Fiscal Policy, Price Surprises, and Inflation∗

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Abstract

This paper argues that the Fiscal Theory of the Price Level (FTPL) is most usefully viewed as a theory of price surprises in an explicitly stochastic economy with incomplete markets. This stochastic context allows extension of the FTPL to the case of no initial government debt. Additionally, it clarifies the roles of monetary and fiscal policy in determining inflation, allocating the role for systematic inflation to monetary policy and the responsibility for price surprises to fiscal innovations. We also show that if there is uncertainty about whether the government is Ricardian or not, then the FTPL applies and price is determined as though the government is not Ricardian. With regime uncertainty and a Ricardian government, multiple equilibria can exist.

Key words: Fiscal Theory of the Price Level, Monetary Policy, Fiscal Policy.

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Fiscal Policy, Price Surprises, and Inflation

1 Introduction

Stated simply, the fiscal theory of the price level says that the price level must assure that the real value of nominal government debt equals the present value of expected future fiscal surpluses, assuring intertemporal government budget balance. Equivalently, the theory can be stated that the price level must equate a representative agent’s demand for consumption, satisfying his Euler equation and intertemporal budget constraint, with the available supply of consumption goods, in an economy in which government debt is net wealth for the agent (Woodford 1995, 1998b, Daniel 2001b). Another equivalent statement, based on asset-pricing, is that the price level must be determined such that the real value of government debt equals the present value of profits from government operation (budget surpluses) (Cochrane 2000). Regardless of how it is expressed, the theory applies only if the government does not assure intertemporal budget balance at each and every price sequence.

This paper provides an explicitly stochastic treatment of the FTPL. The stochastic presentation allows extension of the theory to accommodate recent criticisms, clarifies the roles for monetary and fiscal policy in determining inflation, and extends the range of cases for which the FTPL is likely to apply. This paper explicitly considers two criticisms, one by Niepelt (2002) in which he argues that the FTPL is irrelevant with zero initial debt, and a second by Weil (2002) in which he argues that uncertainty about whether the regime is Ricardian, even when it is non-Ricardian, invalidates the FTPL. Consideration of these two critiques modifies the necessary conditions for the FTPL in interesting ways, implying that the FTPL is more relevant than its critics, and perhaps even its advocates, suppose. Specifically, the analysis shows that when markets are incomplete, the FTPL applies in all periods
in which government debt is not zero, if there is any probability that the government is not Ricardian. The analysis also clarifies the roles of monetary and fiscal policy in determining expected and unexpected inflation when the FTPL does apply, giving monetary policy the role of determining systematic inflation even under the FTPL.

This paper is organized as follows. The first section contains a theoretical presentation of the FTPL for the case in which initial government debt is zero. The model is presented, first, with perfect foresight and, second, with fiscal policy uncertainty and incomplete markets. The next section considers explicit fiscal rules, further illustrating the importance of interpreting the FTPL as applicable in an explicitly stochastic environment. The third section analyzes regime uncertainty and demonstrates that the FTPL applies if there is any possibility that the government is not Ricardian. The final section provides conclusions.

2 FTPL with No Initial Debt

2.1 Perfect Foresight - Benchmark Model

The fiscal theory of the price level (FTPL) is based on the government’s intertemporal budget constraint. To begin, consider a closed economy, in which the government issues money and one-period nominal debt. The government’s flow budget constraint is given by:

\[ M_t + B_t = (1 + i_{t-1})(M_{t-1} + B_{t-1}) + P_t(g_t - \tau_t) - i_{t-1}M_{t-1}, \]  

(1)

where \( P_t \) represents the price level, \( M_t \) and \( B_t \) represent nominal end-of-the-period money balances and bonds, respectively, \( i_{t-1} \) represents the nominal interest rate agreed upon by borrowers and lenders at the end of the period \( t - 1 \), \( g_t \) is real government spending, and \( \tau_t \) is
real lump-sum taxes. Denoting the government’s real primary surplus inclusive of seigniorage revenue by:

\[ s_t = \tau_t - g_t + \left( \frac{i_t}{1+i_t} \right) \frac{M_t}{P_t}, \]

and nominal government debt inclusive of interest by:

\[ D_t = (1+i_t)B_t + M_t, \]

the government’s flow budget constraint becomes:

\[ D_t = (1+i_t)(D_{t-1} - s_tP_t). \tag{2} \]

Imposing \( \lim_{T \to \infty} D_T \Pi_{t=0}^{T-1} \frac{1}{1+i_t} = 0 \) and assuming that the government does not default under perfect foresight, the government’s intertemporal budget constraint from period 0 becomes:

\[ \frac{D_{-1}}{P_0} = \sum_{t=0}^{\infty} s_t R_{0,t}, \tag{3} \]

where

\[ R_{j,t} = \Pi_j^t \left( \frac{1}{1+r_{j-1}} \right), \quad j \geq 0; \quad R_{0,0} = 1 \]

\[ 1 + r_{j-1} = (1+i_{j-1}) \frac{P_{j-1}}{P_j} = \frac{(1+i_{j-1})}{1+\pi_j}, \tag{4} \]

and where \( \pi_j \) is the inflation rate between periods \( j - 1 \) and \( j \). The intertemporal budget constraint (equation 3) states simply that the present value of future government surpluses, inclusive of seigniorage, must equal the real value of initial debt. The intertemporal budget constraint must hold in equilibrium. An equilibrium need not exist, and if it exists, it need not be unique. At a minimum, the existence of equilibrium requires that the present-value of
surpluses must be positive whenever there is initial positive government debt. Leeper (1991) shows that the joint stance of monetary and fiscal policy is important in determining both existence and uniqueness.

A government is said to be Ricardian if it adjusts surpluses to assure that equation (3) holds at any price level \((P_0)\). This makes surpluses endogenous to the quantity of real government debt. It also implies that intertemporal government budget balance places no restrictions on the price level, leaving the price level to be determined by other conditions in the economy.

Alternatively, a government is non-Ricardian if it chooses present-value surpluses independently of the initial stock of real government debt, and hence, independently of the initial price level. With non-Ricardian policy, the present value of future government surpluses is independent of the real value of government debt. If the right hand side of equation (3) is independent of the price level, then the only way that intertemporal government budget balance can hold is if the price level adjusts to assure that it holds. This is the assumption made under the fiscal theory of the price level.

A key to understanding the FTPL is that under the FTPL, equation (3) is not a government budget constraint, but an equation for goods market equilibrium. To understand this, assume a very simple real economy in which agents receive an endowment each period \((y_t)\), and in which there is no production and no real storage. Wealth consists of nominal money

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2 This requires the assumption that the government can change ordinary taxes net of government spending to offset endogenous changes in seigniorage revenue.
Fiscal Policy, Price Surprises, and Inflation

and one-period nominal bonds. The agent’s flow budget constraint is given by:

\[ P_t c_t + M_t + B_t = (1 + i_{t-1})(M_{t-1} + B_{t-1}) + P_t(y_t - \tau_t) - i_{t-1}M_{t-1}. \]  

(5)

Utility is separable in consumption and real money. Prices are completely flexible. The representative agent chooses money, bonds, and consumption to maximize utility, given by:

\[ U_t = \sum_{t=0}^{\infty} \left[ u(c_t) + v\left(\frac{M_t}{P_t}\right) \right], \]

where both \( u \) and \( v \) are concave functions, subject to the flow budget constraint. First order conditions yield the standard Euler equation:

\[ \frac{\beta (1 + i_t) u'(c_{t+1})}{(1 + \pi_{t+1}) u'(c_t)} = 1, \]  

(6)

and a money demand equation:

\[ \frac{i_t}{1 + i_t} = \frac{v'\left(\frac{M_t}{P_t}\right)}{u'(c_t)}. \]  

(7)

To derive the agent’s intertemporal budget constraint, use the simplifying notation above, to express the agent’s flow budget constraint as:

\[ D_t = (1 + i_t) [D_{t-1} - P_t (s_t + g_t + c_t - y_t)]. \]

Imposing \( \lim_{T \to \infty} D_T \Pi_{t=0}^{T-1} \left( \frac{1}{1+i_t} \right) = 0 \), the agent’s intertemporal budget constraint is given by:

\[ \sum_{t=0}^{\infty} c_t R_{0,t} = \frac{D_{-1}}{P_0} + \sum_{t=0}^{\infty} [y_t - g_t - s_t] R_{0,t}. \]  

(8)

An equilibrium for this economy requires satisfaction of goods market equilibrium \( (c_t = y_t - g_t) \), the two first order conditions, equations (6) and (7), together with the intertemporal budget
constraints for both the government and the agent, equations (3), and (8), respectively. Note that the agent’s intertemporal budget constraint equation (8), together with goods market equilibrium, yields the equation (3), which is the equation for the government’s intertemporal budget constraint and equivalently the equation for the FTPL. Therefore, we have the necessary equations for equilibrium without imposing the requirement for government intertemporal budget balance. Intertemporal government budget balance is obtained as a result of intertemporal budget balance for the agent together with goods market equilibrium. Intertemporal government budget balance need not be viewed as a constraint because it will be satisfied in equilibrium even when not imposed as a requirement for equilibrium.

Consider the mechanics of achieving equilibrium. Suppose the economy begins in equilibrium and that government cuts taxes permanently, making no additional changes. According to equation (8), \( s \) has fallen, raising the present value of the agent’s lifetime resources, raising desired consumption. However, since the aggregate endowment for the economy has not changed, this increase in consumption is not consistent with equilibrium. An increase in \( P_0 \) suffices to reduce consumption demand back to its previous equilibrium level by reducing the real value of the agent’s wealth.

Therefore, under perfect foresight, the FTPL states that the initial price level \( (P_0) \) is determined by the present value of future surpluses relative to the value of outstanding nominal government debt, as in equation (3). To understand the determination of next period’s price level \( (P_1) \), equivalently inflation, it is necessary to take the government’s flow budget constraint (equation 2) forward one period to determine the next period’s level of
nominal debt. This requires a nominal interest rate.

From equation (7), the monetary authority can control the nominal interest rate by controlling the stock of money through open market operations. To keep the analysis simple, assume that the monetary authority has an objective function with a target inflation rate given by the constant $\pi^*$. That is, it chooses the nominal interest rate each period with the objective of minimizing its loss function, given by:

$$L_0 = \sum_{t=0}^{\infty} \beta^t (\pi_t - \pi^*)^2.$$  

(9)

Note that from equation (6), the interest rate set at time 0 determines inflation over the coming period ($\pi_1$). Therefore, monetary policy from $t = 0$ cannot control $\pi_0$ directly with $i_0$, since $i_0$ together with $r_0$ determine $\pi_1$. Under non-Ricardian fiscal policy, monetary policy’s choice of $i_0$ has no influence over $\pi_0 = \frac{P_0}{P_{-1}} - 1$ since $P_0$ is determined by fiscal policy and $P_{-1}$ is predetermined. The best the monetary authority can do is to set the nominal interest rate such that $\pi_t = \pi^*$ for $t > 0$. Therefore, with this loss function and non-Ricardian fiscal policy, the monetary authority will set the nominal interest rate such that $P_t = P_{t-1}(1 + \pi^*)$.

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\footnote{This loss function is not meant to represent optimal monetary policy in the sense of maximizing utility of the representative agent. It is meant to provide a simple way to determine the nominal interest rate. We avoid specifying monetary policy as a rule, since the rule would need to be different in Ricardian and non-Ricardian regimes.}

\footnote{With a Ricardian fiscal authority, the monetary authority could use an unstable policy rule like a Taylor rule with an inflation coefficient greater than one, to get current and future inflation to equal the fixed rate target. However, when the fiscal authority is non-Ricardian, the monetary authority has (almost) no incentive to follow an unstable Taylor rule. This is because an unstable rule would imply ever-widening deviations of inflation from target over time. The only incentive the monetary authority could have for such a policy is that of making economic conditions so bad as to force the fiscal authority to become Ricardian, giving full inflation control to the monetary authority. However, since the legislature typically has authority to revoke central bank independence (Coleman 2001), it is unlikely that such a fiscal response would follow monetary policy which created ever widening deviations of inflation from target.}
Fiscal Policy, Price Surprises, and Inflation

This choice of the nominal interest rate determines the evolution of nominal government debt from equation (2). Substituting $D_{-1}$ from equation (3) into the government’s flow budget constraint (equation 2), making use of the definition of real and nominal interest rates in equations (4), yields the equation for the FTPL from period 1 as:

$$\frac{D_0}{P_1} = \sum_{t=1}^{\infty} s_t R_{1,t}.$$ 

Fiscal policy, defined as the present-value of future surpluses, determines real government debt. Subject to this constraint, the monetary authority’s choice of a nominal interest rate determines both the increase in the quantity of nominal debt and the increase in the price level, yielding control of inflation to the monetary authority. Therefore, even when the necessary conditions for the FTPL are satisfied, under perfect foresight, the fiscal authority only controls the initial price level. Monetary policy, not fiscal policy, controls inflation over time.

To summarize, under perfect foresight, the FTPL implies that the present value of future government surpluses determines the initial price level, while monetary policy determines inflation rates over time. This leaves fiscal policy very little role for determining prices, but Niepelt (2002) questions even this role.

Consider an initial period with no government debt. Logically, when a government is initially created, it begins with no debt. Intertemporal government budget balance from period 0 is given by:

$$0 = \sum_{t=0}^{\infty} s_t P_0 R_{0,t}.$$ 

The government’s intertemporal budget constraint has no implications for the price level.
Fiscal Policy, Price Surprises, and Inflation

The government must plan to balance its intertemporal budget constraint at any price level, satisfying the definition of Ricardian policy. Hence, Niepelt (2002) entitles a paper “The Fiscal Myth of the Price Level.” The government’s initial period flow budget constraint determines the initial price level from:

\[ D_0 = -P_0 s_0 (1 + i_0). \]  

Therefore, under perfect foresight and no initial government debt, the FTPL is irrelevant for prices and inflation in all periods. Even with positive initial debt, the FTPL is irrelevant for prices after the initial period. However, many presentations of the FTPL allow uncertainty. Next, we consider the implications of the model when it is modified to have uncertainty and incomplete markets.

2.2 Uncertainty and Incomplete Markets

Now, introduce uncertainty about the present value of future surpluses and incomplete markets, as is standard in many presentations of the FTPL. We assume that the present value of future surpluses in the non-Ricardian regime is stochastic taking on different values in different states of nature. To focus on government financing issues, we assume that surplus shocks take the form of shocks to lump-sum taxes. There is no other uncertainty. This allows a dichotomy between the real sector and the nominal sector, which simplifies the exposition. Following Niepelt (2002), consider a new government which has no initial debt. Equilibrium is now defined by a set of prices and quantities such that the goods market clears, the Euler equation (6) holds in expectation, the first order condition on money in equation (7) holds,
and both private and government intertemporal budgets balance, as in equations (8) and (3), respectively.\footnote{Recall that it is not necessary to impose the government intertemporal budget constraint because it is a consequence of the private intertemporal budget constraint and goods market equilibrium.}

The monetary authority is assumed to choose a nominal interest rate. Taking expectations of the Euler equation (6), under the assumption that the time path of equilibrium consumption is deterministic, the interest rate choice determines expected inflation (specifically, $E_t \left( \frac{1}{1 + \pi_{t+1}} \right)$). We assume that the monetary authority chooses the nominal rate such that expected inflation equals a fixed target according to:

$$E_t \left( \frac{1}{1 + \pi_{t+1}} \right) = \frac{1}{1 + \pi^*}. \quad (11)$$

Therefore, the monetary authority has full control over expected inflation through its choice of the nominal interest rate.

Now, consider the role of the fiscal authority in determining inflation when surplus policy is stochastic. First, we show that when government debt is zero, the government must choose primary surpluses such that their present value is zero. The government’s intertemporal budget constraint from time 0 is given by:

$$P_0 \hat{s}_0 = 0, \quad (12)$$

where

$$\hat{s}_0 = \sum_{t=0}^{\infty} \frac{P_t s_t}{P_0} \left( \Pi_{j=1}^t (1 + i_{j-1}) \right),$$

giving $\hat{s}_0$ the interpretation of the present-value of future surpluses. This requires that the present-value surplus be zero in all states, not just on average. With the standard assumption
that the government can commit not to default, equation (12) implies that \( \hat{s}_0 \) cannot be stochastic and must equal zero. Therefore, as in Niepelt (2002), the government’s present value surplus is irrelevant for determining the initial price level. For a rational expectations equilibrium with no default to exist, the government must plan to balance its intertemporal budget constraint from its initial inception no matter what the price level. Equation (12) is a constraint, which must be satisfied. When there is no government debt, all governments are Ricardian.

Next, we show that the present-value of surpluses can be stochastic from a period in which debt is not zero as long as it satisfies the constraint on the actual present-value surpluses, given by equation (12). Consider the implications of equation (12) for the government’s choice of \( \hat{s}_1 \). Note that we can write equation (12) equivalently as:

\[
P_0 \hat{s}_0 = P_0 s_0 + \frac{P_1 \hat{s}_1}{1 + i_0} = 0.
\]

(13)

Although \( \hat{s}_0 \) cannot be stochastic, equation (13) implies that its components can be, subject to restrictions. To understand this, substitute for \( P_0 s_0 \) from equation (10), to yield:

\[
P_1 \hat{s}_1 = D_0.
\]

(14)

Therefore, for \( D_0 \neq 0 \), actual intertemporal budget balance is satisfied with \( \hat{s}_1 \) stochastic, as long as \( P_1 \hat{s}_1 \) is fixed at \( D_0 \). For example, any downward movement in \( \hat{s}_1 \) must be accompanied by an upward movement in \( P_1 \).

To derive the FTPL, recognize that in a rational expectations equilibrium, equation (8) implies that the agent determines consumption by forming an expectation of present-
value surpluses. In equilibrium, equation (14) requires that this expectation equal real debt according to:

\[ E_t \hat{s}_1 = \frac{D_0}{P_1}, \]  

(15)

where \( E_t \) denotes the expectation conditional on information available at time \( t \). Solving for price yields the fiscal theory of the price level:

\[ P_1 = \frac{D_0}{E_1 \hat{s}_1}. \]  

(16)

Given a realization for \( E_1 \hat{s}_1 \), the FTPL determines \( P_1 \).\(^6\) This implies that \( E_1 \hat{s}_1 \) can be stochastic as long as \( P_1 E_1 \hat{s}_1 \) is not.

Now, recognize that although \( E_1 \hat{s}_1 \) can be stochastic, its distribution is restricted. To understand this, take the time 0 expectation of equation (15), yielding:

\[ E_0 (E_1 \hat{s}_1) = E_0 \left( \frac{D_0}{P_1} \right) = \frac{d_0}{1 + \pi^*}, \]  

(17)

where the second equality uses equation (11). From the end of the period, looking forward, the government must plan to balance its intertemporal budget. The restriction on the distribution assures that, ex ante, the government is not expected to extract a capital levy or create a capital gain on government debt. However, once the next period arrives, if government debt is not zero, then an innovation in \( E_1 \hat{s}_1 \) will be offset by an innovation in \( P_1 \) such that \( P_1 E_1 \hat{s}_1 \) is constant at \( D_0 \). Ex poste, the government can use capital gains or losses on nominal government debt to balance its intertemporal budget, although it cannot be expected ex ante to do this. The realization of the expected future present-value surplus

\(^6\) These results are consistent with those in Christiano and Fitzgerald’s (2000) analysis of stochastic fiscal policy. They do not apply their results to the time zero problem.
from period one together with initial government debt, determines the actual price level as in the FTPL.\(^7\)

Additionally, note equations (14) and (16) also require

\[ \hat{s}_t = E_t \hat{s}_t. \]

That is, actual present value surpluses from time \( t \) must equal their time \( t \) expectation. Therefore, any surplus innovation at time \( t + i, i > 0 \) must not affect actual present-value surpluses from the starting time \( t \). Above, a surplus innovation in period 1 does not affect the present value of surpluses from period 0. Rewriting equation (13) as

\[ \hat{s}_0 = s_0 + \frac{\hat{s}_1}{(1 + i_0)(P_0/P_1)} = 0 \]

shows that a surplus innovation in period 1 is offset by a corresponding innovation in the real rate of return on government debt. This change in the real rate of return generates the revenue necessary for the intertemporal budget to balance from period 0, and is an alternative, but equivalent, way of viewing the capital gains and losses on debt created by price surprises. As before, an innovation in the real return on debt affects surpluses only if outstanding debt is not zero.\(^8\)

In summary, the government must always plan to balance its intertemporal budget looking forward from the end of the previous period. However, whenever government debt is

\(^7\) Note that, loosely speaking, the probability of capital gains must offset the probability of capital losses. Although Woodford (1998) discusses reasons the government might want to create capital losses, I know of no reasons it might want to create capital gains. Perhaps, it must create gains sometimes, so it gets the stochastic distribution right, giving it the option of creating capital losses. Further investigation awaits further research.

\(^8\) In this example, \( s_0 \neq 0 \).
Fiscal Policy, Price Surprises, and Inflation

not zero, innovations to the present-value primary surplus create innovations to the current price level, giving fiscal policy the role of determining price surprises. Monetary policy retains the responsibility for systematic inflation. Unexpected capital gains and losses on government debt, equivalently real rate of return innovations, provide the revenue to assure actual intertemporal budget balance in the presence of stochastic primary surplus innovations. Therefore, even when the FTPL applies, monetary policy determines expected inflation, while innovations in fiscal policy determine price surprises.\(^9\)

Explicit consideration of the possibility of zero debt modifies the FTPL according to:

**Proposition 1** Given stochastic non-Ricardian fiscal policy, government commitment not to default, and incomplete markets, the price level is determined by the expected present value of future surpluses relative to the value of outstanding nominal government debt, as in equation (16), in all periods except those in which government debt is zero.

These results differ from those of Niepelt’s (2002) because he assumes complete markets. With complete markets, a deviation of the present-value future surplus from its initial expected level does not create government revenue since payouts on debt are state-contingent. To understand this, consider an economy with a constant equilibrium consumption stream. In such an economy when markets are complete, equilibrium returns on debt must be equal in all states. With incomplete markets, returns are state contingent, with states in which there is a negative innovation in present-value surpluses providing a lower real rate of return. This occurs because with incomplete markets, equilibrium restricts the expected rate of return, not the state-contingent rate. Therefore under complete markets, the government must

\(^9\) It is useful to recognize that this complete dichotomy between responsibility for systematic inflation and innovations to inflation occurs due to the assumption that government bonds have one-period maturity. Daniel (2003) shows that the presence of long-term government debt gives the monetary authority the ability to offset price surprises in exchange for an increase in expected inflation. In general, monetary and fiscal policy bear joint responsibility for inflation.
always balance its intertemporal budget constraint without resort to unexpected changes in real returns which offset unexpected policy changes. All governments, which issue a complete set of contingent claims, must behave in a Ricardian manner.

These results can be further illustrated and additional insights derived with an explicit specification for a non-Ricardian fiscal policy rule.

3 Explicit Fiscal Rules

We demonstrate the above results and derive new results using an explicit rule for non-Ricardian policy. With the rule, we show that with zero initial debt, equilibrium requires that the government balance its intertemporal budget. However, when initial debt is not zero, equilibrium dynamics are characterized by a saddlepath, yielding uniqueness for price, as well as price surprises in response to fiscal innovations. Systematic surplus changes have no effect on prices or inflation, leaving expected inflation to be determined by monetary policy’s choice of the nominal interest rate. Additionally, we show that from the end of any period looking forward, the government must plan to balance its intertemporal budget, such that it does not plan to use capital gains and losses on government debt as a systematic source of revenue. Finally, we specify an explicit rule for Ricardian policy and demonstrate that the time paths for real debt and surpluses are observationally equivalent across the two regimes in the absence of an explicit set of identifying restrictions.
3.1 Non-Ricardian Fiscal Rule

Following Christiano and Fitzgerald (2000), a non-Ricardian fiscal rule can be expressed as:

\[ s_t = s_{t-1} + \alpha [\bar{s}_t - s_{t-1}] + \eta_t, \]

(18)

where \( \eta_t \) is a white noise surplus innovation with zero mean. Assume that the target surplus for the non-Ricardian regime is given by:

\[ \bar{s}_t = \bar{s}_{t-1} + z_t, \]

(19)

where \( z_t \) is also white noise with mean zero.

The equation for the evolution of government debt is independent of the fiscal rule. Using equation (2), it can be expressed as:

\[ d_t = (1 + i_t) \left( \left( \frac{P_{t-1}}{P_t} \right) d_{t-1} - s_t \right). \]

(20)

To solve for the time paths of future surpluses and future debt, we make some assumptions to simplify the system of differential equations such that it is a constant coefficient system in real debt and surpluses. We assume that the monetary authority pegs the nominal interest rate at a constant value given by a constant value for the real rate. We assume that the real rate is constant due to a constant path for endowments net of government spending. Define \( \gamma_t \) as the reduction in the real value of debt due to a positive price level surprise. With \( \mathbb{E}_{t-1} \left( \frac{P_{t-1}}{P_t} \right) = 1 \) through the monetary authority’s interest rate choice, this implies that

\[ \gamma_t \equiv d_{t-1} \left( \frac{P_{t-1}}{P_t} - 1 \right). \]

(21)
Fiscal Policy, Price Surprises, and Inflation

This definition together with equation (16) imply:

\[ \gamma_t = E_t \hat{s}_t - d_{t-1}. \]

Therefore, according to the FTPL, innovations in expected present-value surpluses must be offset by innovations in the real value of debt, given by \( \gamma_t \).

Using equations (18) and (19), the equation for the surplus becomes:

\[ s_t = (1 - \alpha) s_{t-1} + \alpha \left[ \bar{s}_{-1} + \sum_{j=0}^{t} z_j \right] + \eta_t. \tag{22} \]

From equations (20) and (21), the debt equation is given by:

\[ d_t = (1 + i) (d_{t-1} + \gamma_t - s_t). \tag{23} \]

Consider the solution for the system of equations given by (22) and (23). The roots are 1 - \( \alpha \) and 1 + \( i \). Requiring that the coefficient on the explosive root be zero yields a solution for real debt and real surpluses as:

\[
\begin{align*}
    d_t &= \frac{1 + i}{i} \left( \bar{s}_{-1} + \sum_{j=0}^{t} z_j \right) + \left( \frac{1 + i}{\alpha + i} \right) \left[ (1 - \alpha) (s_{-1} - \bar{s}_{-1}) + \sum_{j=0}^{t} \left( \frac{1}{1 - \alpha} \right)^j (\eta_j - (1 - \alpha) z_j) \right] (1 - \alpha)^{t+1} \\
    s_t &= \bar{s}_{-1} + \sum_{j=0}^{t} z_j + \left[ (1 - \alpha) (s_{-1} - \bar{s}_{-1}) + \sum_{j=0}^{t} \left( \frac{1}{1 - \alpha} \right)^j (\eta_j - (1 - \alpha) z_j) \right] (1 - \alpha)^{t}. \tag{24}
\end{align*}
\]

The requirement that the coefficient on the explosive root be zero implies:

\[
\begin{align*}
    d_{t-1} - \left( \frac{1 + i}{\alpha + i} \right) \left[ \left( \frac{1 + i}{i} \right) \alpha \bar{s}_{-1} + (1 - \alpha) s_{-1} \right] + \sum_{j=0}^{t} \left( \frac{1}{1 + i} \right)^j \left[ \gamma_j - \left( \frac{1 + i}{\alpha + i} \right) \left( \frac{1 + i}{i} \right) \alpha z_j + \eta_j \right] &= 0.
\end{align*}
\]

This equality holds only if each term in the sum equals zero and the remaining term equals zero.
Requiring each term in the sum to be zero determines innovations in the real value of debt due to surplus innovations according to:

$$\gamma_j = \left(\frac{1 + i}{\alpha + i}\right) \left[\left(\frac{1 + i}{i}\right) \alpha z_j + \eta_j\right].$$  \hspace{1cm} (26)

This is a standard result for models which are saddlepath stable. Under the FTPL the real value of the debt must jump to offset surplus innovations, allowing the economy to reach the saddlepath. The solution for surpluses, given by equation (25), can be used to show that the right-hand side of equation (26) is the innovation to present-value surpluses in period $j$. Therefore, equation (26) requires that the innovation in present-value surpluses create an offsetting innovation in the real value of government debt. Note, additionally, that if government debt is zero, then $\gamma_j$ is identically zero, implying that surplus innovations in period $j$ are not feasible. In the case with zero government debt, there can be no innovations to present-value surpluses, as in Niepelt (2002).

Note, also, that the zero coefficient on the explosive root places restrictions on initial conditions according to:

$$d_{-1} - \left(\frac{1 + i}{\alpha + i}\right) \left[\left(\frac{1 + i}{i}\right) \alpha \bar{s}_{-1} + (1 - \alpha) s_{-1}\right] = 0.$$  \hspace{1cm} (27)

Using equation (25) to calculate the expected present value of surpluses from time -1 reveals that equation (27) requires initial debt to equal the expected present-value of surpluses before the realization of period 0 innovations, that is $d_{-1} = E_{-1} \bar{s}_0$. As in equation (17), the government must plan to balance its intertemporal budget from any initial date looking forward. Equivalently, the government cannot plan on capital gains and losses on debt to generate government revenue.
A phase diagram is useful to understand the dynamic implications of fiscal innovations. Taking first differences of equations (22) and (23) yields the equations for the phase diagram as:

\[ \Delta s_t = \alpha (\bar{s}_{t-1} - s_{t-1}) + \eta_t + \alpha z_t \]  
\[ \Delta d_t = id_{t-1} - (1 + i) [\alpha \bar{s}_{t-1} + (1 - \alpha) s_{t-1} + \eta_t + \alpha z_t - \gamma_t] \]

where \( \Delta x_t \) denotes \( x_t - x_{t-1} \) for \( x \in (s_t, d_t) \). The phase diagram, conditional on \( \bar{s}_{t-1} \) and \( \eta_t = z_t = 0 \), is given in Figure 1.

![Figure 1](image-url)  
**Figure 1**  
Non-RicardianRegime

The \( \Delta s_t = 0 \) is vertical at \( \bar{s}_{t-1} \). The \( \Delta d_t = 0 \) has an intercept which is increasing in \( \bar{s}_{t-1} \).
and it is positively sloped. Dynamics are characterized by an upward-sloping saddlepath.

Assume that the system begins in a long-run equilibrium at point A. Consider the dynamic effect of a negative surplus disturbance, modeled as a fall in $\eta_t$. Assume that there are no other present or future shocks to $\eta_t$ and $z_t$. The negative surplus shock moves the system to point B, reducing the surplus and increasing debt. However, point B does not characterize a short-run equilibrium since it is not on the saddlepath through point A. The standard presentation of non-Ricardian policy sets $z_t = 0$ and lets $d_t$ jump downward as $\gamma_t$ jumps downward to reach the saddlepath at a lower level of debt at point C. Adjustment occurs along the saddlepath until point A is reattained. However, this is not the only possible non-Ricardian equilibrium, as there is no theoretical justification for restricting $z_t = 0$. Current surplus innovations could be coupled with changes in the surplus target, as argued by Cochrane (2001).

Cochrane (2001) argues that a negative surplus shock is accompanied by an increase in expected future surpluses enabling the government to raise the revenue to finance the negative surplus shock. To consider this case, assume that the negative surplus shock is a combination of a positive shock to $z_t$ and a negative shock to $\eta_t$ such that in equilibrium, $\gamma_t = 0$. In this case, the current surplus innovation does not change expected present-value surpluses, and, therefore, there is no need for an unexpected price level jump. From equation (26), this requires $z_t = -\left(\frac{1}{1+i}\right) \frac{\eta_t}{\alpha}$. The positive $z_t$ raises $\bar{s}_t$, shifting the $\Delta s_t = 0$ curve right and raising the intercept on the $\Delta d_t = 0$ curve. The result is to shift the saddlepath up to reach B with $\gamma_t = 0$. In the absence of future innovations, adjustment occurs along

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10In the non-Ricardian system, $\gamma_t$ must be regarded as adjusting to yield equilibrium, instead of as a shock.
the saddlepath to a new higher level of long-run surpluses and debt at point D. With no price level jump and with debt rising after a negative surplus innovation, this dynamic path looks strikingly like that described by Canzoneri et al. (2001) for Ricardian policy. In fact, it is straightforward to specify the restrictions yielding observational equivalence between Ricardian and non-Ricardian policy if we specify and solve a Ricardian system.

3.2 Ricardian Fiscal Rule

Define a Ricardian regime as one in which fiscal policy responds to the real value of government debt as in:

\[ s_t = s_{t-1} + \lambda \left[ \left( \frac{i}{1+i} \right) \left( \frac{P_{t-1}}{P_t} \right) d_{t-1} - s_{t-1} \right] + \epsilon_t. \]

Using the definition of \( \gamma_t \) to write this as a linear equation yields:

\[ s_t = s_{t-1} + \lambda \left[ \left( \frac{i}{1+i} \right) (d_{t-1} + \gamma_t) - s_{t-1} \right] + \epsilon_t. \]

(30)

The Ricardian system is given by equations (30) and (23). In a Ricardian system with a fixed interest rate, price level jumps revaluing nominal debt, characterized by \( \gamma_t \) can be considered as stochastic shocks.\(^{11}\)

Consider the solution for the Ricardian system. The roots are unity and \((1 - \lambda)(1 + i)\). For \((1 - \lambda)(1 + i) < 1\), the system moves towards a non-stationary equilibrium, irrespective of initial conditions. The solution is given by:

\[ d_t = \frac{\lambda d_{-1} - (1 + i) (1 - \lambda) s_{-1} + \sum_{j=0}^{t} \left( \lambda \gamma_j - (1 + i) \epsilon_j \right)}{1 - (1 - \lambda)(1 + i)} \]

(31)

\(^{11}\)Davig, Leeper, and Chung (2003) present a model, which they solve numerically, in which monetary policy changes in a Ricardian regime to rule out stochastic \( \gamma_t \).
Fiscal Policy, Price Surprises, and Inflation

\[
\left\{ (1 + i) (1 - \lambda) (s_{-1} - \frac{d_{-1}}{1+i}) - \sum_{j=0}^{t} \left( \frac{1}{(1-\lambda)(1+i)} \right)^j [i (1 - \lambda) \gamma_j - (1 + i) \epsilon_j] \right\} \left[ (1 + i) (1 - \lambda) \right]^{t+1} \]

\[
s_t = \frac{\lambda \left( \frac{i}{1+i} d_{-1} - i (1 - \lambda) s_{-1} + \sum_{j=0}^{t} \left( \frac{1}{(1-\lambda)(1+i)} \right)^j [i (1 - \lambda) \gamma_j - (1 + i) \epsilon_j] \right)}{1 - (1 - \lambda) (1 + i)} + \frac{\lambda \left( (1 + i) (1 - \lambda) \left( s_{-1} - \frac{d_{-1}}{1+i} \right) - \sum_{j=0}^{t} \left( \frac{1}{(1-\lambda)(1+i)} \right)^j [i (1 - \lambda) \gamma_j - (1 + i) \epsilon_j] \right)}{1 - (1 - \lambda) (1 + i)} \left[ (1 + i) (1 - \lambda) \right]^{t} \tag{32} \]

With \( \gamma_t \) free, there are an infinity of solutions, indexed by realizations for \( \gamma_t \). This is just an expression of the result that the price level in a Ricardian regime with a fixed interest rate is indeterminate. Even so, the present value of surpluses can be calculated to yield:

\[
\hat{s}_0 = d_{-1} + \gamma_0 = \frac{d_{-1} P_{-1}}{P_0}. \]

No matter what value \( \gamma_0 \) (\( P_0 \)) takes on, the present value of surpluses adjusts to assure that intertemporal budget balance holds. This is the definition of a Ricardian system.

A comparison of the solution to the Ricardian system, given by equations (31) and (32) with the solution to the non-Ricardian system, given by equations (24), (25), (26), and (27), reveals observational equivalence between the Ricardian system, specified by equations (30) and (23), and the non-Ricardian system, specified by equations (22) and (23).

**Proposition 2** In the absence of restrictions on \( \gamma_t \) in the Ricardian regime and \( z_t \) in the non-Ricardian regime, the time paths for real debt and real surpluses are observationally equivalent in Ricardian and non-Ricardian regimes for \( \eta_j = (1 + i) \epsilon_j \) and \( 1 - \alpha = (1 - \lambda) (1 + i) \).

To prove this, use equations (26) and (27) to write \( \gamma_j \) and \( d_{-1} \) in terms of the variables present in the non-Ricardian system. This restricts the relationship between \( \gamma_t \) and \( z_t \) to satisfy the saddlepath equilibrium. Substitute these values into the solution for the Ricardian
system, given by equations (31) and (32). Show that the systems are identical if the above conditions on errors and roots holds.

Note that these results demonstrate the type of restrictions that would be necessary to invalidate observational equivalence. To rule out non-Ricardian behavior, we would have to be able to restrict the behavior of $\gamma_t$, $z_t$, and $\eta_t$ such that the saddle-path relationship in the non-Ricardian model was violated. However, given that innovations in $z_t$ can substitute for innovations in $\gamma_t$, this does not appear possible. And, in the absence of these restrictions, empirical evidence on the time paths of real surpluses and real government debt is not helpful in determining the nature of the fiscal regime.\footnote{This point is also made by Woodford (2001) and Cochrane (2001) on the grounds that the equilibrium conditions for the two systems are identical. It is also made in a model of monetary and fiscal policy switching by Davig, Leeper, and Chung (2003).}

A phase diagram is helpful to understand the dynamics of the Ricardian system. In first differences, the Ricardian system can be expressed as:

$$\Delta s_t = \lambda \left[ \left( \frac{i}{1 + i} \right) d_{t-1} - s_{t-1} \right] + \epsilon_t + \lambda \left( \frac{i}{1 + i} \right) \gamma_t$$

$$\Delta d_t = (1 + i) (1 - \lambda) \left[ \left( \frac{i}{1 + i} \right) d_{t-1} - s_{t-1} \right] - (1 + i) \epsilon_t + (1 + i (1 - \lambda)) \gamma_t.$$  \hspace{1cm} (33) \hspace{1cm} (34)

The phase diagram for the Ricardian system is given in Figure 1. We draw $\Delta s_t = 0$ and $\Delta d_t = 0$ for a long-run equilibrium in which $\gamma_t = \epsilon_t = 0$. Note that for the Ricardian system, the $\Delta s_t = 0$ and $\Delta d_t = 0$ curves lie on top of each other. A disturbance moves the system away from this long-run equilibrium relationship, but the system returns, perhaps to
Assume that the system is initially in a long-run equilibrium position at point A. Consider a negative surplus shock, that is a fall in $\epsilon_t$. Assume that there are no other present or future shocks to $\epsilon_t$ and $\gamma_t$. From equation (33), the surplus falls, and from equation (34) debt increases, moving the system to point B. Subsequently, if no other shocks occur, both the surplus and the debt rise according to the arrows of motion until both attain a new long-run equilibrium position at point C.

This is generally assumed to be a standard Ricardian result, and it is the one that Canzoneri, Cumby, and Diba (2001) used to describe US fiscal policy as Ricardian. For
\( \gamma_t = 0 \), this is the only equilibrium. And for \( \eta_t = (1 + i) \epsilon_t \) and \( z_t = -\left( \frac{i}{1+i} \right) \frac{\eta_t}{\alpha} \), this path is identical to the non-Ricardian path with \( \gamma_t = 0 \). Alternatively, if we allow shocks to \( \gamma_t \), which can occur under the assumed interest rate peg, then there are an infinite number of equilibrium paths, which differ depending on the realization of the path of \( \gamma_t \). We could also do an example in which the jump in \( \gamma_t \) in the Ricardian system allows that system to mimic the non-Ricardian system with a shock only to \( \eta_t \).

4 Regime Uncertainty and the FTPL

Observational equivalence between the time paths of surpluses and debt under Ricardian and non-Ricardian regimes implies that agents cannot use empirical evidence on the time paths of real debt and real surpluses to learn which fiscal regime their government is following. This raises the possibility that agents might not know whether fiscal policy is Ricardian or not. Assume that agents are uncertain about whether the regime is Ricardian or not. Weil (2002) claims that regime uncertainty implies that the FTPL does not apply. Consider price determination when agents assign a non-zero probability to the fiscal regime being non-Ricardian. We show, contrary to Weil (2002), that this weakens the necessary conditions for the FTPL according to:

**Proposition 3** Given stochastic fiscal policy, incomplete markets, uncertainty over whether fiscal policy is Ricardian or not, and government commitment not to default, the price level is determined by the expected present value of future surpluses relative to the value of outstanding nominal government debt, as in equation (16), in all periods except those in which government debt is zero.

The proposition implies that if there is any probability that the government is non-Ricardian, then the equilibrium price level will be determined as if the government is non-
Ricardian. It also implies that the government does not have to be able to commit to non-Ricardian behavior for the FTPL to apply.\textsuperscript{13} All that is necessary is some probability of non-Ricardian policy.

To prove this, begin with period 1, assuming that government debt was issued in period 0.\textsuperscript{14} Consumption is determined by the expectation of equation (6) together with the expected present-value budget constraint, equation (8), given by:

\[ E_1 \sum_{t=1}^{\infty} c_t R_{1t} = \frac{D_0}{P_1} + E_1 \sum_{t=1}^{\infty} [y_t - g_t - s_t] R_{1t}. \] (35)

To determine consumption, the agent forms an expectation about the present value of surpluses net of government spending. Agents know that fiscal policy follows either equation (18) or (30). Assume that at \( t = 1 \), the agent believes that the government is Ricardian with probability \( 0 < \rho_1 \leq 1 \) and is non-Ricardian with probability \( 1 - \rho_1 \). To compute the expected present-value of surpluses, the agent first computes expectations conditional on each regime.

For the Ricardian regime, the agent computes the present value of future surpluses by using the government’s intertemporal budget constraint together with the transversality condition on government debt to yield:

\[ E_{1|R} \sum_{t=1}^{\infty} s_t R_{1,t} = \frac{D_0}{P_1}, \] (36)

where \( E_{1|R} \left( E_{1|N} \right) \) denotes expectations taken at time one, conditional on the regime being Ricardian (non-Ricardian). Equation (36) states that, conditional on the regime being

\textsuperscript{13}This is relevant given Bassetto’s (2002) question about the government’s ability to commit.
\textsuperscript{14}We begin in period 1 since the FTPL does not apply in period 0 with no government debt. Note that there is no requirement for \( E_0 \hat{s}_1 \) to equal \( E_{-1} \hat{s}_1 \).
Fiscal Policy, Price Surprises, and Inflation

Ricardian, no matter what the initial price level, the expected present value of surpluses will assure that the government’s intertemporal budget constraint holds. Substituting for surpluses in equation (35), the expected present value of consumption, conditional on the regime being Ricardian, is given by:

\[ E_{1|R} \sum_{t=1}^{\infty} c_t R_{1,t} = E_{1|R} \sum_{t=1}^{\infty} [y_t - g_t] R_{1,t}. \] (37)

Note that since the present value of government spending in the Ricardian regime must equal the present-value of ordinary taxes together with seigniorage revenue, that the right hand side of equation (37) has the interpretation of the present value of disposable income.

Alternatively, if the agent believes the government is non-Ricardian, then the expected present value of surpluses takes on some other value, independent of the initial price level, given by:\(^{15}\)

\[ E_{1|N} \sum_{t=1}^{\infty} s_t R_{1,t} = E_{1|N} s_1. \] (38)

Note that \( E_{1|N} s_1 \) is not necessarily equal to \( E_{0|N} s_1 \). The expected value of consumption, conditional on the regime being non-Ricardian, is:

\[ E_{1|N} \sum_{t=1}^{\infty} c_t R_{1,t} = \frac{D_0}{P_1} + E_{1|N} \sum_{t=1}^{\infty} [y_t - g_t] R_{1t} - E_{1|N} s_1 \] (39)

\(^{15}\)Using equation (22), the expected present value of surpluses is given by:

\[ E_{1|N} s_1 = E_{0|N} s_1 + \frac{1+i}{\alpha+i} \left[ \eta_1 + \frac{1+i}{i} \varphi_1 \right], \]

where \( E_{0|N} s_1 = d_0 \) since \( \pi^* = 0 \).
Combining equations (37) and (39), the time zero expected value of the agent’s consumption is given by:

\[
E_1 \sum_{t=1}^{\infty} c_t R_{1,t} = \rho_1 E_{1|R} \sum_{t=1}^{\infty} [(y_t - g_t)] R_{1,t} \\
+ (1 - \rho_1) \left( \frac{D_0}{P_1} + E_{1|N} \sum_{t=1}^{\infty} [y_t - g_t] R_{1t} - E_{1|N} \hat{s}_1 \right). \tag{40}
\]

Goods market equilibrium requires \( c_t = y_t - g_t \) for each regime. Substituting this, together with

\[
E_1 \sum_{t=1}^{\infty} c_t R_{1,t} = \rho_1 E_{1|R} \sum_{t=1}^{\infty} c_t R_{1,t} + (1 - \rho_1) E_{1|N} \sum_{t=1}^{\infty} c_t R_{1,t},
\]

into equation (40) yields:

\[
0 = (1 - \rho_1) \left( \frac{D_0}{P_1} - E_{1|N} \hat{s}_1 \right). \tag{41}
\]

Therefore, for \( \rho_1 < 1 \), goods market equilibrium requires that the price level be determined by equation (41). The real value of outstanding government debt less the realization of the expected present value of government surpluses, conditional on the regime being non-Ricardian, determines the price level. This is equivalent to the government’s intertemporal budget constraint with the expected value of future variables determined in the non-Ricardian regime.\(^{16}\)

Unless non-Ricardian behavior can be ruled out with certainty, that is set \( \rho = 1 \), then the FTPL applies.\(^{17}\) Lack of a completely credible commitment to Ricardian behavior leaves the price level subject to fiscal shocks.

\(^{16}\) Weil (2002) considers a similar problem without imposing equation (36) and obtains a different answer.

\(^{17}\) This potentially addresses Bassetto’s (2002) criticism that a government might not be able to commit to non-Ricardian policy at off-equilibrium prices, when it needs to borrow. This proposition says that for the FTPL to determine price, the government does not have to commit. Agents must assign a non-zero probability to non-Ricardian behavior.
Consider the implications of the above for price level determinacy. The literature on the FTPL claims that, for the monetary policy assumed above and a Ricardian fiscal policy, the price level is indeterminate. However, the foregoing results show that if fiscal policy is Ricardian, but agents are uncertain about its Ricardian behavior, then the price level is determined. Specifically, it is determined by beliefs about surplus policy by the non-Ricardian government. And since the government is Ricardian, promising to make surpluses equal to real debt, there is nothing to anchor beliefs. This raises the possibility of multiple equilibria when the government is Ricardian but lacks full credibility.

**Proposition 4** When monetary policy fixes expected inflation and fiscal policy is Ricardian with $\rho_t < 1$, then the equilibrium price level is determined by beliefs about non-Ricardian fiscal policy, implying differing equilibria indexed by differing beliefs.

To understand this proposition, note that the Ricardian government adjusts future surpluses to validate any price level. Therefore, expectations of future surpluses imply an equilibrium price level because the Ricardian government adjusts future surpluses to validate expectations. This modifies the well-known result that for a Ricardian government, in which monetary authority pegs the nominal interest rate, any price level is an equilibrium. When there is uncertainty about the Ricardian nature of government, not just any price will do. Ricardian behavior with less than perfect credibility adds the restriction that the price level is determined by expected fiscal policy for a non-Ricardian government. The price level is no longer indeterminate; it is determined by beliefs. But with a Ricardian government, there is nothing to anchor beliefs.
5 Conclusion

This paper highlights the need to consider the Fiscal Theory of the Price Level (FTPL) in an explicitly stochastic context. The first section shows that with initial government debt of zero, the FTPL has no role to play in determining prices or inflation in any period, as in Niepelt (2002). However, introduction of stochastic fiscal policy, together with incomplete markets, gives fiscal policy a role in determining prices in all periods in which government debt is not zero. The stochastic context also clarifies the roles of monetary and fiscal policy in determining inflation, with responsibility for expected inflation going to monetary policy and responsibility for price surprises going to fiscal policy. The fiscal authority cannot explicitly plan to generate surplus innovations to create price surprises, implying that it has no control over systematic inflation.

The paper also reconsiders the conditions necessary for the FTPL to apply. It demonstrates that, if markets are incomplete, current government debt is not zero, and there is any possibility that fiscal policy is non-Ricardian, then the FTPL applies. We formally demonstrate observational equivalence between the two regimes, implying that agents cannot use empirical evidence on the time paths of real debt and real surpluses to learn which type of fiscal regime prevails. Since it is difficult to rule out non-Ricardian behavior with certainty - witness the controversy in the literature - this increases the set of cases in which the theory is relevant. This leaves the price level subject to shocks from fiscal innovations. Fiscal policy has a role in determining inflation, independent of the monetary authority’s role. And when Ricardian fiscal policy is not completely credible, multiple equilibria, indexed by beliefs
about non-Ricardian fiscal policy, can exist.

The results imply that the FTPL is more likely to apply than previous literature has supposed. The fiscal regime does not have to be non-Ricardian. For the FTPL to apply, agents must assign a non-zero probability to the fiscal regime being non-Ricardian. Even so, monetary policy retains responsibility for systematic inflation, while fiscal innovations determine only price surprises. Therefore, even though we argue that the FTPL is likely to apply, responsibility for systematic inflation lies with the monetary authority.
Fiscal Policy, Price Surprises, and Inflation

References


Fiscal Policy, Price Surprises, and Inflation


