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Abstract

In this paper I analyze the classes of price-paths arising from a non-Ricardian fiscal-monetary plan along the lines of the Fiscal Theory of the Price Level (FTPL), under a price-invariant nominal money supply rule in a standard Sidrauski-Brock model. I first show that fiscalist speculative deflationary paths are irrational bubbles. Then I argue that a fully autonomous fiscal policy is, in most cases, no implementable, regardless of the time-horizon, thus complementing Buiter's (2001, 2002) findings. Finally, I claim that, contrary to the FTPL's arguments, a speculative hyperinflation can never be a necessary result. This latter observation is taken as an evidence against the analogy drawn between the equilibrium value of a firm's stock and money, as recently suggested by some proponents of this new paradigm in monetary economics.

Keywords: Fiscal-monetary interactions, Fiscal Theory of the Price Level, explosive pricepaths, transversality conditions.

JEL classification: E31, E42, E61.

1 Introduction

The existence of multiple money-price equilibria is a well known result in many economic models and the issue has attracted much attention from economists. But, like many other basic aspects in monetary economics, the question of what are the "fundamental" determinants of the equilibrium value of money remains open. Firstly, modern government-issued money, being an intrinsically useless object, posses an important modeling problem: what is the role to be given to such an intrinsically useless asset? Although trying to give an answer to this question goes well beyond the aim of this paper, it is still useful in order to identify a first candidate to be an important determinant of the real value of money: the role played by money in the economy. Secondly, as pointed out by Sargent and Wallace (1981), since the monopolistic production of money may have effects on the balance-sheet of the issuer institution (in this paper, the government), public finance considerations seem to be another important candidate: the quantity of money and/or its value may be affected by fiscal factors.

In this paper I deal with two theoretical paradigms that share a common goal: combine the two broad sets of "determinants" given above so as to give an answer to the same question, i.e. where does the value of money come from? Apart from this common concern, everything else is conflicting in the two theories considered here: the traditional monetarist approach *à la* Sargent-Wallace and the recently developed Fiscal Theory of the Price Level[1] (FTPL, henceforth).

The monetarist paradigm is consistent with the following interpretation of the two determinants outlined above. The equilibrium price sequence depends positively on the sequence of money supplies. Of course, the equilibrium price level will also depend on the role played by money, i.e. it is also determined by those factors shaping the demand for money. Regarding the influence of fiscal variables, Sargent and Wallace argue that government deficits and debt are relevant for the price level as long as the government accommodates its monetary stance to meet some fiscal targets via seigniorage. With respect to the role of money in the economy, the degree of consensus within this paradigm is rather low. Still, many monetary models, different in their views about the underlying demand for money, allow for a familiar monetarist result: when money is perceived by private individuals to be a purely fiat asset (i.e. non-convertible into intrinsically valuable goods or assets given by the government), speculative hyperinflationary paths along which the demand for real balances vanishes cannot be eliminated[2]. Also, the standard

[1] Some of the seminal contributions on this new paradigm are contained in Leeper (1991), Sims (1994) and Woodford (1994, 1995). Since then, a growing number of papers have further developed this theory (see e.g. Bassetto (2002), Cochrane (1998, 2001, 2005), Daniel (2004), Davig and Leeper (2004), Gordon and Leeper (2002), Leeper and Nason (2005), Leeper and Yun (2005), Sims (1999, 2002) and Woodford (1998, 2001).

[2] This result holds for models with money in the utility function (e.g. Obstfeld and Rogoff (1983)), overlapping generations models (e.g. Sargent and Wallace (1981)), random-matching models (e.g. Kiyotaki and Wright (1989)) and models in which money is explicitly modeled as the most liquid asset (e.g. Kiyotaki and Moore (2001)).

monetarist wisdom dictates that price-paths along which the demand for real balances grows without limit in a deflationary speculative fashion can be ruled out on the basis of individual optimality (see, e.g. Brock (1974, 1975) and Obstfeld and Rogoff (1983)).

The FTPL's view on the above particular issues is, basically, the opposite to the monetarist one. According to the FTPL, the price level is, fundamentally, a fiscal phenomenon. Fiscal variables like government surpluses/deficits, government debt (and its denomination, real or nominal) are thought to be the main determinants of the price level. Money supply and demand play a very marginal role. Indeed, money may be dropped from the economy, and the FTPL would still be able to say what the price level is, as long as the private sector holds some initial financial wealth denominated in dollars and some general sign conditions hold[3]. The fiscal-monetary policy-coordination highlighted by Sargent and Wallace is not longer present in a fiscalist world. Fiscal and monetary policies can be designed and implemented in a fully uncoordinated fashion, implying, among other things, that an independent central bank does not longer guarantee inflation stability. Further, this theory is consistent with a rather counterintuitive result: the government, through a particular fiscal policy, may unchain an explosive deflation or hyperinflation, even in the stark example in which money supply is thought to remain constant at every future date. Thus, the FTPL is not simply consistent with the general view that the actions of one agent (the government) can induce changes in the optimal actions of other agents (households), but also is consistent with, e.g., the idea that government can act in a particular way that necessarily results in the private agents losing their "faith" in fiat money (i.e. causing a speculative hyperinflation).

A central objective of this paper is to shed some light on the current debate on the consistency of the fundamental postulates of the fiscal theory, confining the analysis to monetary rules based on a discretionary choice of the sequence of money supplies by the central banker, in which the term *discretionary* is referred to a monetary plan which is designed and executed in an autonomous way, i.e. free of any form of direct fiscal dominance and independently from the state of the economy. This is a natural terrain to study divergent price-paths, along which the price level explodes or implodes as time passes without a parallel change in the stock of money. Also, such a class of monetary rules has attracted much attention in the previous papers that analyze the internal consistency and/or the empirical plausibility of this theory. Yet the level of consensus within this branch of the literature is rather low. In a series of influential articles, Buiter (1999, 2001, 2002) argues that in a standard Sidrauski-Brock model with a finite number of periods, a monetary rule based on a discretionary choice of the sequence of money supplies coupled with a fully autonomous fiscal plan, as the ones considered by the FTPL, is likely to result in an over-determined system with more equations than unknowns. This is, to the best of my knowledge, one of the most clear-cut criticisms

[3] The cash-less limiting case has been studied by Bassetto (2002) and Weil (2002), among others.

of the fiscal theory, for it is based on an uncontroversial simple mathematical result. However, Buiter argues that such an over-determinacy problem vanishes as one considers an infinite horizon economy, thus implicitly admitting the feasibility of fiscally-driven divergent price-paths. A central theme of the paper is to show that Buiter's arguments for the finite horizon case *necessarily* extend to the infinite horizon framework. This result is interesting on several grounds. First, because it naturally adds to the consistency of the current analysis of the fiscal theory. Second, because many macro-monetary models are cast within the infinite-horizon framework. The output obtained here regarding this question can be posed in plain words as follows: *totally uncoordinated fiscal-monetary plans, as those considered by Buiter, result in a problem of over-determination of the price level, regardless of the economy's time-horizon.*

The above observation pertains to the (in-)equilibrium prescriptions of this theory and, as such, should not be much controversial. I then turn the view to the off-equilibrium arguments exploited by the FTPL to justify the possibility of a fiscalist hyperinflation. An interesting insight arises from the analysis of this extreme possibility. Treating the government intertemporal budget constraint as a money-valuation-equation, as advocated by the FTPL's proponents, rather than as an identity, is not sufficient to sustain the FTPL's arguments. If one thinks of an economy in which money could be positively valued by private individuals even when it is publicly known that money will never be turned into intrinsically valuable consumption goods by the government (and the economy under study allows for such a possibility), then one cannot explain an equilibrium in which money is valueless (i.e. the terminal situation along a hyperinflationary path) by drawing an analogy between money and a private firm's share, as advocated by some proponents of the FTPL[4]. No matter how low is the present-value stream of fiscal surpluses (zero in the limit), a zero value for money would never be a necessary unique result. A particular form of the government *default versus supersolvency asymmetry* discussed in a companion paper (Arce, 2005) applies here: the government can use its ability to raise taxes so as to avoid a speculative hyperinflation (as shown by Obstfeld and Rogoff (1983)) by committing to pay a price for money higher than that prevailing in the market, thus creating an arbitrage opportunity, but the government cannot force a speculative hyperinflation by "committing" to pay nothing for an asset (money) that, at the prevailing market-price, could be positively valued by private agents.

The paper is structured as follows. In Section 2, I develop a simple model that has been widely used in the previous literature and discuss the main implications regarding the equilibrium price-sequence determination under alternative monetarist and fiscalist formulations. In section 3, I show that fiscalist speculative deflationary price-paths can not be part of an equilibrium. In section 4, I first argue that a non-Ricardian plan involving a complete lack of fiscal and monetary coordination causes a problem of price

[4]For a recent exposition of this argument, see e.g. Cochrane (2005).

over-determination, regardless of the time-horizon of the economy. I then discuss the fiscalist arguments concerning the occurrence of a divergent hyperinflationary path as a unique equilibrium outcome. Section 5 contains a summary of the main conclusions.

2 Monetarist discipline vs Fiscalist *laissez-faire*

In this section, I first present a simple set-up to frame the arguments of the two paradigms at stake, the monetarist and the fiscalist. The model developed below contains a continuum of identical households and the government. Each household tries to maximize its total discounted utility in a Walrasian competitive environment and the government collects taxes, issues and purchases debt, consumes some real goods and prints money. Time is discrete, there is no uncertainty and households are assumed to form their expectations rationally. Then, I introduce the definition of alternative policies, according to the fiscalist Ricardian versus non-Ricardian distinction and, using some particular examples of these two broad classes of policies, I characterize the Walrasian competitive equilibria arising under each policy specification. The general aim here is to provide a general picture of the implications of several Ricardian and non-Ricardian fiscal-monetary programs for the determination of the equilibrium price sequence as they are usually presented in the previous literature[5].

2.1 A simple model

In most of the cases analyzed in this paper, I study price-level determination using an infinite-horizon economy[6]. The representative household is assumed to enjoy utility from consuming real goods and holding real balances and tries to maximize the following objective function[7]

$$\max_{\{c,M\}} \sum_{t=1}^{\infty} \beta^{t-1} \left[\frac{1}{1-\theta} c_t^{1-\theta} + \frac{1}{1-\theta} \left(\frac{M_t}{P_t} \right)^{1-\theta} \right] \tag{1}$$

where c_t represents the household's consumption, and $\frac{M_t}{P_t}$ corresponds to real money holdings, i.e., nominal balances, M_t, deflated by the general price level, P_t. The parameter $\beta \in (0,1)$ is the subjective discount factor. The parameter θ is strictly positive. As θ approaches unity, the felicity function converges to the natural-logarithmic form. The

[5] The examples presented below closely follow those contained in Sargent and Wallace (1981), for Ricardian policies, and in Woodford (1995), for the non-Ricardian fiscal-monetary mix.

[6] In section 4, I use a one-period version of this general model to facilitate the comparison with Buiter's results.

[7] The choice of this particular utility function is made for simplicity. To my knowledge, most of the previous papers about the FTPL in which real balances enter as an argument in the utility function assume consumption-money separability. Consideration of an isoelastic utility function adds to the simplicity of some mathematical derivations and allows for different classes of equilibrium price-paths just by assuming different values for the parameter θ, as discussed later.

household's flow of funds budget constraints are given by

$$b_t + \frac{B_t + M_t}{P_t} \leq y - \tau - c_t + (1 + r_{t-1})\, b_{t-1} + \frac{(1 + i_{t-1})\, B_{t-1} + M_{t-1}}{P_t} \quad (t \geq 1) \qquad (2)$$

where $y > 0$ is the exogenous household's endowment of consumption goods, τ is a real-denominated lump-sum tax collected by the government[8]; b_t and B_t are the amount of bonds denominated in real and monetary terms, respectively, demanded/supplied by the household at the beginning of period t. Bonds are assumed to mature one period after issued. Each real-denominated bond issued at $t-1$ is redeemed at a value equivalent to $1 + r_{t-1}$ consumption goods at t. Each dollar-denominated bond issued at $t-1$ is redeemed at a value equivalent to $1 + i_{t-1}$ dollars at t. Households are also endowed with some financial wealth at the beginning of the first period ($t = 1$), that may include government bonds, inclusive of interest, $(1 + i_0)\, B_0$ and $(1 + r_0)\, b_0$, and money balances, M_0. The face-value of this initial financial wealth is given exogenously and assumed to be strictly positive. Households are also constrained by the following no-Ponzi games condition[9]

$$\lim_{T \to \infty} \left(b_T + \frac{B_T + M_T}{P_T} \right) / \prod_{j=1}^{T-1} (1 + r_j) \geq 0 \qquad (3)$$

Combining (2) and (3), we learn that the household's intertemporal budget constraint at any period $t \geq 1$ is given by

$$(1 + r_{t-1})\, b_{t-1} + \frac{(1 + i_{t-1})\, B_{t-1} + M_{t-1}}{P_t} + \sum_{j=0}^{\infty} \frac{y - \tau}{\prod_{s=0}^{j-1} (1 + r_{t+s})} \geq \sum_{j=0}^{\infty} \frac{c_{t+j} + \frac{i_{t+j}}{1 + i_{t+j}} \frac{M_{t+j}}{P_{t+j}}}{\prod_{s=0}^{j-1} (1 + r_{t+s})} \qquad (4)$$

When the household behaves optimally, equations (2), (3) and (4) all hold as equalities. The remaining necessary conditions of the maximization problem faced by the representative household are

$$c_t^{-\theta} - \lambda_t = 0 \qquad (5a)$$

$$\frac{m_t^{-\theta} - \lambda_t}{P_t} + \beta \frac{\lambda_{t+1}}{P_{t+1}} = 0 \qquad (5b)$$

$$-\frac{\lambda_t}{P_t} + \beta \frac{(1 + i_t)\, \lambda_{t+1}}{P_{t+1}} = 0 \qquad (5c)$$

$$-\lambda_t + \beta\, (1 + r_t)\, \lambda_{t+1} = 0 \qquad (5d)$$

[8] For notational simplicity, both y and τ are assumed to be constant through time. The same assumption applies later for government consumption, g.

[9] This form for the no-Ponzi games condition, in which the present value of the *aggregate* long-run private financial wealth is required to be non-negative can be found, e.g. in Benhabib *et al.* (2002), Buiter (1999, 2001, 2002), Buiter and Sibert (2004), Canzoneri *et al.* (2001), Daniel (2004), Woodford (1995, 2001, 2003). By contrast, McCallum (2001, 2003) argues in favor of a separate non-negative limiting condition for each of the assets involved considered individually. I analyze the implications of these two different constraints in section 3.

where the λ's are the familiar Lagrangian multipliers and $m_t \equiv \frac{M_t}{P_t}$.

The fiscal branch of the government sets the level of taxes and government consumption and manages the public debt, issuing, purchasing and redeeming bonds. The central bank chooses the sequence of money supplies independently of any other variable in the economy. The policy mix is assumed to be consistent with the following general restrictions: $M_t^s \geq 0$ and $g < y$, where g stands for government consumption. The consolidated government's flow of funds constraint is given by

$$b_t^s + \frac{B_t^s + M_t^s}{P_t} = g - \tau + (1 + r_{t-1})\, b_{t-1}^s + \frac{M_{t-1}^s + (1 + i_{t-1})\, B_{t-1}^s}{P_t} \quad (t \geq 1) \qquad (6)$$

where b_t^s, B_t^s and M_t^s are, respectively, the government's demand/supply of real-denominated and nominal bonds and the supply of money during period t. Combining the sequence of constraints in (6) with the following transversality condition

$$\lim_{T \to \infty} \left(b_T^s + \frac{B_T^s + M_T^s}{P_T} \right) / \prod_{j=1}^{T-1} (1 + r_j) = 0 \qquad (7)$$

gives the following government intertemporal constraint,

$$(1 + r_{t-1})\, b_{t-1} + \frac{(1 + i_{t-1})\, B_{t-1} + M_{t-1}}{P_t} = \sum_{j=0}^{\infty} \frac{\tau - g + \frac{i_{t+j}}{1+i_{t+j}} \frac{M_{t+j}^s}{P_{t+j}}}{\prod_{s=0}^{j-1} (1 + r_{t+s})} \qquad (8)$$

2.2 Ricardian vs non-Ricardian

In this subsection I introduce a standard definition of Ricardian and non-Ricardian policies and examine the implications of alternative fiscal-monetary programs for the equilibrium of the model. In particular, I will assume that the policy announcements from both economic authorities are taken as credible by the households, thus respecting the standard Ricardian and non-Ricardian arguments. The following definition contains a standard Ricardian *versus* non-Ricardian distinction[10].

Definition 1 *A government policy is Ricardian if it is formulated in such a way that the transversality condition (7) is satisfied for any price sequence* $\{P_t\}_{t=1}^{\infty}$ *. It is non-Ricardian otherwise.*

The definition of a Walrasian competitive equilibrium for this economy is given below.

Definition 2 *A perfect foresight equilibrium in this economy is a set of allocations* $\{c_t\}$, $\{b_t\}$, $\{B_t\}$, *and* $\{M_t\}$,*a set of positive prices and interest rates sequences* $\{P_t\}$,$\{r_t\}$, $\{i_t\}$, *and a government policy such that the following conditions are satisfied:*

[10] See, e.g., Woodford (1995, 2001).

1. *Households maximize their utility subject to the constraints (2) and (3), the price and interest rates sequences and the government policy.*

2. *The government satisfies its budget constraint (6) as an equality in every single period and the transversality condition (7).*

3. *All markets clear in every period, i.e.,* $y = c_t + g$, $M_t = M_t^s$, $b_t = b_t^s$ *and* $B_t = B_t^s$ *for* $t \geq 1$.

A fiscal-dominance Ricardian regime Let's consider a fiscal plan involving an exogenous sequence of constant primary deficits, $\tau - g < 0$ for $t \geq 1$. Also, let's assume, for simplicity, that all debt is real-denominated[11]. As the fiscal authority moves first, the central banker must adjust its monetary policy so that the consolidated government intertemporal budget constraint (8) holds for any feasible price sequence, i.e. the sequence of seigniorage, $\left\{\frac{M_t - M_{t-1}}{P_t}\right\}_{t=1}^{\infty}$, adjusts endogenously. For example, if the monetary authority tries to collect a constant level of seigniorage, s, money supply must obey the following rule

$$M_t = P_t s + M_{t-1} \quad (t \geq 1) \tag{9}$$

where s satisfies

$$s = g - \tau + (1 - \beta)(1 + r_0) b_0 \tag{10}$$

Equation (10) is derived from the intertemporal constraint (8) and the individual optimization and market clearing conditions. Of course, as long as there is an upper limit for a constant level of seigniorage, say s^*, the fiscal authority is always limited in its choice of the primary deficit by the following constraint

$$g - \tau < s^* - (1 - \beta)(1 + r_0) b_0 \tag{11}$$

Further, depending on the properties of the utility function, a non-price contingent sequence of primary deficits may not be sustainable at all. The following examples illustrate this observation. First, if $\theta \geq 1$[12], the following condition holds as a strict inequality

$$\lim_{m \to 0} m \frac{\partial \left[\frac{1}{1-\theta} m^{1-\theta}\right]}{\partial m} \geq 0 \tag{12}$$

In such a case we learn that there cannot be speculative hyperinflationary paths in equilibrium[13], so there is a unique equilibrium price sequence. It follows that a policy of constant seigniorage and primary deficits satisfying (10) and (11) is feasible, in the sense that, in equilibrium, the government always meets its predetermined fiscal plans. For

[11] This set-up resembles the one considered by Sargent and Wallace (1981; Appendix B) in which all government debt is indexed or real-denominated.

[12] The equality part is understood as $\theta \searrow 1$.

[13] See Obstfeld and Rogoff (1983).

example, in the limiting case in which θ approaches unity, so that the liquidity services function is represented in logarithmic form, the initial equilibrium price level satisfies

$$\frac{M_0}{P_1} = -\left(1 + r_0\right) b_0 + \frac{\tau - g + c}{1 - \beta} \tag{13}$$

The rest of the elements of the equilibrium price sequence can be solved uniquely combining the first order conditions (5a), (5b) and (5d), the market clearing conditions and the money supply rule (9).

Second, if $\theta < 1$, condition (12) holds as an equality and, hence, speculative hyperinflationary paths along which the demand for real balances falls towards zero cannot be ruled out, unless the government commits to implement a price-contingent money-convertibility plan, as described by Obstfeld and Rogoff (1983) and Nicolini (1996). It follows, that in the absence of such a contingent convertibility plan, the commitment to run an exogenous sequence of primary surpluses may not be credible[14]. But even if paths with real balances disappearing are not observed in equilibrium, a feasible exogenous fiscal policy does not guarantee price uniqueness, as the same constant level of seigniorage may be collected for different inflation and price paths along a hump-shaped inflation-tax Laffer curve[15].

A monetary-dominance Ricardian regime Let's now consider the opposite regime in Sargent and Wallace's "game of chicken", in which the monetary authority moves first, announcing a constant exogenous growth rate for the nominal stock of money, i.e. $M_t = (1 + \mu) M_{t-1}$, with $\mu > 0$ and the initial condition $M_0 > 0$ taken as given. As in the fiscal-dominance regime above, if condition (12) holds as a strict inequality there is a unique equilibrium price sequence which can be solved by combining the money and consumption-goods market clearing conditions and the first order condition (5b). In this case, the only fiscal variable that affects the equilibrium price-sequence is the level of government expenditure since, in equilibrium, it determines the available resources for private consumption and, hence, the demand for real balances. On the other hand, if (12) is satisfied as an equality then we cannot rule out multiple price sequences along speculative hyperinflationary paths. In either case the fiscal authority must adjust the sequence of primary surpluses so as to satisfy (8) as an identity.

Summarizing, under both Ricardian regimes the price level and the inflation rate are purely "monetary" phenomena. Fiscal variables like debt and primary surpluses only influence directly the price sequence if the central bank accommodates its policy so as to collect a particular targeted level of seigniorage[16]. When condition (12) is satisfied as an

[14] This is just a reflection of the fact that, at some point(s) in time, it may not be possible to extract any seigniorage from pure fiat money, for in that case, there may be equilibria along which the demand for real balances drops to zero.

[15] Both kinds of speculative inflation paths, with and without a sustainable constant level of seigniorage, are analyzed by Sargent and Wallace (1981, 1987).

[16] As noticed above, strictly speaking, government consumption influences the equilibrium price sequence

equality, the most intuitive case according to Obstfeld and Rogoff (1983), the stronger version of the "game of chicken", according to which one of the economic authorities moves first, fixing exogenously its policy instruments, yields some "unpleasant" results. Under a monetary-dominance regime, nothing precludes a multiplicity of equilibrium price paths. Also, a fiscal-dominance regime may not be implementable unless there is a clear commitment from both fiscal and monetary authority to alter their original plans so as to implement a price-contingent money-convertibility plan. Overall, one of the central messages arising from the two policies analyzed here is that a certain degree of fiscal and monetary coordination is always needed, as dictated by the government intertemporal budget constrain (8).

A non-Ricardian regime Here I describe the FTPL's arguments concerning price level determination using the simplest class of non-Ricardian policies, namely, policies characterized by a complete lack of fiscal and monetary coordination along which both authorities set their policy instruments without any feedback from the observed price level[17]. Let's assume that the central bank announces an exogenous sequence of money supplies, $\{M_t\}_{t=1}^{\infty}$. First, let's suppose that the fiscal authority targets an exogenous sequence of constant primary surpluses/deficits. Then, the FTPL suggests that the entire equilibrium price-sequence can be solved from the government intertemporal budget constraint (8), which must be respected in equilibrium. Whether the price sequence constructed in this way is unique or not depends on the properties of the utility function. Specifically, the sign of the relationship between the inflation-tax terms on the right hand side of (8), $\frac{i_{t+j}}{1+i_{t+j}}\frac{M^s_{t+j}}{P_{t+j}}$, and the inflation rate, $\frac{P_{t+j+1}}{P_{t+j}}$, depends on the value of the parameter θ according to the following condition[18]

$$\frac{\partial\left(\frac{i_{t+j}}{1+i_{t+j}}\frac{M^s_{t+j}}{P_{t+j}}\right)}{\partial\frac{P_{t+j+1}}{P_{t+j}}} > 0 \ (=0) \ [<0] \quad \text{if} \quad \theta > 1 \ (\searrow 1) \ [<1]$$

Let's define Ω_t as the time-t discounted value of the current and future inflation-tax terms, i.e.

$$\Omega_t \equiv \sum_{j=0}^{\infty} \frac{\frac{i_{t+j}}{1+i_{t+j}}\frac{M^s_{t+j}}{P_{t+j}}}{\prod_{s=0}^{j-1}(1+r_{t+s})}$$

through its effect on private consumption.

[17] This generic class of non-Ricardian fiscal-monetary programs, in which both economic authorities set their policy instruments without any feedback from the price level, has been considered by a large number of authors, both defendants and opponents of the FTPL (see e.g. Buiter (1999, 2001, 2002), Cochrane (2005), Evans and Honkapohja (2004), Woodford (1995, 1998, 2001)).

[18] This condition is derived under the assumption that the corresponding individual first order conditions are satisfied.

It can be readily verified that the following sign condition holds

$$\text{sign}\left\{\frac{\partial\Omega_1}{\partial P_1}\right\} = \text{sign}\left\{\frac{\partial\left(\frac{i_{t+j}}{1+i_{t+j}}\frac{M^s_{t+j}}{P_{t+j}}\right)}{\partial\frac{P_{t+j+1}}{P_{t+j}}}\right\}$$

Then, provided $\theta \geq 1$, we learn that if there is a price level P_1 that satisfies the intertemporal budget constraint (8), then it must be the unique one satisfying that condition. Of course, for such a price level to be part of an equilibrium, the following sign condition must hold[19]

$$-\left(1+r_{t-1}\right)b_{t-1} + \sum_{j=0}^{\infty}\frac{\tau_{t+j} - g_{t+j} + \frac{i_{t+j}}{1+i_{t+j}}\frac{M^s_{t+j}}{P_{t+j}}}{\prod_{s=0}^{j-1}\left(1+r_{t+s}\right)} > 0 \tag{14}$$

The case in which $\theta < 1$ requires a separate argument. As in this case both sides of (8) are decreasing in P_1, we cannot get a clean single-crossing result as before, as there may potentially be several initial price levels (and inflation sequences) compatible with that constraint. Generally, a similar argument applies to any utility function that yields a hump-shaped inflation-tax Laffer curve. In view of this potential multiplicity of equilibria, Woodford (1995) proposes the following tax policy

$$\tau = \overline{\tau} - \frac{i_t}{1+i_t}\frac{M_t}{P_t} \tag{15}$$

where $\overline{\tau}$ is set exogenously. Such a tax policy implies that the right hand side of the budget constraint (8) does not contain any price-dependent variable, i.e.,

$$\left(1+r_{t-1}\right)b_{t-1} + \frac{\left(1+i_{t-1}\right)B_{t-1} + M_{t-1}}{P_t} = \sum_{j=0}^{\infty}\frac{\overline{\tau} - g}{\prod_{s=0}^{j-1}\left(1+r_{t+s}\right)} \tag{16}$$

It follows that, as long as a sign condition similar to (14) holds, there is unique price level, P_1, such that (16) is satisfied. The characterization of the entire price-sequence constructed in that way is then straightforward. Once P_1 is uniquely determined, the net supply of government bonds can be computed uniquely from the flow of funds constraint (6), with the composition of the total end-of-period stock of debt being autonomously fixed by the issuing agent. Then, we can solve for a unique P_2 following the same argument as before, i.e. by computing (16) one period forward, and, in this fashion, the unique price sequence consistent with the foregoing fiscal-monetary non-Ricardian plan.

Thus, according to the FTPL, a fully uncoordinated fiscal-monetary plan like the one just presented works *de facto* as an equilibrium selection device, as pointed out by Kocherlakota and Phelan (1999). It is worth noticing that the unique fiscalist price path need not to coincide with the fundamental monetarist one, in the sense that, even in face of a constant money supply policy, the fiscal decisions may well unchain either

[19] Recall the assumption that the dollar-denominated household's initial financial wealth (i.e. dollars and nominal bonds inherited from period 0) is strictly positive.

a hyperinflation or a deflation. These issues, i.e. the degrees of freedom of the fiscal authority to implement a policy which is only consistent with a particular divergent hyperinflationary or deflationary path, and some potential "anomalies" implicit in the construction of the fiscalist price-sequence just described are analyzed in the following sections.

3 Fiscalist speculative deflations: An issue of rationality

Woodford (1995) argues that the only requirement to be imposed on the evolution of the stock of total financial wealth is the transversality condition (7), thus admitting the possibility that the total discounted value of each of the three terms in that condition (real balances and debt, nominal and real) differs from zero. That is, according to that argument the following constraint is not strictly necessary for equilibrium

$$\lim_{T\to\infty} \frac{b_T^s}{\prod_{j=1}^{T-1}(1+r_j)} = \lim_{T\to\infty} \frac{B_T^s/P_T}{\prod_{j=1}^{T-1}(1+r_j)} = \lim_{T\to\infty} \frac{M_T^s/P_T}{\prod_{j=1}^{T-1}(1+r_j)} = 0 \tag{17}$$

All that matters regarding the individual optimization problem is that the present value of the long-run aggregate financial wealth, i.e. the sum of the three terms above, converges to zero: "*Equilibria of the kind constructed above will, for some specifications of the monetary and fiscal sequences, imply explosive growth of real money balances to such an extent that (17) is violated. These solutions* [...] *involve the supply of government debt becoming negative - i.e., the government must become a net lender to the private sector.* [...] *Because their monetary assets are offset by debt, households are not over-accumulating wealth along such paths.*" (Woodford (1995), equation numbering adapted[20]).

A similar environment (i.e., non-Ricardian exogenous sequences of money supplies and primary surpluses/deficits in an infinite-horizon economy) has been studied by some other authors analyzing the FTPL. Buiter (1999, 2001, 2002) provides a lucid proof against the fiscalist arguments in a finite-horizon economy in which real balances enter as an argument in the household's utility function (to be discussed later in detail), however he explicitly recognizes that a symmetric argument cannot be applied to an infinite-horizon economy: "*In the simple 'money in the direct utility function' model of this paper, unbounded real balances do not violate the equilibrium conditions, because the nominal interest rate would go to zero, creating an unbounded equilibrium demand for real balances without consumption becoming unbounded.*". (Buiter (2001)). Marimón (2001) presents a model inspired in a firm's equity valuation problem, similar in most respects to the one employed here. He analyzes fiscalist deflationary paths like the ones described by Woodford in an infinite-horizon set-up. Some of the main conclusions in that article are

[20] A similar argument can be found in Woodford (2003).

the following: "*Nevertheless, the (fiscalist) determinacy result requires that proper present value calculations are made by all agents. In our deterministic context this is already difficult; in a stochastic context, [...] it may be close to impossible. [...] As existing experimental evidence suggests, it is unlikely that all the equilibrium paths determined by the fiscal theory will arise. This again, is an empirical matter* [...]" (Parentheses added).

With respect to the above criticisms, here I take a further step, showing that speculative deflationary paths associated with a violation of (17), in the sense described later, can not be part of an equilibrium for this economy. For the sake of the clarity, I first consider a non-monetary economy in which real bonds are the only available financial asset. Although such a scenario does not shed any light on the question of whether fiscalist deflationary paths are possible equilibrium outcomes, it provides some useful insights on the economic meaning of the transversality condition. Then, I introduce money along the lines of the model discussed in the preceding section to show that a long-run accumulation of real balances by the households inconsistent with (17) tantamounts to a violation of an individual optimization condition. Without loss of generality, for the remaining of this section it is assumed that the utility functions in (1) are logarithmic[21]. Also, to save on notation, it is assumed that government consumption is zero ($g = 0$).

3.1 A cash-less economy

Let's first think of an economy in which individuals maximize the following felicity function,

$$\max_{\{c,M\}} \sum_{t=1}^{\infty} \beta^{t-1} \log c_t$$

subject to the sequence of flow of funds constraints

$$b_t \leq y - \tau - c_t + (1 + r_{t-1})\, b_{t-1} \quad (t \geq 1)$$

Thus, money is not traded at all. Consistently, nominal bonds, whose real value is linked to money, are not transacted either. As before, households are assumed to hold some initial financial wealth in the form of real-denominated bonds, inclusive of interest, maturing at the beginning of period 1, $(1 + r_0)\, b_0 > 0$. As the stock of money and nominal bonds are identically equal to zero at each date, the equivalent to the transversality condition imposed previously, (3), would now read as follows

$$\lim_{T \to \infty} b_T / \prod_{j=1}^{T-1} (1 + r_j) \geq 0 \tag{18}$$

[21] This assumption simplifies computations, as the equilibrium inflation-tax Laffer curve is independent of the inflation rate. Such an assumption is critical to rule out hyperinflationary paths, as discussed before, but it is irrelevant with respect to deflationary paths analyzed here.

For logarithmic utility function, the Euler equation takes the form

$$\frac{c_{t+1}}{c_t} = \beta\,(1 + r_t) \tag{19}$$

The government budget constraint now becomes

$$b_t^s = -\tau + (1 + r_{t-1})\, b_{t-1}^s \quad (t \geq 1)$$

After imposing market clearing and individual optimization together with the no-Ponzi games condition (18) holding as an equality, the existence of equilibrium for this economy calls for a unique tax sequence for which, according to the assumption of constant tax rate, each element (denoted by τ^M) satisfies the following condition

$$\tau^M = (1 - \beta)\,(1 + r_0)\, b_0 \tag{20}$$

Although obvious, it is worth stressing the argument followed to label the tax rate satisfying (20) as the unique equilibrium one: implementation of any other (constant) tax policy requires a departure from some fundamental features of the economy we are studying. For example, a tax rate below τ^M, maintaining the assumption of zero g, could only be implemented by, e.g., allowing the government to break its commitment to redeem the initial stock of government bonds at its contractual value or to employ some coercive instruments to force individuals to purchase bonds that pay a real return below its opportunity cost, i.e. by violating (19). A special case of such a coercive action is that associated with the transversality condition (18) holding as a strict inequality, for in that case the households would be forced to accumulate government bonds whose present redemption value is zero. Likewise, a tax rate above τ^M would require the payment of a supersolvency premium on the initial stock of bonds or the commitment by the government to borrow (lend) at a real rate above (below) the one consistent with the Euler equation (19). An example of such a fiscal strategy can be constructed by allowing the government to accumulate bonds issued by the households in an amount that violates the transversality condition (18). To see this, let's assume that the government implements a tax rate τ^H, such that $\tau^H > \tau^M$. Under this policy the government intertemporal budget constraint becomes

$$(1 + r_0)\, b_0 = \frac{\tau^H}{1 - \beta} + \lim_{T \to \infty} \beta^{T-1} b_T \tag{21}$$

with $\lim_{T\to\infty} \beta^{T-1} b_T < 0$. One readily recognizes that such a long-run accumulation of bonds plays the role of a mechanism to distribute resources from an otherwise supersolvent government to the private sector. Thus, the purchase of those bonds tantamounts to an outright transfer (equivalent to a reduction in the tax rate[22] from τ^H to τ^M), and not to

[22] Indeed, the government's purchase of those bonds would require a direct individually-based form of allocation, e.g. rationing, very much as a tax reduction.

a process of accumulation of *wealth*, for, indeed, the government is never going to recover those resources transferred in this way. In such a scenario, one could even argue that the last term in (21) does not represent a stock of properly defined bonds, since the buyer is expecting a future zero payoff from that financial investment.

In sum, implementation of a tax policy different from the one for which the transversality condition (18) is not satisfied requires the incorporation of some strange elements into the definition of equilibrium for the canonical economy described here, like the ability of the government to sell bonds whose return is not in line with the marginal rate of substitution, as dictated by the first order condition (19), or to violate the limiting condition (18) in order to transfer resources to the private sector by purchasing "bonds" that are never going to be redeemed (henceforth, *non-performing bonds*).

3.2 Introducing money

Now I return to the general model with money described in the preceding section. To facilitate the comparison with the cash-less economy analyzed above, I maintain the same assumptions, i.e. logarithmic utility functions, time-invariant sequences of taxes and zero government expenditure. The numerical values of y, $(1+r_0)\,b_0$ and β are thought to be the same as in the cash-less example. For the sake of the clarity, I first focus on a simple monetary rule along which the central bank keeps the stock of money constant at its initial value, i.e. $M_t = M_0 > 0$, $t \geq 1$. As the aim here is to study the implications of a positive present-value of the long-run stock of real balances held by the households coupled with an equivalent accumulation of bonds by the government, and the denomination of those bonds is insubstantial for this issue, I focus on the simplest case in which the amount of nominal debt is negligible.

With the foregoing set of assumptions, the relevant equilibrium intertemporal government constraint computed at the initial period is

$$\frac{M_0}{P_1^F} + (1+r_0)\,b_0 = \frac{\tau + y}{1-\beta} \tag{22}$$

For the fiscalist price, P_1^F, to be well defined, the sequence of primary surpluses must be consistent with the following sign condition (similar to (14))

$$\frac{\tau + y}{1-\beta} - (1+r_0)\,b_0 \geq 0$$

Given the specification for the sequence of government consumption and the constant money supply rule, we learn that the fundamental monetarist equilibrium price level, i.e. the price that satisfies the first order condition (5b) and is consistent with the transver-

sality condition (17), call it P^f, is constant. Its value is given by

$$P^f = (1-\beta)\frac{M_0}{y} \tag{23}$$

As the stock of money is constant, seigniorage is identically equal to zero, so money is neutral from a fiscal perspective. Then, it can be readily verified that the unique equilibrium tax sequence consistent with that monetarist solution is τ^M, given above by (20).

In order to obtain a fiscalist deflationary price sequence consistent with (3) holding as an equality and with a simultaneous violation of (17), the tax sequence, denoting each element by τ^H as in the previous subsection, must satisfy the following (equivalent) sign conditions

$$\begin{aligned} \frac{\tau^H}{1-\beta} &> (1+r_0)\,b_0 \\ \tau^H &> \tau^M \end{aligned}$$

When these inequalities hold, the following inequalities are also satisfied

$$\begin{aligned} P_1^F &< (1-\beta)\frac{M_0}{y} \equiv P^f \\ P_{t+1}^F &< P_t^F \quad (t \geq 1) \end{aligned}$$

where P_t^F refers to the elements of the price sequence for which (5b) is satisfied at every period, given the market clearing conditions. Then, the terms in (17), by construction, satisfy

$$-\lim_{T\to\infty}\frac{b_T}{\prod_{j=1}^{T-1}(1+r_j)} = \lim_{T\to\infty}\frac{M_T^s/P_T}{\prod_{j=1}^{T-1}(1+r_j)} = -(1+r_0)\,b_0 + \frac{\tau^H}{1-\beta} > 0$$

with $(1+r_t) = \beta^{-1}$ $(\forall t \geq 1)$ and $\lim_{T\to\infty}\beta^{-1}\frac{P_{T+1}}{P_T} = 0$.

Thus, such a path is associated with a long-run accumulation of households' bonds by the government and, symmetrically, with a positive present-value stock of real balances in hands of the households, as described in Woodford's passage. A natural question arises: does this accumulation of bonds by the government hide an outright uncompensated transfer of resources, as in the cash-less example, or, on the contrary, the parallel accumulation of monetary wealth by the private sector is sufficient to compensate that transfer? To see how the inclusion of money might change the picture described in the cash-less economy, it is useful to rewrite the government intertemporal constraint (22) as follows,

$$(1+r_0)\,b_0 = \frac{\tau^H}{1-\beta} + \lim_{T\to\infty}\beta^{T-1}b_T \tag{24}$$

By comparing (21) and (24) we arrive at an uncontroversial result: adding money does not change anything. The same anomalies described in the cash-less economy are present here, i.e. the long-run stock of bonds accumulated by the government plays the role of a pure uncompensated transfer to the private sector and, hence, considering those "bonds" as "wealth" is a conceptual anomaly[23].

Then, what is special in the fiscalist wealth-offsetting effect? In the limit (as t becomes unboundedly large) we see individuals selling bonds to the government at a unit price of one consumption good and accumulating real balances through a money revaluation-process that, however, does not imply a symmetric *flow of funds* towards the government. The last term in (24) represents resources flowing from the government to the households, but a positive value of $\lim_{T\to\infty} \beta^{T-1}\frac{M_T}{P_T}$ does not represent any flow of resources from the households to the government. At its core, this accounting misspecification is a reflection of a flawed strategy based upon adding flow- and stock-variables together, which is "solved" by introducing a new policy instrument (non-performing bonds)[24].

The above accounting inconsistency extends to the fiscalist explanation of a deflationary bubble in the price level. From the classical works by Brock (1974, 1975) and Obstfeld and Rogoff (1983), we learned that individual optimal behavior calls for a zero present-value for the long-run stock of real balances holdings, $\lim_{T\to\infty} \beta^{T-1}\frac{M_T}{P_T}$, since a strictly positive value tantamounts to the existence of an arbitrage opportunity: an individual could increase its total utility by reducing its monetary holdings and increasing its consumption. A direct implication of that argument is that, in equilibrium, the amount of valuable resources that the private sector is willing to devote to maintain a positive stock of real balances cannot be above that one consistent with the "monetarist-fundamental" price P^f defined in (23).

The FTPL is at odds with that argument, the reason being that the household's attempt to reduce her stock of real balances would cause an immediate default, through a violation of its no-Ponzi games condition (3). However, from the above analysis, we know that private default, i.e. the long-run accumulation by the government of non-performing private bonds, is unavoidable given the fiscal commitment to a tax sequence like τ^H, and no change in the price level will correct it. In a sense, Woodford's assertion that the

[23] The analysis here differs from the one carried out by Marimón (2001) in this important respect. Marimón draws an analogy between the stock of money and the outstanding shares of a company, and labels a non-Ricardian policy violating (17) as a policy of permanently undistributed profits, in that the firm (i.e. the government) accumulates more profits (i.e. primary surpluses) than needed to redeem the initial stock of debt. Here I am sticking to the same interpretation as in the cash-less example: the extra "profits" are being distributed through the purchase of non-performing bonds, since, otherwise, the sequence of flow of funds *constraints* would be violated.

[24] In a recent paper Buiter and Sibert (2004) also justify the possibility of a deflationary bubble along which (17) is violated. Although they do not refer to a non-Ricardian fiscal plan, the same accounting anomaly as the one analyzed here applies in their environment: an unbounded accumulation of real balances by the households does not offset an unbounded accumulation of (non-performing) bonds by the government and, hence, along a deflationary bubble constructed in this way the private sector becomes insolvent in the sense just described. A similar observation applies to some deflationary equilibria studied by Benhabib *et al.* (2002, see e.g. their Section VI).

households are not over-accumulating wealth is true, since the households, at the aggregate level, are indeed insolvent, for those bonds sold in the long-run are never being redeemed. Thus, if one really wishes to rule out private default as an equilibrium outcome, a necessary first step is to impose the limiting condition $\lim_{T\to\infty}\beta^{T-1}b_T = 0$ (which clearly forces a change in the tax plan). Once this condition is imposed, $\lim_{T\to\infty}\beta^{T-1}\frac{M_T}{P_T} = 0$ appears as an equilibrium condition driven by *individual optimization* and deflationary bubbles are then eliminated. If, on the other hand, one is willing to *assume* the possibility of private default in equilibrium (i.e. non-performing bonds being traded, the former equality is not necessary for equilibrium, *by assumption*, but the latter will still bite, as long as the household, *by assumption*, maximizes her utility.

Thus, regardless of whether the government behaves like a private optimizing agent, by not purchasing non-performing bonds, or not, it is never optimal for the household to over-accumulate real balances in this economy and, hence, deflationary bubbles consistent with the violation of $\lim_{T\to\infty}\beta^{T-1}\frac{M_T}{P_T} = 0$ can only be based on non-optimal private portfolio choices. Offsetting a non-standard[25] government fiscal plan with a non-optimizing "equilibrium" individual behavior does not help much to understand the conditions under which a deflationary bubble could take place and the role, if any, that fiscal policy might play in unchaining it.

Extending the analysis to a money supply rule for which money is not fiscally neutral, in the sense that seigniorage is not identically equal to zero at each date, will not alter the main conclusion above. In this more general case, the government's intertemporal constraint becomes

$$(1+r_0)\,b_0 = \frac{\tau}{1-\beta} + \sum_{t=1}^{\infty}\beta^{t-1}\frac{M_t - M_{t-1}}{P_t} + \lim_{T\to\infty}\beta^{T-1}b_T$$

As the last term in the right side is negative, the present-value of total net uncompensated inflows of resources, i.e. taxes and seigniorage, exceeds the total standard net uncompensated outflows, that is, the initial stock of bonds. The gap is covered by an uncompensated outflow via purchases of no-performing bonds. But optimal individual choices still require the fulfillment of the limiting condition $\lim_{T\to\infty}\beta^{T-1}\frac{M_T}{P_T} = 0$.

4 Fiscalist non-deflationary paths: Not everything works

In this section I focus on fiscalist price paths along which the price level is not thought to decrease monotonically over time as in the case analyzed in the previous section. This general class of solutions includes both the fundamental monetarist solution and, possibly, multiple speculative hyperinflationary paths. The latter class of price-paths in the context

[25] By non-standard, here I mean the explicit consideration of a non-standard asset or, more precisely, a novel government-policy instrument (i.e. non-performing bonds).

of a Sidrauski-Brock model similar to the one in this paper have been extensively analyzed in the previous literature. Kocherlakota and Phelan (1999) consider a simple experiment consisting in a one-time decrease in the money supply under both a Ricardian-monetarist and a non-Ricardian-fiscalist policy: "*The monetarist device predicts a one-time decrease in the price level [...] the fiscal theory device predicts a speculative hyperinflation. Which prediction seems more plausible? You decide.*" Similarly, McCallum (2001) argues that the standard (fundamental) monetarist price sequence "*is arguably more plausible* (than a fiscalist hyperinflationary one) *since it is the solution that is typically regarded as the bubble-free 'fundamentals' solution.*" (Parentheses added). McCallum (2003) also investigates the learnability of fiscalist hyperinflationary paths in a stochastic environment[26]: "[...] *the fiscalist hypothesis implies that, despite a constant money stock, the bond stock and the price level both explode as time passes - but without violating any optimally condition for private agents.* [...] *The crucial issue is, which of the two solutions provides the better guide to reality, i.e., to price level behavior in actual economies?* [...] *it is demonstrated that with the basic policy specification the traditional fundamentals solution is E-stable and therefore learnable, whereas the fiscal-theory bubble solution is not.*"

Thus, to the best of my knowledge, all the previous papers analyzing the FTPL under an exogenous money supply rule in an infinite-horizon economy in which the velocity of money-circulation depends on the nominal interest rate come to agree on the same general point: fiscalist hyperinflationary paths are counterintuitive, implausible, unrealistic or not learnable, yet theoretically consistent, in the sense that along such paths no necessary condition for equilibrium is violated. Much on the contrary, in the finite-horizon counterpart of the models studied by the authors mentioned above, Buiter contends that in the FTPL "*the initial price level is determined twice, once from the monetary equilibrium conditions and once from the government's intertemporal budget constraint. Except through a fluke, these two values of the initial price level will not be the same.*" (Buiter (2002; p. 474). In plain words, this statement implies, that an arbitrary combination of fiscal and monetary plans coupled with an exogenous initial stock of nominal-denominated assets leads directly to an implementation problem: one of the two economic authorities must blink. In the remaining I first describe Buiter's argument in a simple one-period economy and then show that the same implementation problem is also present in the infinite-horizon version of the model. Finally, I analyze in some detail the FTPL's arguments using an extreme example of a fiscalist hyperinflation, devoting special attention to the role of transversality conditions, the fiscalist stock-analogy and the controversy on the origin of the initial stock of government liabilities.

[26] Evans and Honkapohja (2004) study fiscalist solutions along some learnibility criteria, as well.

4.1 A finite-horizon economy: Buiter's criticism

Let's think of a simple one-period economy, as a special case of the infinite-horizon one discussed so far. In such an economy, Buiter's criticism holds: a fully uncoordinated non-Ricardian fiscal-monetary plan is likely to be non-implementable. Let's assume that the representative household chooses the level of consumption, real money holdings and bonds so as to maximize

$$\frac{1}{1-\theta}c_1^{1-\theta}+\frac{1}{1-\theta}\left(\frac{M_1}{P_1}\right)^{1-\theta} \tag{25}$$

subject to the flow budget constraint

$$b_1+\frac{B_1+M_1}{P_1}\leq y-\tau-c_1+(1+r_0)\,b_0+\frac{(1+i_0)\,B_0+M_0}{P_1}$$

and the borrowing limit $\frac{B_1}{P_1}+b_1\geq 0$. When optimizing, the household behaves according to the following conditions

$$\begin{aligned}\frac{m_1^{-\theta}-c_1^{-\theta}}{P_t}&=0 \qquad (26)\\ c_1=y-\tau+(1+r_0)\,b_0+\frac{(1+i_0)\,B_0+M_0}{P_1}&-\frac{M_1}{P_1}\end{aligned}$$

The government budget constraint is given by

$$b_1^s+\frac{B_1^s+M_1^s}{P_1}=g-\tau+(1+r_0)\,b_0+\frac{M_0+(1+i_0)\,B_0}{P_1}$$

After imposing $\frac{B_1}{P_1}+b_1=0$ as an equilibrium requirement, the government's constraint reads as follows

$$\frac{M_0+(1+i_0)\,B_0}{P_1}=-(1+r_0)\,b_0+\tau-g+\frac{M_1^s}{P_1}$$

Let's assume that the central banker sets M_1^s and the fiscal authority chooses g, both being fixed independently of the observed price level, P_1. Then, given the market clearing conditions $c_1=y-g$ and $M_1=M_1^s$, we learn that there can be, at most, two alternative equilibrium price levels:

$$P_1^f=\frac{M_1}{y_1-g}\quad\text{for any }\theta>0 \tag{27a}$$

$$P_1^h=\infty\quad\text{for any }\theta<1 \tag{27b}$$

Notice that when $\theta>1$, there is a unique equilibrium price level (the fundamental one in (27a)), as in such a case (12) is satisfied as a strict inequality. But even if (12) holds as an equality, we can characterize all the feasible equilibrium price-levels (two in this case, the fundamental and the hyperinflationary one) regardless of the tax policy at work, τ, and of the initial stock of financial wealth (i.e. independently of its magnitude and

composition). It follows that the tax rate may take, at most, two possible values, τ^f and τ^h, each associated with one of the two possible prices consistent with the market clearing conditions and the optimality condition (26), P_1^f and P_1^h, respectively. These two feasible values are given below

$$\begin{aligned} \tau^f &= g + (1+r_0)\, b_0 + \frac{M_0 + (1+i_0)\, B_0}{P_1^f} - \frac{M_1^s}{P_1^f}, \quad \text{for } P_1 = P_1^f \\ \tau^h &= g + (1+r_0)\, b_0 \quad \text{for any } \theta < 1 \quad \text{for } P_1 = \infty \end{aligned} \tag{28}$$

Thus, any fiscal policy not in line with the above feasible tax rates, will result in an over-determined system, so an uncoordinated fiscal policy, in the sense just described, is not implementable.

4.2 An infinite-horizon economy

The above over-determinacy result should be uncontroversial. As pointed out by Buiter, it is just a question of counting equations and unknowns. However, Buiter fails to extend that argument to an infinite-horizon economy: "*Proposition 5, that under a non-Ricardian fiscal-financial-monetary programme with an exogenous rule for the nominal money stock the general price level is over-determined, now* (in the infinite horizon case) *only applies when the velocity of circulation of money does not depend on the nominal interest rate and, through that, on expected future price levels.*" (Buiter (2001), parentheses added). Here I argue that a similar over-determination problem arises in a with infinite-horizon model with real balances in the utility function, i.e. a model in which the velocity of circulation does depend on the nominal interest rate. I distinguish two cases, as before: $\theta \geq 1$ and $\theta < 1$.

First, when $\theta \geq 1$, we know from (12) that speculative hyperinflationary paths are not possible. Once the monetary authority has fixed the sequence of money supplies and the fiscal branch has set the sequence of government consumption, there is a unique equilibrium price sequence, as shown in the preceding section. For example, with logarithmic utility functions, if the central bank sets an exogenous money supply in period 1, M_1, and commits to increase it at a constant rate μ from that period on, then a constant tax rate sequence and the unique equilibrium price sequence must satisfy

$$\tau = \left[\frac{1-\beta}{1-\frac{\beta}{1+\mu}} \frac{(1+i_0)\, B_0 + M_0}{M_1} - 1 \right] (y-g) + g + (1-\beta)\,(1+r_0)\, b_0 \tag{29a}$$

$$P_t = \left(1 - \frac{\beta}{1+\mu} \right) \frac{(1+\mu)^{t-1}\, M_1}{y-g}, \quad (t \geq 1) \tag{29b}$$

It is worth noticing that the equilibrium price sequence in (29b) is completely independent of the tax policy and the initial stock of nominal financial wealth, $(1+r_0)\, b_0 + (1+i_0)\, B_0 +$

M_0. On the contrary, the equality in (29a) makes clear that the unique feasible tax policy depends on the initial volume of government obligations and on the time-path of the money supply and, hence, on the price sequence: a plain monetarist-Ricardian monetary-dominance regime at work.

Second, if $\theta < 1$, we know from the results discussed in section 3.2 that there are multiple equilibrium price-paths, one fundamental and, in an infinite horizon economy, an infinite number of speculative hyperinflationary paths consistent with the first order conditions of the household's optimization problem and the market clearing conditions. This potential multiplicity of equilibrium price-paths might suggest that the tax policy is not subject to a constraint like (29a). Here I argue that even when $\theta < 1$, there are not a continuum of equilibrium price-sequences, in the sense that between two consecutive different feasible hyperinflationary price-sequences (to be defined later), there are a continuum of non-equilibrium price-sequences.

The proof of the above claim (namely, that there are not a continuum of equilibrium price-sequences) is based on a simple observation. From the one-period economy described above, we learn that in a n-period economy there are $n+1$ (potential) equilibrium price sequences, n speculative and one fundamental. Each of the n speculative prices-paths can be labelled by its initial element, P_1^j $(j = 1, ..., n)$, such that $P_1^j > P_1^{j-1} > P_1^f$, where P_1^f is the first element of the unique bubble-free equilibrium sequence. Let's denote the set containing the n (potential) hyperinflationary-equilibrium initial prices by Ψ_n. As $M_t > 0$, there is a continuum of initial non-feasible, thus out-of-equilibrium price levels, P_1^{NE}, not belonging to Ψ_n and satisfying $P_1^j > P_1^{NE} > P_1^{j-1}$. Hence, as the number of periods increases by one, the number of feasible equilibrium price sequences increases by one, but the number of non-feasible price sequences increases by a continuum (i.e. by an infinite measure). Obviously, the argument goes on as we increase n without limit. It follows that a tax sequence chosen arbitrarily need not to be implementable. Formally, let's consider the fiscalist solution discussed in section 3.2 with the added simplifying assumptions used above, i.e. constant money supply ($M_t = M_0$ for $t \geq 1$) and constant and exogenous government consumption. The equivalent to the government valuation equation (16) now is given by[27]

$$\frac{(1+i_0)\,B_0 + M_0}{P_1} = \frac{\overline{\tau} - g}{1-\beta} - (1+r_0)\,b_0 \tag{30}$$

In view of (30), the fiscalist proposition according to which "the path of the money supply does not matter" is plainly justified: the sequence of money supplies $\{M_t\}_{t=1}^{\infty}$ is completely irrelevant for the determination of P_1 and the price level is only affected by fiscal variables (put aside M_0, which need not to be strictly positive for the fiscalist argument as long as $B_0 > 0$). However, for an arbitrary $\overline{\tau}$, the price, P_1, satisfying (30) need not to belong

[27] Recall that when $\theta < 1$, solving for the initial price level using the government intertemporal budget constraint may not give a unique solution. As pointed out before, a sufficient condition to preclude that possibility is to impose a tax policy like the one in (15).

to the set containing all P_1^j, even after taking into account that this set may contain an infinite number of elements. If we were to choose a particular $\overline{\tau}$ randomly, the system would be lead to a collapse of the price level with a probability 1.

Formally, if an arbitrary P_1 is not the fundamental one P_1^f, then it must satisfy $P_1 > P_1^f$, so it would be associated with a speculative hyperinflationary path. We also know that the last finite element of any sequence whose first element is in Ψ_n is uniquely given by $P^* = \frac{M}{y-g}$. As $P_1 \notin \Psi_n$, the last finite and positive element of the price sequence satisfying the individual optimization conditions and the market-clearing conditions associated with P_1, call it $\widetilde{P}$, must satisfy $\widetilde{P} > P^*$. But then, the first order condition (5b) is violated, i.e. it satisfies

$$\frac{\left(\frac{M}{\widetilde{P}}\right)^{-\theta} - \left(\frac{M}{P^*}\right)^{-\theta}}{\widetilde{P}} = -\beta \frac{(y-g)^{-\theta}}{\widetilde{P}_{+1}} > 0 \tag{31}$$

where $\widetilde{P}_{+1}$ would be the next period (negative) price level.

Clearly, the tax sequence must satisfy a restriction similar to (29a), although here, as the set of feasible prices contains an infinite number of elements, the set containing the potential constant taxation levels (i.e. those tax policies involving a term $\overline{\tau}$ that avoid the over-determination problem in (31)) includes an infinite number of elements, as well. Each of these elements must satisfy the following restriction

$$\overline{\tau}^f = (1-\beta)\left[\frac{(1+i_0)\,B_0 + M_0}{P_1^f} + (1+r_0)\,b_0\right] + g \quad \text{for } P_1^f \tag{32a}$$

$$\overline{\tau}^j = (1-\beta)\left[\frac{(1+i_0)\,B_0 + M_0}{P_1^j} + (1+r_0)\,b_0\right] + g \quad \text{for } P_1^j \in \Psi_n \tag{32b}$$

It follows that, as P_1^f and P_1^j depend on the particular money-supply sequence $\{M_t\}_{t=1}^{\infty}$, so must depend the sequence of potential constant taxation levels, as well. And, as before, in characterizing the set of feasible equilibrium price-sequences the information on the initial stock of government liabilities is completely irrelevant. In this precise sense, *except through a fluke* a fully uncoordinated non-Ricardian fiscal-monetary program will not pass its preliminary test: consistency with the equilibrium conditions, among which, a non-negative price level should be listed as a fundamental one.

4.3 Speculative hyperinflations: A necessary result?

The previous result poses an important obstacle for the fiscalist interpretation of the government budget intertemporal budget constraint (30) as a government valuation equation, along which the equilibrium price of outstanding nominal-denominated assets is computed as the price of a private firm's equity, since, as just shown, an arbitrary stream of current and future profits (i.e. government surpluses) coupled with an arbitrary initial stock of

firm's shares (i.e. initial nominal financial wealth, $(1+i_0)\,B_0 + M_0$) will, in most cases, lead to a negative price for the firm's equity as time passes. The extension of this critique to a stochastic environment, in which the sequence of fiscal surpluses and/or money supplies are subject to purely exogenous random shocks is straightforward, as well.

Still one could argue that the restriction on the set of implementable tax sequences contained in (32b) does not shed light on the question of which policy, monetary or fiscal, has the last word in the mechanism of equilibrium-prices determination. For example, the FTPL's arguments would be consistent with the idea that, either through a fluke or through a purposively fiscal-monetary coordinated mix, the government may unchain a speculative hyperinflationary path, as suggested by Kocherlakota and Phelan (1999), provided that individual preferences satisfy $\theta < 1$ and the foregoing fiscal-monetary plan is consistent with the implementation condition in (32b)[28]. Although this question, in contrast to those analyzed up to this point, pertains to the off-equilibrium sphere, the starkness of a fiscally-induced speculative hyperinflation provides a natural terrain in which one can learn on the fundamental differences of the two paradigms in question.

The fact that an intrinsically useless asset, like modern government-supplied money, may have a positive real value in equilibrium is not just a well-known result, but it is, perhaps, the most distinctive feature of non-convertible money. However, as the real value of money is only rooted on the private expectations about the value of that durable asset, nothing precludes the possibility of a class of equilibria in which money does not have any positive value. When the faith of the households in the current or future value of money weakens, the current real value of money falls, perhaps, to zero. Such a possibility is a natural result due to the nature of modern money, as long as government-issued notes can be thought as of being an intrinsically useless asset. Moreover, this possible outcome is a "healthy" result in any model of (non-convertible) purely fiat money. As shown by Obstfeld and Rogoff (1983), in an economy identical in its basic aspects to the one studied here, when private faith threatens to vanish, the government, by committing to turn money into a claim for an intrinsically valuable good, may avoid a speculative hyperinflation, adding the "missing doses of private faith" in money. But how can the government purposively reduce the real value of money? According to the monetarist wisdom, this can only be done by announcing a policy of increasing money supplies. But this will result in a 'fundamental' hyperinflation and not necessarily in a speculative one, that is, the real value of money need not drop to zero[29]. Thus, the asymmetry between avoiding a speculative hyperinflation and unchaining it is clear: private faith in money can be reinforced by the government, but the government cannot eliminate it. The FTPL is at odds with this principle. The following simple example seeks to explain why.

[28] As just shown, both conditions are necessary along an equilibrium hyperinflationary path.

[29] Along a non-specualtive hyperinflation the price level remains finite as long as the present and future money supplies remain finite as well.

For simplicity, I consider a version of the simple one-period economy analyzed above[30]. Let's initially think of an economy without government in which the representative household begins her life with a positive (and finite) stock of an intrinsically useless asset, called money and denoted by M, whose quantity can not be altered, so that the end-of-period aggregate stock of money must coincide with the initial one. As before, the household receives an endowment of consumption goods, y. These, consumption goods and money, are the only good/assets transacted in this economy. Preferences are given by (25) and $\theta < 1$ holds. The household-j budget constraint is

$$\frac{M^j}{P} \leq y - c^j + \frac{M}{P}$$

where $\frac{M^j}{P}$ and c^j are, respectively, the household's demand for real balances and consumption goods. The characterization of the two alternative Walrasian competitive equilibria is similar to the model with an active government discussed above. Given individual preferences, we learn that in addition to the fundamental price, $P^f = \frac{M}{y}$, there is another equilibrium in which money is valueless. In either case, equilibrium requires $c^j = y$ and $\frac{M^j}{P} = \frac{M}{P}$.

Now, let's introduce another agent into the picture, the government. This new agent is special in that it has the exclusive right to tax individuals and to supply an asset whose possession does not yield any utility to the households *per se*. Let's refer to this asset as a bond and denote its supply by d, its demand by household-j by d^j and its price, measured in units of consumption goods, by q. Suppose, that at the beginning of the period, before any trade takes place, the government announces that it will make a transfer to the private sector, which involves the delivery of consumption goods and/or money, equivalent to the value of T monetary units. Thus, its constraint reads as follows

$$qb + \tau = \frac{T}{P} \tag{33}$$

The Ricardian approach would be consistent with the following idea. The transversality condition $qb = 0$ must hold *always*, for any vector of prices (P, q). As the flow of funds identity (33) must hold for any conceivable P, the government must raise resources from the private sector to pay the transfer whenever the price is finite, like P^f above and, trivially, $\tau = 0$ holds in the equilibrium in which money is valueless. The FTPL, on the contrary, allows the government to ex-ante commit to a non-contingent zero tax. As a fundamental piece in the fiscalist argument is that the government always honors its commitments, it follows that the unique equilibrium calls for a zero value for money. Why cannot P^f be now part of an equilibrium? Because, according to the fiscalist dictum,

[30] This assumption is made for the clarity of the exposition. Nonetheless one may think of this economy as the first period of a multi-period one, with finite or infinite horizon, in which the endowments of money and consumption goods remain constant and the government commits to a zero primary surplus from period 2 on, thus rolling over any stock of debt alive at the end of period 1.

it would violate the government transversality condition and, with it, some individual optimality and/or market clearing condition. Still, it can be argued that it is always possible for the market for non-performing bonds to clear:

$$qb = q \sum_j b^j = 0 \tag{34}$$

That is, either both supply and demand are equal to zero or so it is the price level, q. This simple argument applies regardless of the value of P. Accepting the possibility that (34) *may* hold always and *assuming* that this is, indeed, the case tantamounts to impose the Ricardian hypothesis, under which P^f may well be an equilibrium outcome. Although to understand the lack of generality of the FTPL's arguments only the *may* part of the previous statement is necessary. The following remarks aim at clarifying some critical questions at this point.

i. Transversality conditions: identities or equilibrium conditions? Intertemporal government constraints or asset valuation equations? These questions are at the centre of the current debate on the FTPL. For some authors, like Buiter, transversality constraints must always hold, both at equilibrium and off-equilibrium prices. On the other hand, some proponents of this theory have provided some arguments for treating them as equilibrium conditions. Among those arguments, I find Cochrane's (2005) ones specially appealing. According to him, one should view government bonds and money as shares whose payoff is given by the expected fiscal surpluses: "The government *auctions* new debt, and accepts whatever price results [...]" (italics as in original). Thus, a positive supply of bonds, $b > 0$, cannot be ruled out *a priori*. In our simple economy, the households could auction consumption goods and/or money in exchange for those bonds. Can we assume that in some contingencies the households supply a positive amount of goods and/or money? Yes, thus violating an optimality condition. The resulting price of a bond would not capture the stream of surpluses backing those bonds, i.e. zero in this simple one-period economy[31]. That price wouldn't be an equilibrium one. In this sense, it can be argued that treating transversality conditions as identities seems a "too strong" assumption. In the same way as the first order condition governing the optimal individual demand for money (5b) may be seen as an asset valuation equation, which, somewhat tautologically, can be violated at off-equilibrium money-prices, the government intertemporal budget may be understood as a bond-valuation equation. But, can we assume that in some contingencies the households do not supply any goods and/or money in exchange for bonds? Yes, such an option is always feasible. In that case, the lending decision is the optimal one. The real value of a bond then drops to zero, in line with the future government's surpluses.

[31] The argument clearly applies in the same manner to an infinite horizon economy, where for a given stream of future fiscal surpluses, determined independently from the price of a bond, and a given stock of government bonds being auctioned, the equilibrium bond-price is unique. The fact that in a finite horizon economy the equilibrium bond-price for bonds auctioned in the terminal period is zero only adds a numerical detail.

Then, no matter what P happens to be, the government must abandon its target for a zero tax so as to satisfy $\tau = \frac{T}{P}$. Taking for granted that the government auctions new debt whenever P is finite, which assumption captures better the household's off-equilibrium lending behavior? This is a religious issue. Can we establish any link between P and the household's lending decision? No. Independently of the particular value of P, a household's strategy of a zero supply of goods and/or money in exchange for bonds is always feasible and optimal. Thus, regardless of whether one views transversality conditions as identities or as equilibrium conditions, there is *always* room for a Ricardian-like mechanism to operate, which, tautologically, means that the FTPL's non-Ricardian mechanism need not to operate.

Concerning the above two questions, the Ricardian hypothesis, takes a rather conservative approach: we know how to describe in an unambiguous way what the unique optimal lending decision is, but we do not have any guide to explain a non-optimal lending decision as a function of the value of money, hence we assume that the lending decision is the right one for any money-price. Such a hypothesis will not rule out equilibria in which money is not positively valued. Yet, as stressed above, that possibility *should* always arise in an economy in which money is a purely fiat asset. On the other hand, such a hypothesis will rule out the idea that money cannot be positively valued in equilibrium because, if that were the case, the households would feel an irrepressible temptation to demand (useless) government bonds and/or the market for money and/or consumption goods could not clear.

ii. Money as a private firm's stock. In Arce (2005), it is argued that the fiscalist stock-analogy can be interpreted as a useful tool to understand the limits of the FTPL as a theory capable to challenge the traditional monetarist propositions on the equilibrium value of fiat money. Here I take up the stock-analogy to argue that along a fiscalist hyperinflation the mechanism of price determination has no resemblance to the standard asset-valuation argument employed in solving for the equilibrium value of a firm's stock. The logic of this claim is simple. Following the fiscalist argument, let's think of the outstanding beginning-of-period stock of money and nominal bonds as residual claims to the government's fiscal surpluses. From the no-government case analyzed above, we know that there is an equilibrium in which the initial stock of money still has a positive value, simply because there is an underlying liquidity services function. This illustrates an important difference between money and the share of a firm. The former may be positively valued by the private sector even when its issuer commits to never redeem it in exchange for any intrinsically valuable good or to pay any dividend on it. Then, if money is still thought to be a "government share", it must be recognized that it may well be traded at a positive price even when the government is expected to make no profits. Then, how can we justify a zero value for money as a necessary unique equilibrium outcome? Clearly, not simply by arguing that the expected stream of profits backing the stock of money is zero, for those profits were already zero in the no-government case (by construction)

and there was an equilibrium at which money was positively valued[32]. In this sense, the stock analogy does not provide a sufficient intellectual framework to justify a fiscalist hyperinflation, this being a reflection of the fact that treating transversality conditions as equilibrium conditions is not sufficient to justify the off-equilibrium link between money prices, debt prices, market clearing and individual optimality implicit in the fiscalist hypothesis.

iii. The initial stock of nominal assets. Where did it come from? Does it matter? The FTPL regards the existence of an initial stock of nominal-denominated assets (i.e. money and/or nominal bonds) as a necessary condition for a non-Ricardian fiscal-monetary to yield equilibrium uniqueness. Niepelt (2004) forcefully argues against this hypothesis: if individuals would had anticipated the future implementation of a non-Ricardian regime at the time of purchasing the initial stock of government-issued assets (not explicitly modeled), they wouldn't have bought as much nominal assets in the first place. In view of these reflections, he suggests that the non-Ricardian argument would work properly if instead of assuming that there exists a positive stock of assets which were voluntarily bought by the households in some past date, the government commits to make nominal transfers and/or to levy taxes in a given nominal amount. The example constructed above clearly fulfills Niepelt's requirements to activate a fiscalist price-determination mechanism. On the one hand, the initial stock of money is explicitly treated as an exogenously given endowment. One may clearly understand this as the government dropping (i.e. giving for free) that money evenly across households at the beginning of the history, before voluntary trade takes place. On the other hand, we have just checked in the above example that regarding T as a pure nominal-denominated transfer rather than as a bunch of maturing government nominal bonds does not make any difference regarding the ability of the government to "choose" a hyperinflationary path as a unique equilibrium. Something is special in the FTPL, but it has no connection with the *voluntary-trade versus coercive-transfer* distinction highlighted by Niepelt. By contrast, most of the analysis on the special features of the FTPL carried out in the paragraphs above is focused on the role of the transversality conditions. This seems a natural strategy after recognizing that the Ricardian *versus* non-Ricardian distinction is, indeed, driven by an assumption about transversality conditions (Definition 2), and *only* by that.

Summarizing, none of the arguments built up to support the validity of the FTPL listed above provide a lucid explanation of the question we are after: how can the government implement a fiscal policy that *necessarily* results in private individuals loosing their faith on money? Although such a possibility may be seen as a minor pitfall in this theory, confined to a counterintuitive, although remote, theoretical possibility, it must be

[32] At this point one could argue that the government, apart from its monopolistic right to levy taxes, may also change the stock of money, so that it could use the latter to always meet its commitment to transfer T units of money to the private sector. This is true, the government may always finance a nominal-denominated transfer by printing money, but such a strategy leads to a plain *monetarist* fiscal-dominance regime similar to the one described in section 2.2.

recognized that the core mechanism of this theory works always in the same manner, regardless of whether the mechanism leads to the stark corner of a divergent hyperinflation or to a seemingly appealing explanation of some observed facts, and independently of the monetary rule at work (say, an interest rate peg or a nominal stock target).

5 Conclusions

In this paper, I dealt with a particular question raised in the recent debate on the validity of the Fiscal Theory of the Price Level (FTPL): the feasibility of fiscal-driven divergent price-paths in economies in which the monetary authority sets a nominal anchor by announcing an exogenous sequence of money supplies. In part, this question, as opposed to those tackled in a companion (Arce (2005)), pertains to the behavior of the economic variables *in equilibrium*, and, as such, should not be much controversial. Yet, for a theory that seems to posses a special ability to attract confusion, the degree of consensus on that question is still low. In a series of influential papers, Buiter (1999, 2001, 2002) argues that uncoordinated monetary-fiscal programs as those proposed by the FTPL are generally non-implementable in finite-horizon economies, for they involve a mathematical over-determination problem. However, he denies the existence of that problem in infinite-horizon models in which the demand for real balances depends upon expected inflation. This observation has been overlooked in the subsequent work on the FTPL devoted to the study of fiscalist deflationary or hyperinflationary paths. This piece of work is intended to fill this gap, by answering the following specific question: Do the implementation problems of non-Ricardian programs vanish in an infinite-horizon economy?

The answer to that question provided here is unambiguously negative. Using a standard model with money in the utility function, I first show that fiscalist divergent deflationary price-paths along which the private sector violates its solvency constraint are irrational bubbles, since, regardless of the government's fiscal plans it is never optimal for the household to accumulate an infinite amount of real balances. Second, I argue that, even when preferences allow for the possibility of a speculative hyperinflation, a fully uncoordinated fiscal non-Ricardian plan, as those considered by Buiter, will generally result in a negative price level. These are the two ways in which Buiter's findings for a finite-horizon economy emerge in the infinite counterpart. In this way, this work adds to a better understanding of some of the fundamental obstacles of this relatively new theory to offer a solid alternative to the traditional Ricardian-monetarist paradigm.

Also, I exploit the extreme case of a fiscalist hyperinflation to argue that the price-determination mechanism stressed by FTPL cannot be supported by just assuming that transversality conditions are equilibrium conditions (rather than identities) or by arguing that the equilibrium value of money can be determined following the same arguments traditionally employed in solving for the equilibrium value of a firm's equity.

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