

Equilibria under ‘active’ and ‘passive’ monetary and fiscal policies

Eric M. Leeper*

Board of Governors of the Federal Reserve System, Washington, DC 20551, USA

Received February 1990, final version received November 1990

Monetary and fiscal policy interactions are studied in a stochastic maximizing model. Policy is ‘active’ or ‘passive’ depending on its responsiveness to government debt shocks. Schemes for financing deficits and, therefore, the existence and uniqueness of equilibria depend on two policy parameters. The model is used to: (i) characterize the equilibria implied by various financing schemes, (ii) derive policies where fiscal behavior determines how monetary shocks affect prices, and (iii) reinterpret Friedman’s 1948 policy framework. The paper reconsiders the result that prices are indeterminate when the nominal interest rate is pegged. The setup can be used to interpret reduced-form studies on fiscal financing.

1. Introduction

The policy literature has evolved substantially since Simons’s (1936) proposal that policy should obey rules. After forty years of occasionally heated debate, Lucas (1976) noted that a coherent characterization of the policy process is required for consumers’ decision problems to be well defined. This paper extends the traditional research program by categorizing given equilibrium policies as representing ‘active’ or ‘passive’ behavior. Further, the paper

*The author is a staff economist in the International Finance Division. He thanks Joe Gagnon, Dale Henderson, Ross Levine, Chris Sims, and Chuck Whiteman for helpful comments, and is especially grateful to Dave Gordon for many discussions and careful readings. Marvin Goodfriend’s suggestions helped clarify some of the points of the paper. The comments of an anonymous referee improved the paper’s exposition. This paper represents the views of the author and should not be interpreted as reflecting those of the Board of Governors of the Federal Reserve System or other members of its staff.

shows how this categorization is useful for interpreting macroeconomic time series.¹

I couch active and passive policy in terms of the constraints a policy authority faces. An active authority pays no attention to the state of government debt and is free to set its control variable as it sees fit. A passive authority responds to government debt shocks. Its behavior is constrained by private optimization and the active authority's actions.

The paper analyzes the stochastic equilibria produced by a class of monetary and fiscal policy rules suggested by actual policy behavior. The monetary authority sets the nominal interest rate as a function of the current inflation rate and the fiscal authority chooses a level of direct taxes that depends on the quantity of real government debt held by the public. For simplicity, policies are restricted to direct lump-sum taxes, which the fiscal authority controls, and to anticipated and unanticipated inflation taxes, which the monetary authority controls. Only anticipated inflation taxes distort behavior. The parameters of the policy rules determine the degree of reliance on each of the three revenue sources. Parameters associated with active behavior make policy unresponsive to current budgetary conditions and parameters connected with passive behavior force the authority to use its tax to balance the budget.

Much of the profession's understanding of monetization is based on the belief that when an economy relies heavily on seigniorage revenues, its average level of seigniorage should be high. Thus, the reasoning goes, money financing must not be important for countries, like the United States, where seigniorage is a small fraction of federal revenues.² Sargent (1982) exploits this intuition to argue that the European inter-war hyperinflations grew out of persistently active fiscal policies that forced monetary authorities to adjust the money stock passively to meet higher average levels of government deficits.

The insights of Sargent and Wallace (1981) and McCallum (1984), who use deterministic models to study monetary and fiscal policy interactions, cannot be carried over directly to stochastic environments. Following Aiyagari and Gertler (1985) and Sims (1988), this paper studies the financing of *shocks* to the real value of government debt, shifting the focus away from average and toward marginal sources of revenues. The analysis makes clear that the

¹In a different line of research that follows Kydland and Prescott (1977), Barro and Gordon (1983) derive policy behavior endogenously. They distinguish between policy rules arrived at by ongoing policy making and rules produced when policy makers can commit their future actions. This distinction rationalized observed policy behavior that seemed anomalous in light of Sargent and Wallace's (1975) natural rate model with rational expectations. My characterization of policies does not seek to derive their source and is relevant whether or not policy makers have access to a commitment technology.

²King and Plosser (1985, p. 149) calculate that in the United States seigniorage is about as important an average source of revenues as federal excise taxes on liquor.

average level of seigniorage revenues is irrelevant for the question of whether debt shocks are monetized: Even when, on average, government debt is backed entirely by direct taxes, innovations to debt may be systematically and completely monetized.

The intertemporal government budget constraint requires that shocks to the real value of government debt produce changes in *some* future tax. Interpretations of economic time series of fiscal financing, therefore, hinge on whether real government debt shocks bring forth higher future net-of-interest surpluses or money creation. By emphasizing deficit shocks, the model provides a formal framework for interpreting reduced-form studies of monetized deficits [for example, Dwyer (1982), Joines (1985), King and Plosser (1985)].

The equilibrium policies can be dichotomized into those where future direct lump-sum taxes back debt shocks entirely and those where fluctuations in real debt generate current or future money creation. In the first set, monetary policy is active and fiscal policy is passive. The monetary policy aspects of this policy behavior are studied in a host of papers initiated by McCallum (1981). Among the papers that analyze monetary and fiscal policies, the first set of policies are like Sargent and Wallace's (1981) regime with 'dominant' monetary policy, Aiyagari and Gertler's (1985) 'polar Ricardian' regime, or Sims's (1988) setup where the fiscal authority 'accommodates' monetary policy. Under these policies, fiscal disturbances do not influence equilibrium prices, interest rates, or real balances.

In the second set, fiscal policy is active and monetary policy is passive.³ These policies resemble Sargent and Wallace's dominant fiscal regime and reproduce the full range of Aiyagari and Gertler's non-Ricardian regimes, as well as Sims's results with accommodating monetary policy. Thus, deficit shocks increase inflation now or in the future. Prices depend on the aggregate supply of government liabilities and nominal interest rates depend on the ratio of money to debt. Because they require higher money growth in the future, monetary contractions raise future inflation and, therefore, the nominal interest rate; their effect on current inflation depends on fiscal behavior.

Sargent and Wallace (1975) started a literature that characterizes monetary policy as simple nominal interest rate rules. McCallum (1981) shows that when the rules include some response of interest rates to nominal magnitudes, monetary policy is completely specified. Recent work by Sims (1988) and Woodford (1988) argues that a government budget constraint makes Sargent and Wallace's interest rate peg a well-specified policy. I generalize this line of research and show that whether simple interest rate and tax rules completely specify policy depends on the mix of active and passive policies. A

³The models due to McCallum (1981) and others, which focus solely on monetary policy, cannot be used to address the policies in the second set.

unique pricing function requires that at least one policy authority sets its control variable actively, while an intertemporally balanced government budget requires that at least one authority sets its control variable passively. When both policies are passive, policy is incompletely specified and the pricing function is indeterminate. Two active policies that are allowed some independent variation violate the government budget constraint.

I embed the policy behavior in a monetary economy where an optimizing consumer receives an endowment of goods each period. After characterizing policy behavior, I use the framework to address several issues in the policy literature. Under pegged nominal interest rates and active fiscal behavior, monetary policy's effect on prices depends on how the fiscal authority adjusts direct taxes in response to real debt movements. When taxes are unresponsive to debt, unanticipated monetary contractions immediately raise nominal interest rates and real debt and lower real balances. Prices respond with a lag. If future direct taxes rise (fall) with increases in real debt, the contraction lowers (raises) current inflation.

I also reinterpret Friedman's (1948) proposals for short-run stability as a particular equilibrium with active fiscal and passive monetary policies. In this model with a constant equilibrium real interest rate, Friedman's proposal pegs nominal interest rates, thereby pegging expected inflation. Although Friedman's policies do not seem to contribute to short-run stability, they are consistent with long-run stability.

Section 2 lays out the economic environment and the rules policy authorities follow. Section 3 characterizes active and passive policy behavior and relates the behavior to determining equilibria. Section 4 displays the properties of various equilibria and reinterprets existing work.

2. The model

A representative infinitely-lived consumer receives a constant endowment of y units of the consumption good each period. The government extracts $g < y$ units of the good for government purchases that yield no utility to consumers.

Fiat currency earns no interest and real balances provide consumers with utility separably from consumption. Real balances, m_t , are the ratio of nominal balances, M_t , and the price level, p_t . Private agents may also save one-period nominal government debt, B_t , which has real value $b_t = B_t/p_t$ and earns interest at the risk-free gross nominal rate R_t .

The consumer discounts utility at rate $\beta \in (0, 1)$, pays τ_t units of the consumption good in direct taxes each period, and chooses the decision vector $\{c_t, m_t, b_t\}$ to solve

$$\max E_0 \sum_{t=0}^{\infty} \beta^t [\log(c_t) + \log(m_t)],$$

subject to

$$c_t + \frac{M_t}{p_t} + \frac{B_t}{p_t} + \tau_t = y + \frac{M_{t-1}}{p_t} + R_{t-1} \frac{B_{t-1}}{p_t}, \quad (2.1)$$

given the variables inherited from time -1 and taking the stochastic processes for $\{y, \tau_t, R_t, p_t\}_{t=0}^{\infty}$ parametrically. To solve their optimization problem, individuals must forecast future endowments, prices, interest rates, and taxes. I assume they know the probability distributions.

The equilibrium real interest rate is constant. Let the gross rate of inflation be $\pi_t = p_t/p_{t-1}$. After imposing the feasibility condition $c_t = y - g$, the first-order necessary conditions for the consumer reduce to the Fisher and money-demand relations:

$$\frac{1}{R_t} = \beta E_t \left[\frac{1}{\pi_{t+1}} \right], \quad (2.2)$$

$$m_t = c \left[\frac{R_t}{R_t - 1} \right], \quad (2.3)$$

plus (2.1). The conditional expectation in (2.2) is taken with respect to an information set containing all current and past individual and aggregate variables. Besides satisfying conditions (2.1)–(2.3) and feasibility, an optimal solution must satisfy transversality conditions for real balances and real debt [see McCallum (1984) for a recent example].

The government uses direct lump-sum taxes, money creation, and debt to finance the constant level of purchases each period subject to the budget constraint:

$$\frac{B_t}{p_t} + \frac{M_t}{p_t} + \tau_t = g + \frac{M_{t-1}}{p_t} + R_{t-1} \frac{B_{t-1}}{p_t}, \quad (2.4)$$

given the inherited variables.

The transversality condition for government bonds, which ensures consumers willingly hold debt, requires the present value of debt to equal zero. Imposing this optimality condition on government behavior results in the intertemporal budget constraint:⁴

$$\frac{B_t}{p_t} = \sum_{s=0}^{\infty} \left(\prod_{j=0}^s \pi_{t+j+1} R_{t+j}^{-1} \right) \left[\tau_{t+s+1} - g + \frac{M_{t+s+1} - M_{t+s}}{p_{t+s+1}} \right]. \quad (2.5)$$

⁴Obstfeld and Rogoff (1983) show that logarithmic preferences rule out 'speculative hyperinflations'. I also need to rule out hyperdeflations. Such price processes would imply explosive real balance and real debt paths that violate transversality.

I consider a class of rules suggested by actual policies. Although I do not explicitly address optimal policies, certain general features of the rules can be motivated by imagining a more complicated model with a policy authority that has two objectives: to smooth distorting direct taxes over time and to stabilize prices. Barro (1979) shows that tax smoothing creates a role for public debt, making it interesting to study equilibria in which consumers willingly hold that debt. In addition, policy authorities that care about price stability will implement fully-specified policies that determine the equilibrium pricing function. The *ad hoc* policy rules I study allow policy to ensure that government debt is valued and prices are determined.

The monetary authority sets the nominal interest rate as a function of current inflation:

$$R_t = \alpha_0 + \alpha\pi_t + \theta_t,$$

$$\theta_t = \rho_1\theta_{t-1} + \varepsilon_{1t}, \quad |\rho_1| \leq 1, \quad \varepsilon_{1t} \sim N(0, \sigma_1^2), \quad (2.6)$$

while the fiscal authority adjusts direct lump-sum taxes in response to the level of real government debt outstanding:

$$\tau_t = \gamma_0 + \gamma b_{t-1} + \psi_t,$$

$$\psi_t = \rho_2\psi_{t-1} + \varepsilon_{2t}, \quad |\rho_2| \leq 1, \quad \varepsilon_{2t} \sim N(0, \sigma_2^2). \quad (2.7)$$

There are no *a priori* restrictions on the signs or magnitudes of the α and γ coefficients. The constant terms, α_0 and γ_0 , affect the deterministic steady state but play no role in the analysis that follows. I assume that for given (α, γ) , α_0 and γ_0 are such that steady-state real debt, real balances, and the net nominal interest rate are positive.

The innovations to the policy shocks are serially and mutually uncorrelated:

$$E \varepsilon_{it} \varepsilon_{jt-k} = 0 \quad \text{for all } k \quad \text{and} \quad i, j = 1, 2, \quad i \neq j.$$

The rules consist of systematic policy responses to economic conditions (the $\alpha\pi_t$ and γb_{t-1} terms) and random shocks (the θ_t and ψ_t terms). The systematic responses reflect fiscal financing considerations. When consumers hold both nominal government liabilities, the government can levy anticipated and unanticipated inflation taxes.⁵ The monetary authority's responsiveness to inflation, given by the magnitude of α in eq. (2.6), determines the

⁵The literature on inflation taxes begins with Friedman's (1953) and Bailey's (1956) analyses of anticipated inflations. Fischer and Modigliani (1978) survey the literature on anticipated and unanticipated inflation and list the real effects of these taxes.

extent and the type of inflation financing. Anticipated inflation extracts resources by distorting private agents' money-demand decisions. Unanticipated inflation devalues existing stocks of nominal liabilities, supplying the government with seigniorage revenues. Unexpected inflation taxes are lump-sum. The fiscal authority levies only lump-sum direct taxes; γ in (2.7) indexes the extent that such taxes respond to government debt disturbances.

The usual approach in the literature on policy rules posits that private behavioral relations contain random disturbances, while policy authorities obey deterministic rules.⁶ To characterize the private equilibrium, conditional on monetary and fiscal policy behavior, I reverse the usual asymmetry: Private agents obey deterministic decision rules and policy authorities follow *ad hoc* rules with random terms.

The error terms in these rules, the θ 's and the ψ 's, represent aspects of policy behavior that may stem from either the technology for implementing policy choices or the incentives facing policy makers. The first interpretation is analogous to Dotsey and King's (1983) treatment of disturbances to policy rules as 'control errors'. In this view, authorities can control their instruments only up to a random error, which suggests the shocks should be serially uncorrelated, as they are in Dotsey and King's setup.

Another perspective interprets the shocks as policy responses to unmodeled or noneconomic shocks. These influences might be real shocks, fluctuating political pressures, or demographic changes that may be transitory or permanent, as the assumptions on θ and ψ suggest. The specification in (2.6) and (2.7) is consistent with both interpretations. Importantly, these shocks reflect variations in monetary and fiscal policy that are independent of each other.

3. 'Active' and 'passive' policies

The decision rule for each policy instrument may depend on one or both of the exogenous shocks, depending on the policy parameters. Before deriving this dependence in section 4, I characterize the equilibria in terms of deviations of the linearized model from the deterministic steady state.⁷

3.1. Deriving the system

Eqs. (2.1)–(2.4), (2.6), and (2.7) reduce to a recursive system in inflation and real debt. Combine the interest-rate rule with the Euler equation for

⁶Sargent and Wallace (1975) started this approach. McCallum (1981, 1986), Goodfriend (1987), and Barro (1989), among others, have continued it.

⁷The model is nearly linear: The feasibility condition and the policy rules are linear and the Euler equations are linear in logarithms. This suggests that the linear version may not be a bad approximation to the true nonlinear behavior. By analyzing the linearized model, I cannot directly check that the transversality condition is satisfied.

debt and linearize to get:

$$E_t \tilde{\pi}_{t+1} = \alpha \beta \tilde{\pi}_t + \beta \theta_t, \quad (3.1)$$

where the tilde denotes deviation from the deterministic steady state.

The law of motion for real debt comes from substituting the policy rules and the real balance relation into the government budget constraint:

$$\varphi_1 \tilde{\pi}_t + \tilde{b}_t + \varphi_2 \tilde{\pi}_{t-1} - (\beta^{-1} - \gamma) \tilde{b}_{t-1} + \varphi_3 \theta_t + \psi_t + \varphi_4 \theta_{t-1} = 0, \quad (3.2)$$

where

$$\varphi_1 = \frac{c}{(R-1)} \left[\frac{1}{\beta\pi} - \frac{\alpha}{(R-1)} \right] + \frac{b}{\beta\pi},$$

$$\varphi_2 = \frac{\alpha}{\pi} \left[\frac{c}{(R-1)^2} - b \right], \quad \varphi_3 = -\frac{c}{(R-1)^2}, \quad \varphi_4 = \frac{\varphi_2}{\alpha},$$

and c , R , π , and b are the deterministic steady-state values of consumption, the gross nominal interest rate, the gross inflation rate, and real debt.

3.2. *The meaning of 'active' and 'passive' policies*

Because an active authority is not constrained by current budgetary conditions, it is free to choose a decision rule that depends on past, current, or expected future variables.⁸ A passive authority is constrained by consumer optimization and the active authority's actions, so it must generate sufficient tax revenues to balance the budget. Thus, the passive authority's decision rule necessarily depends on the current state of government debt, as summarized by current and past variables.

Viewing active policy as forward-looking and passive policy as backward-looking is consistent with the 'rules versus authorities' debate [Simons (1936)]. Friedman (1948) argues against 'discretionary action in response to cyclical movements' (p. 250) because it requires policy makers 'to forecast accurately the economic changes that would occur in the absence of government action' (p. 255). In the model this requires authorities to forecast the exogenous θ and ψ processes when setting their instruments. Friedman's point is that policy makers are too ignorant about these processes to forecast them well.

⁸The next section argues, however, that if the active authority responds only to current and past variables, the equilibrium may be underdetermined.

In his 1948 proposal, however, Friedman does not oppose 'automatic' responses of fiscal variables to fluctuations in economic activity. I interpret the automatic behavior as passively setting policy instruments as a function of current and past variables, which does not require knowing the true processes generating the shocks. This views the debate as a selection among rules that differ only by the nature of the arguments in the policy functions.⁹

Of course, the rules-versus-authorities debate encompasses a broad range of issues that centers on the desirability of setting policy to attenuate business-cycle fluctuations. By focusing on how policy authorities respond to the state of government debt, the model's depiction of active and passive behavior is narrower than that envisaged in the earlier debate, but is consistent with the older usage.^{10, 11}

Recent work poses equilibrium policy as the outcome of a game between the monetary and fiscal authorities. For example, in Sargent's (1986) depiction of a Ricardian regime, the monetary authority is the 'dominant player', while the fiscal authority 'follows' and raises taxes as necessary to balance the budget. This is consistent with active monetary and passive fiscal policies. Sargent and Wallace's (1981, p. 2) unpleasant monetarist arithmetic arises from a coordination scheme in which 'fiscal policy dominates monetary policy' and 'the monetary authority faces the constraints imposed by the demand for government bonds...'. This corresponds to active fiscal and passive monetary behavior.¹²

3.3. *Determinate equilibria*

The policy parameter space can now be divided into four disjoint regions according to whether monetary and fiscal policies are active or passive. This policy behavior is linked to the model's stability characteristics since the roots

⁹Friedman and Heller (1969) can be read in this light.

¹⁰Citing the rapid money growth in the early 60's, Samuelson (1967, p. 6) describes American policy in 1961–1965 as 'a case of *active* fiscal policy which was coupled with or financed by a *supporting* monetary policy' [emphasis added]. In his view, monetary policy accommodates fiscal expansions to counteract the interest-rate increases that would crowd out investment. In my model, monetary accommodation prevents deficit shocks from raising interest rates and producing an explosive path of government debt. (In drawing this parallel, of course, I have glossed over the distinction between real and nominal interest rates.)

¹¹Olivera (1970) and Black (1972) define an exogenous money stock as active monetary policy and an exogenous price level as requiring passive monetary policy. For reasons I hope to make clear, I don't find these definitions to be particularly useful for interpreting time series or for organizing my thoughts about monetary and fiscal interactions.

¹²Sargent (1982) argues that the European hyperinflations in the 1920's arose from active fiscal and passive monetary policies and were ended by switching to active monetary and passive fiscal policies. In a similar vein, Dornbusch, Sturzenegger, and Wolf (1990) cite endogenous money financing of budget deficits as an important aspect of recent rapid inflations in a number of countries.

of the system in (3.1) and (3.2) are $\alpha\beta$ and $\beta^{-1} - \gamma$. Label the regions of the policy parameter space as:¹³

Region I: Active monetary and passive fiscal policy when $|\alpha\beta| > 1$ and $|\beta^{-1} - \gamma| < 1$.

Region II: Passive monetary and active fiscal policy when $|\alpha\beta| < 1$ and $|\beta^{-1} - \gamma| > 1$.

Region III: Passive monetary and passive fiscal policy when $|\alpha\beta| < 1$ and $|\beta^{-1} - \gamma| < 1$.

Region IV: Active monetary and active fiscal policy when $|\alpha\beta| > 1$ and $|\beta^{-1} - \gamma| > 1$.

In region I, monetary policy is unconstrained and can actively pursue price stability by reacting strongly to inflation. Fiscal policy obeys the constraints imposed by private and monetary policy behavior and passively adjusts direct taxes to balance the budget. In the second region, the fiscal authority refuses to adjust direct taxes strongly, preventing deficit shocks from being financed entirely with future taxes. Now the monetary authority obeys the constraints imposed by private and fiscal policy behavior and allows the money stock to respond to deficit shocks.

A sufficient condition for a unique saddle-path equilibrium is that one root of the system lies inside the unit circle and one root lies outside [Blanchard and Kahn (1980)]. Active behavior completely specifies policy and uniquely determines the equilibrium pricing function. Passive policy prevents an explosive path of government debt. Combinations of policy parameters from either of these two regions yield one stable and one unstable root.

In region III, each policy authority acts passively, as though it is constrained to balance the budget. Without the additional constraint imposed by one authority behaving actively, there are many money growth processes – indexed by the initial money stock – that are consistent with the equilibrium conditions. This reproduces Sargent and Wallace's (1975) price-level indeterminacy result, which shows up algebraically as a system with no unstable roots. The indeterminacy arises even if the interest-rate rule depends on inflation, but the dependence is not overly strong. In contrast, in region II, fiscal policy is sufficiently unresponsive to debt shocks that the initial money stock is pinned down by the government's budget constraint.

¹³I choose the unit circle as the dividing line between stable and unstable solutions because this produces jointly covariance-stationary equilibrium processes. If a linear-quadratic model were underlying eqs. (3.1) and (3.2), then the condition for existence is that the roots be less than $\beta^{-1/2}$ in absolute value. There are also cases of borderline stability where one or both roots equal unity.

Finally, in region IV each authority actively disregards the budget constraint by trying to determine prices. This produces two unstable roots. There does not exist a money-growth process that ensures consumers will hold government debt unless the policy shocks are related in a way that violates the assumption of mutually uncorrelated shocks.¹⁴

4. Properties of equilibria

The previous section showed that policy parameters drawn from regions I and II produce determinate equilibria. I now derive the properties of these equilibria. For these experiments, suppose that some set of well-specified policies have been in effect forever, generating a history of equilibrium variables. At time 0, policy inherits the time -1 variables and unexpectedly and permanently changes to obey the rules studied below.

4.1. Region I: Active monetary and passive fiscal policies

When monetary policy reacts strongly to inflation ($|\alpha\beta| > 1$) and fiscal policy raises taxes sharply when debt increases ($|\beta^{-1} - \gamma| < 1$), the solution for inflation comes from solving (3.1) 'forward':

$$\tilde{\pi}_t = \left[\frac{\beta}{\rho_1 - \alpha\beta} \right] \theta_t, \quad (3.3)$$

using the assumption that $\{\theta_t\}$ is AR(1). Substituting this into the interest rate rule implies

$$\tilde{R}_t = \left[\frac{\rho_1}{\rho_1 - \alpha\beta} \right] \theta_t. \quad (3.4)$$

In region I equilibria, inflation and nominal-interest-rate fluctuations depend entirely on the parameter of the monetary policy rule, the discount factor, and the monetary policy shock. Monetary policy stabilizes prices by preventing deficit shocks from affecting inflation. For a particular path of the monetary policy shock, the solutions for $\{\tilde{\pi}_t, \tilde{R}_t\}$ imply the unique (linearized) time path of real balance movements given by $\tilde{m}_t = [-c/(R-1)^2]\tilde{R}_t$.

I now derive the decision rule for the growth rate of money, defined as $h_t = M_t/M_{t-1} = m_t\pi_t/m_{t-1}$. Combine this definition with the equilibrium condition for real balances in (2.3), linearize, and substitute the solutions for

¹⁴This is a precise sense in which there can be no independent variation in monetary and fiscal policies when both policies are active. The result is shown in an appendix available from the author.

inflation and nominal interest rates to get

$$\bar{h}_t = \frac{\beta}{\rho_1 - \alpha\beta} \left[1 - \frac{\rho_1}{R-1} \right] \theta_t + \left[\frac{\beta\rho_1}{(R-1)(\rho_1 - \alpha\beta)} \right] \theta_{t-1}. \quad (3.5)$$

In equilibrium, the monetary authority responds to current and past monetary policy shocks, θ , but not to fiscal policy shocks, ψ .¹⁵

Fiscal policy seems ‘irrelevant’ because parameters and variables associated with fiscal policy do not appear in expressions (3.3) and (3.5). This reduced-form interpretation is misleading. Given that $|\alpha\beta| > 1$, an equilibrium exists *only because* fiscal behavior supports the prevailing monetary policy by raising taxes enough to prevent explosive real debt paths. Debt then evolves according to the stable difference equation in (3.2), whose ‘backward’ solution (when θ is serially uncorrelated) is

$$\begin{aligned} \bar{b}_t = & \sum_{i=0}^t (\beta^{-1} - \gamma)^i \left[\frac{1}{\alpha\beta\pi} \left(\frac{c}{R-1} + b \right) \theta_{t-i} - \psi_{t-i} \right] \\ & + (\beta^{-1} - \gamma)^{t+1} \bar{b}_{-1}. \end{aligned} \quad (3.6)$$

Shocks to θ that induce the monetary authority to reduce current money growth (and inflation) elicit real debt expansions that, through the tax rule, raise the present value of direct taxation by enough to offset the current lump-sum negative inflation tax. Tax cuts brought forth by negative realizations of ψ reflect changes in the timing, but not the present value of direct taxation. Active monetary and passive fiscal policies, therefore, correspond to Aiyagari and Gertler’s (1985) polar Ricardian regime.

The equilibrium has an interesting feature. Given data on equilibrium $\{\bar{R}_t, \bar{\pi}_t\}$, it is not possible to use least squares to recover the true value of α in the monetary policy rule. An econometrician who runs the regression $\bar{R}_t = \delta \bar{\pi}_t + u_t$ will obtain the estimate $\hat{\delta} = \rho_1/\beta$ with $R^2 = 1$. Because $|\alpha\beta| > 1$ and θ is stationary, this estimate of monetary policy’s reaction to inflation never exceeds $1/\beta$, implying passive monetary policy behavior. This situation arises because the econometrician observes only equilibrium sequences of

¹⁵Expressions (3.3) to (3.5) may underlie Friedman’s (1968) contention that nominal interest rates are misleading indicators of monetary conditions. For example, when θ shocks are permanent ($\rho_1 = 1.0$), positive realizations of θ raise current money growth but induce an expectation of tight money tomorrow, which decreases current nominal rates. The fall in interest rates increases money demand sufficiently that current inflation also falls.

interest rates and inflation, but the monetary authority reacts to inflation rates that are off equilibrium paths.¹⁶

4.2. Region II: Passive monetary and active fiscal policies

When monetary policy is unresponsive to inflation ($|\alpha\beta| < 1$) and taxes do not rise strongly with higher debt ($|\beta^{-1} - \gamma| > 1$), the solution is more complicated. The budget constraint in (3.2) is an unstable difference equation in real debt with the 'forward' solution:

$$\begin{aligned} \bar{b}_{t-1} = \sum_{i=0}^{\infty} \left(\frac{1}{\beta^{-1} - \gamma} \right)^{i+1} E_{t-1} [& \varphi_1 \bar{\pi}_{t+i} + \varphi_2 \bar{\pi}_{t+i-1} + \varphi_3 \theta_{t+i} \\ & + \varphi_4 \theta_{t+i-1} + \psi_{t+i}]. \end{aligned} \quad (3.7)$$

The first two terms in brackets are expectations of future values of inflation that can be evaluated using the stable difference equation (3.1). The three remaining expectations in (3.7) are evaluated using the assumed exogenous processes. Performing both of these evaluations and dating the result at time t gives:

$$\begin{aligned} \bar{b}_t = \left[\frac{\varphi_1 \alpha \beta + \varphi_2}{\beta^{-1} - \gamma - \alpha \beta} \right] \bar{\pi}_t + \left(\left[\frac{\varphi_1 - \beta \gamma \varphi_1 + \beta \varphi_2}{(\beta^{-1} - \gamma - \alpha \beta)(\beta^{-1} - \gamma - \rho_1)} \right] \right. \\ \left. + \left[\frac{\varphi_3 \rho_1 + \varphi_4}{\beta^{-1} - \gamma - \rho_1} \right] \right) \theta_t + \left[\frac{\rho_2}{\beta^{-1} - \gamma - \rho_2} \right] \psi_t. \end{aligned} \quad (3.8)$$

Solving (3.8) and the budget constraint (3.2) simultaneously yields equilibrium real debt and inflation functions in terms of current and past variables.¹⁷

I now reconsider the policies that Woodford (1988) studies: pegged nominal interest rates and exogenous direct taxes. I interpret a 'pegged' interest

¹⁶Kareken and Solow (1963) discuss the difficulty inherent in inferring policy behavior from equilibrium data in the context of Friedman's timing evidence on the effects of monetary policy. Papell (1989) and Bryant (1990) are recent attempts to draw analogous inferences. Khoury (1990) is an extensive survey of related work.

¹⁷The general solution is not a pretty sight. It is available from the author.

rate as arising when $\alpha = 0$, so nominal rates are exogenous;¹⁸ similarly, $\gamma = 0$ makes direct taxes exogenous. When the policy shocks are serially uncorrelated, the solutions for equilibrium prices and quantities are:

$$\bar{R}_t = \theta_t, \quad (3.9)$$

$$\bar{\pi}_t = - \left[\frac{1}{\varphi_1} \right] \psi_t + \beta \theta_{t-1}, \quad (3.10)$$

$$\bar{b}_t = \left[\frac{c}{(R-1)^2} \right] \theta_t, \quad (3.11)$$

$$\bar{m}_t = - \left[\frac{c}{(R-1)^2} \right] \theta_t. \quad (3.12)$$

The money growth decision rule is

$$\bar{h}_t = - \left[\frac{1}{\varphi_1} \right] \psi_t - \left[\frac{\beta}{R-1} \right] \theta_t + \left[\frac{\beta R}{R-1} \right] \theta_{t-1}. \quad (3.13)$$

Using the definition $d_t = b_t \pi_t / b_{t-1}$, the linear expression for the growth rate of nominal debt is

$$\bar{d}_t = - \left[\frac{1}{\varphi_1} \right] \psi_t + \left[\frac{c\pi}{b(R-1)^2} \right] \theta_t + \left[\beta - \frac{c\pi}{b(R-1)^2} \right] \theta_{t-1}. \quad (3.14)$$

Fiscal shocks affect only nominal values by changing the aggregate level of nominal liabilities held by the public. Monetary shocks affect real magnitudes by altering the composition of government liabilities in consumers' portfolios.¹⁹ Because direct taxes are unresponsive to debt, any increase in real debt must lead to higher money growth now or in the future. If future money creation finances a current tax cut, nominal interest rates must rise to induce consumers to hold the additional government debt. When $\alpha = 0$, the monetary authority prevents rates from rising by expanding the money supply now

¹⁸Usually 'pegged' means the interest rate is literally constant, which requires the variance of θ to be zero ($\sigma_\theta^2 = 0$). Setting $\alpha = 0$ pegs the nominal rate in the sense that rates are not permitted to move in response to fiscal disturbances. This is consistent with American monetary policy during World War II, when the objective of the interest-rate peg was to reduce the interest costs of financing the war [Friedman and Schwartz (1963)].

¹⁹Aiyagari and Gertler (1985) get a similar result in their polar non-Ricardian regime.

and generating lump-sum inflation tax revenues sufficient to balance the budget. Eqs. (3.10) and (3.13) report this outcome.²⁰

Monetary policy shocks that unexpectedly increase the ‘pegged’ interest rate represent a pure asset exchange, with the decrease in the nominal money stock equaling the increase in nominal debt outstanding. Higher interest rates induce consumers to substitute out of currency and into debt in the offsetting ways described by expressions (3.11) and (3.12). The aggregate stock of government liabilities is unchanged by this exchange, and so, too, is the current price level.²¹ In the next period, the increased debt service requires additional tax revenues that cannot come from the exogenous direct taxes. Instead, these resources are extracted by printing money and generating inflation, giving θ its lagged effect on inflation and money growth in (3.10) and (3.13).

4.3. *Reinterpreting Friedman’s 1948 proposal*

Friedman’s 1948 ‘Monetary and Fiscal Framework for Economic Stability’ also calls for deficits to elicit monetary expansions and surpluses to produce contractions. His proposal has four ingredients that concern us here: (1) fiscal deficits and surpluses are produced automatically by cyclical fluctuations; (2) the monetary authority does not conduct discretionary open-market operations; (3) deficits automatically expand the aggregate quantity of money and surpluses contract it; and (4) the government does not issue interest-bearing securities.

The model can conform closely to Friedman’s proposal. Fiscal behavior is consistent with ingredient (1) when direct taxes depend only on ψ , if shocks to ψ are viewed as triggered by cyclical fluctuations whose effects on revenues arise from automatic stabilizers in the tax code. This requires setting $\gamma = 0$. When the variability of the monetary policy shock is eliminated by setting $\sigma_1^2 = 0$ (implying $\theta, \equiv 0$), the monetary authority cannot conduct discretionary open-market swaps of bonds for money, satisfying the second ingredient. I interpret the automatic expansion and contraction of the money stock listed in ingredient (3) as meaning deficits are monetized and surpluses are demonetized immediately. The money stock’s contemporaneous response to fiscal disturbances necessarily prevents these disturbances from altering nominal interest rates, effectively pegging the interest rate at its steady-state value. This result emerges when $\alpha = 0$. Under these conditions, real debt and

²⁰When the monetary authority sets $\alpha > 0$, fiscal shocks are financed by distorting expected inflation taxes and the monetization is spread over time: Higher deficits increase expected money creation and inflation, pushing up current nominal interest rates. In this case, as King and Plosser (1985) claim, deficits will Granger-cause money growth.

²¹I return to this feature of the equilibrium below.

real money balances are constant [eqs. (3.11) and (3.12)], but their nominal magnitudes fluctuate.

The exercise has several interesting implications. First, Friedman's goal of automating monetary and fiscal behavior does not require the government to cease issuing nominal debt. Nominal debt moves lock-step with the nominal money stock and the price level precisely because ingredients (1) and (3) prevent future taxes – both direct and inflation – from responding to fiscal disturbances. This fixes real debt. Second, the formalization of Friedman's proposal requires that nominal interest rates be pegged. With real rates constant, expected inflation is stable. This is in the spirit of Friedman's long-standing opposition to monetary policies that support bond prices.²²

Third, Friedman emphasizes that the proposal should enhance the economy's short-run stability. To evaluate this claim, I compare the variances of inflation, nominal interest rates, and real balances implied by Friedman's framework [eqs. (3.9), (3.10), and (3.12)] to those implied by active monetary policy in region I [eqs. (3.3), (3.4), and real money demand]. I assume that the shocks are white noise. No general pattern of relative variances emerges. Nominal interest rates and real balances are constant in region I, just as they are in Friedman's proposal. The variances of inflation are:

Friedman's proposal:

$$\text{var}(\pi_t) = (1/\varphi_1^2)\sigma_2^2,$$

where

$$\varphi_1^2 = \frac{1}{\beta^2\pi^2} \left[\frac{c}{R-1} + b \right]^2,$$

Region I:

$$\text{var}(\pi_t) = (1/\alpha^2)\sigma_1^2,$$

where

$$|\alpha| > \beta^{-1}.$$

Even if the variance of the monetary policy shock is nonzero under region I policies, the relative variance of inflation under the two policies can be anything. Although this interpretation of Friedman's proposal does not support his claim of enhanced short-run stability (relative to active monetary

²²The deleterious effects of interest-rate pegs are described in Friedman (1959,1968) and Friedman and Schwartz (1963). These can be read as arguing that the monetary authority should not peg nominal interest rates to control real rates and, thereby, influence investment and output.

and passive fiscal policies), the proposal is consistent with long-run stability associated with satisfying the government's intertemporal budget constraint.

4.4. *The delayed effects of monetary shocks on prices*

An active fiscal authority can determine the contemporaneous price effects of a monetary shock by choosing how future direct taxes respond to real debt. When γ differs from zero, but the nominal rate is pegged (so $\bar{R}_t = \theta_t$), equilibrium inflation is

$$\bar{\pi}_t = -\frac{\gamma}{\beta^{-1} - \gamma} \left[\frac{\beta^2 c \pi}{c + b(R - 1)} \right] \theta_t - \left[\frac{1}{\varphi_1} \right] \psi_t + \beta \theta_{t-1}. \quad (3.15)$$

In a steady state with nonnegative real debt, the sign of γ determines the effect of a monetary policy disturbance on current inflation. When higher real debt increases future taxes ($0 < \gamma < \beta^{-1} - 1$), we obtain the 'usual' case where a monetary contraction – initiated by a positive realization of θ_t – lowers current inflation, but increases expected future inflation. Tight money today temporarily decreases inflation, as in Sargent and Wallace (1981). In contrast, when higher real debt signals lower future direct taxes ($\gamma < 0$), the aggregate level of nominal liabilities increases, raising current inflation. This reproduces Sargent and Wallace's second 'unpleasant' outcome that tight money today may raise current inflation.²³

The result that fiscal behavior can determine the direction of an open-market operation's effects on prices sheds new light on an old issue in monetary economics. Friedman (1961) notes that monetary changes operate more quickly on asset prices than on nominal income. The policy mix consistent with his 1948 proposal implies precisely this pattern of responses to a monetary policy shock.²⁴ Recent explanations of the delayed price response emphasize the costs of carrying out financial transactions [Grossman and Weiss (1983) and Rotemberg (1984)]. The monetary transmission mechanisms in these papers rely on the wealth redistributions and real-interest-rate changes resulting from open-market operations. The present model exploits neither of these mechanisms. Instead, the lagged response of prices to monetary shocks is a direct consequence of fiscal behavior.

²³Sargent and Wallace (1981) obtain this result by altering parameters describing private behavior. My derivation fixes the private parameters and alters policy parameters.

²⁴Much of Friedman's early empirical work on monetary policy effects is based on data dominated by the two World Wars, when fiscal policy behavior was almost certainly active in the sense defined in this paper: Increases in real government debt were not expected in the near future to bring forth direct tax increases of sufficient size to balance the budget. I thank an anonymous referee for bringing this example to my attention.

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