, such a modified framework provides no new insights into the determination of equilibrium inflation.

Under the supposition of exogenous policy rules, Sargent and Wallace's [1981] analysis therefore remains exhaustive. The FTPL does not add to our understanding of the interaction between monetary and fiscal policy. Further progress in that respect should come from a better appreciation of the *choices* underlying fiscal and monetary policy. What is then needed is a specification of policy makers' preferences and the restrictions they face. As this paper has confirmed, the latter include the government's intertemporal budget constraint.

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unclear where this period comes from. If introduced, the assumption of a non-Ricardian regime is led *ad absurdum,* as discussed in Section III.

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