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OPTIMAL MONETARY GROWTH

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ABSTRACT

In the absence of monetary superneutrality, inflation affects capital accumulation and the demand for real balances. This paper derives the combination of monetary and lump-sum fiscal policy which maximizes the sum of discounted utilities of representative consumers in present and future generations. Under the optimal policy package, the steady state has a zero nominal interest rate and has monetary contraction at the rate of intergenerational discount. As the rate of intergenerational discount rate approaches zero, optimal policy maximizes steady state utility of the representative consumer. In this case, the optimal steady state is characterized by a constant nominal money supply.

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This paper re-examines the implications of finite lifetimes for optimal monetary and fiscal policy. It is well-known from Sidrauski (1967) that if consumers have infinite horizons, then money is superneutral.[1] Under superneutrality, the steady state capital stock is independent of the rate of monetary growth, and the optimal rate of monetary growth is that rate which leads consumers to hold the satiation level of real balances as suggested by Friedman (1969). By contrast, if selfish consumers have finite lives, then, as suggested by Tobin (1980, p.90) in his discussion of Wallace (1980), and as demonstrated more formally by Weiss (1980) and Drazen (1981), superneutrality does not hold. In the absence of superneutrality, the consideration of optimal monetary growth must take account of the effects of inflation on capital accumulation as well as on the demand for real balances.

Using the utility of the representative consumer in the steady state as the criterion for evaluating policy, both Summers (1981) and Weiss (1980) conclude that the optimal net rate of nominal monetary growth is positive. Summers reaches this conclusion by using U. S. data to calibrate certain parameters of a monetary growth model in which savings is not determined by utility maximization, but rather is specified to be proportional to disposable income as in Tobin (1965). Weiss's conclusion is a theoretical proposition based on an overlapping generations model with money in the utility function. In addition, Weiss points out that optimal monetary policy will not satisfy Friedman's prescription that the satiation level of real balances be held, or equivalently, that the nominal interest rate be equal to zero in the steady state. However, Weiss's conclusions about optimal monetary policy are based on an analysis of second-best policy. In general, two independent policy instruments are required to allow the competitive economy to reach the first-best optimum. I will demonstrate in this paper that the policy package which allows the competitive economy to maximize the utility of the representative consumer in the steady state is characterized by a constant nominal money supply and a zero nominal interest rate. These results differ from Weiss's results because, (a) consistent with

Friedman (1969), I specify the existence of a satiation level of real balances and (b) I determine first-best rather than second-best policy. This characterization of optimal policy applies whether money creation takes place via lump-sum government transfers or as a result of monetizing the fiscal deficit.

Section I presents a model of a deterministic competitive economy with money and capital. The analysis of optimal policy requires some criterion function to evaluate the outcome of policy. Section II presents the criterion function introduced by Samuelson (1967,1968) and then develops a justification for this criterion function based on individual utility maximization. In a limiting case, maximization of this criterion function is equivalent to maximization of the utility of the representative consumer in the steady state. Section III presents the policy package which maximizes the policy criterion function in the steady state. Steady state utility of the representative consumer is maximized by a constant nominal money stock and a fiscal policy that supports a zero nominal interest rate. More generally, if the policy criterion function discounts the utility of future generations, then the optimal steady state is still characterized by a zero nominal interest rate, but has a constant (negative) growth rate of nominal money balances rather than a constant level of nominal balances. The optimal policy in section III is derived under the asumption that money creation is effected through lump-sum transfers. In section IV, I model money creation as arising from the financing of fiscal deficits and demonstrate that the optimal policy in the steady state is virtually the same as with monetary transfers as in section III.

I. The Competitive Economy

The model analyzed in this section follows Weiss (1980) with minor modification so the description will be brief. Let N_t be the number of consumers born at the beginning of period t. Each consumer lives for two periods and inelastically supplies one unit of labor when young. Old consumers do not work. The aggregate production function is linearly homogeneous in capital K_t

and labor N_t, and the production function can be written in intensive form as

$$y_t = f(k_t) \qquad f' > 0,\ f'' < 0 \tag{1}$$

where y_t is the output/labor ratio and $k_t \equiv K_t/N_t$ is the capital/labor ratio.

The homogeneous output can be consumed or used as capital in the following period. In competitive factor markets the (gross) interest rate, R_t, and the wage rate, w_t, are equal to the marginal products of capital and labor, respectively,

$$R_t = R(k_t) \equiv 1 + f'(k_t) \tag{2}$$

$$w_t = w(k_t) \equiv f(k_t) - k_t f'(k_t) \tag{3}$$

There are two assets in the economy. In addition to capital, there is fiat money. Let M_t be the nominal aggregate stock of fiat money outstanding at the beginning of period t and let H_t be the nominal aggregate amount of (lump-sum) monetary transfers (i.e., new money) given to old consumers immediately after the beginning of period t. Thus the evolution of nominal aggregate money balances is given by

$$M_{t+1} = M_t + H_t \equiv \mu_{t+1} M_t \tag{4}$$

In (4) μ_{t+1} is defined as the gross growth rate of the nominal aggregate stock of fiat money during period t. Letting p_t denote the money price of goods, define the real stock of fiat money and the real value of monetary transfers, each deflated by the number of young consumers as

$$m_t \equiv M_t/(p_t N_t) \tag{5}$$

$$h_t \equiv H_t/(p_t N_t) \tag{6}$$

Let $\pi_{t+1} \equiv p_{t+1}/p_t$ be defined as the gross rate of inflation. In the steady state with a constant rate of monetary growth, μ, and with constant real balances per capita, the rate of inflation is constant

$$\pi = \mu/G \tag{7}$$

where $G \equiv N_t/N_{t-1}$ is the gross rate of population growth.

Let c_t denote the consumption of a young consumer in period t and let x_t denote the

consumption of an old consumer in period t. A representative consumer born in period t obtains utility from consumption when young, c_t, consumption when old, x_{t+1}, and the real stock of money he holds at the end of period t. Since all money is held by young consumers at the end of each period, the value of real balances held by a representative consumer at the end of period t is $M_{t+1}/(p_t N_t) = G\pi_{t+1} m_{t+1}$. The utility of a representative consumer is

$$U_t = U(c_t, x_{t+1}, G\pi_{t+1} m_{t+1}) \tag{8}$$

where $U(\ ,\ ,\ )$ is strictly concave and is strictly increasing in c_t and x_{t+1}. In addition, suppose that c_t and x_{t+1} are each normal goods and that for each $c_t, x_{t+1} > 0$ there exists a satiation level of real balances m* such that $\partial U(c_t, x_{t+1}, G\pi_{t+1} m^*)/\partial m = 0$. The existence of a satiation level of real balances is an important element of Friedman's optimal quantity of money.

Finally, suppose that there is a balanced-budget pay-as-you-go lump-sum tax and transfer system which, in period t, taxes each young consumer τ_t and gives each old consumer a subsidy of $G\tau_t$.

It is convenient to define s_t as the saving of a consumer born at the beginning of period t

$$s_t = w_t - \tau_t - c_t \tag{9}$$

Recalling that at the end of period t the consumer holds real balances of $G\pi_{t+1} m_{t+1}$, it is clear that the consumer's holding of capital is equal to $s_t - G\pi_{t+1} m_{t+1}$. In period t+1, when the consumer is old, his resources available for consumption are equal to the sum of his gross capital income ($[s_t - G\pi_{t+1} m_{t+1}]R_{t+1}$), his money balances carried over from the previous period (Gm_{t+1}), the monetary transfer he receives (Gh_{t+1}), and the fiscal transfer he receives ($G\tau_{t+1}$), so that

$$x_{t+1} = (s_t - G\pi_{t+1} m_{t+1})R_{t+1} + (m_{t+1} + h_{t+1} + \tau_{t+1})G \tag{10}$$

Using the definition of saving in (9), equation (10) can be used to derive the lifetime budget constraint

$$R_{t+1}c_t + x_{t+1} + (R_{t+1}\pi_{t+1} - 1)Gm_{t+1} = R_{t+1}(w_t - \tau_t) + G(h_{t+1} + \tau_{t+1}) \quad (11)$$

Note that $R_{t+1}\pi_{t+1} - 1$ is the net nominal interest rate , and then observe that the left hand side of (11) is the future value of expenditures on consumption when young, consumption when old, and the rental of real balances. The right hand side of (11) is the future value of lifetime income net of taxes.

The first-order conditions for the consumer's optimization problem are easily obtained by using (9) and (10) to substitute for c_t and x_{t+1} in the utility function (8) and then differentiating with respect to s_t and m_{t+1}. Evaluating these conditions in the steady state and using (7) to substitute for steady state inflation yields

$$U_c = RU_x \quad (12)$$

$$[\mu(R/G) - 1]U_x = (\mu/G)U_m \quad (13)$$

where $U_c \equiv \partial U(\ )/\partial c$, $U_x \equiv \partial U(\ )/\partial x$, $U_m \equiv \partial U(\ )/\partial(G\pi m)$ in the steady state.

To interpret (12) note that a young consumer who chooses to hold an additional unit of capital by foregoing a unit of consumption suffers a utility loss of U_c from the reduction in consumption when young. However, his consumption when old is increased by R units which raises utility by RU_x. An optimizing consumer will invest to the point where the utility loss U_c equals the utility gain RU_x. To interpret (13), use the expression for the steady state rate of inflation in (7) to obtain $U_m = (R - 1/\pi)U_x$. A consumer who rearranges his portfolio by reducing his holding of capital by one unit and increasing his holding of real balances by one unit loses $(R - 1/\pi)$ units of second period consumption which induces a utility loss of $(R - 1/\pi)U_x$. The optimizing consumer equates this utility loss with the utility gain U_m from holding an additional unit of real balances.

Finally, observe that the optimal saving of a consumer, s_t, can be written as

$$s_t = s(w_t - \tau_t\ ,\ G[h_{t+1} + \tau_{t+1}]\ ,\ \pi_{t+1}\ ,\ R_{t+1}) \quad (14)$$

The assumption that c_t and x_{t+1} are normal goods implies that $0 < s_1 < 1$ and $-1/R_{t+1} < s_2 =$

$-(1-s_1)/R_{t+1} < 0$ where s_i is the partial derivative of $s(\ ,\ ,\ )$ with respect to its ith argument. In addition, it follows that $ds_t/d\tau_t + ds_t/d\tau_{t+1} < 0$ so that a permanent increase in the fiscal transfer from young consumers to old consumers leads to a reduction in individual saving.

II. The Policymaker's Objective Function

The competitive monetary growth model in section I is essentially identical to that in Weiss (1980). Weiss then used this model to examine the effects of policy on the utility of the representative consumer in the steady state. In this section I adopt a more general criterion function for policy evaluation. In particular, I follow Samuelson (1967,1968) and assume that in period t the policymaker attempts to maximize

$$W_t = (1-\beta) \sum_{j=-1}^{\infty} \beta^j U_{t+j} \qquad 0 < \beta \leq 1 \qquad (15)$$

subject to the aggregate resource constraint

$$c_t + x_t/G = f(k_t) + k_t - Gk_{t+1} \qquad (16)$$

and the constraint that c_{t-1} is fixed by history. As pointed out by Calvo and Obstfeld (1985), the utility of old consumers, U_{t-1}, must be included in the period t criterion function to avoid dynamic inconsistency.[2]

The criterion function in (15) may strike some readers as *ad hoc*. There are two answers that may be offered to such an objection. First, if one is willing to use Weiss's criterion function—maximizing the utility of a representative consumer in the steady state—then one may merely set β equal to one in the discussion of optimal policy in sections III and IV. Formally, the Samuelson welfare function approaches the criterion function used by Weiss as $\beta \to 1$.

A second justification for (15) involves an alternative specification of the individual utility function which leads to optimal decision rules for an individual consumer which are identical to

those derived in section I. Specifically, let V_t be the utility of an individual generation t consumer and let $\underline{V}_t$ be the average utility of the entire cohort of generation t consumers. Now suppose that an individual generation t consumer cares about the average level of utility of the entire generation t cohort and the average level of utility of the entire generation t+1 cohort, in addition to his own consumption and real money balances as in (8). In particular, let the utility function of a generation t consumer be

$$V_t = U_t + \alpha \underline{V}_t + \gamma \underline{V}_{t+1} \tag{17}$$

where $\alpha > 0$, $\gamma > 0$, $\alpha + \gamma < 1$ and U_t is given by (8). Provided that N_t is large, the decision rules for an individual which maximize (17) will be identical to those which maximize (8). Thus, the behavior of a competitive economy with maximizing consumers will be unchanged if the individual utility function (8) is replaced by (17).

To obtain an expression for average utility in terms of the streams of consumption and real money balances, calculate the average value (over generation t consumers) of both sides of (17),

$$(1-\alpha)\underline{V}_t = \underline{U}_t + \gamma \underline{V}_{t+1} \tag{18}$$

where $\underline{U}_t$ is the average value of U_t. Equation (18) is a linear first-order constant coefficient difference equation. The non-explosive solution to the equation can be written easily by defining $\beta \equiv \gamma/(1-\alpha)$ and observing that $0 < \beta < 1$. With this definition observe that

$$\underline{V}_t = (1-\alpha)^{-1} \sum_{j=0}^{\infty} \beta^j \underline{U}_{t+j} \tag{19}$$

Finally, observe that $\underline{V}_{t-1} = (1-\alpha)^{-1} W_t$ where $\underline{V}_{t-1}$ is the average utility of old consumers at time t and W_t is the policy criterion function in period t as shown in (15). Thus, in the steady state, maximization of $\underline{V}_t$ is equivalent to maximization of the Samuelsonian criterion function in (15).

marginal cost of producing money is zero.

B. Optimal Policy

In this section I present the combination of monetary and fiscal policies which allows the competitive economy to achieve the social optimum in the steady state. This strategy is different from that pursued by Weiss (1980). Weiss essentially restricted his analysis to a second-best framework by assuming that the policy authority can "control only the size of the nominal transfer to each old person. Particularly, the authority is denied the possibility of acquiring real capital." (p. 568). In the optimal policy package presented below, the policy authority will, as in Weiss, be prevented from acquiring real capital. However, the policy authority will have two instruments: the gross rate of nominal monetary growth, μ, and the size of the balanced-budget pay-as-you-go intergenerational transfer τ.[3]

The optimal policy package in the steady state is

$$\mu = \beta \tag{21a}$$

τ such that $$\beta m^* + Gk^* = s(w(k^*) - \tau, G[(\beta-1)m^*+\tau], \beta/G, G/\beta) \tag{21b}$$

where k^* is the Modified Golden Rule capital stock and m^* is the satiation level of real balances. Equation (21a) implies that (using (7)) the steady state gross rate of inflation is $\pi = \beta/G$ so that the steady state gross real (pecuniary) rate of return on money is G/β. Equation (21b) states that when the real rates of return on money and capital are each equal to G/β the Modified Golden Rule capital stock and the satiation level of real balances will be willingly held by consumers when τ is optimally chosen. To see that there exists a unique optimal τ (which may of course be negative) recall that the normality of c and x implies that if k, m, and μ are given, then $ds/d\tau = ds_t/d\tau_t + ds_t/d\tau_{t+1} < 0$.[4] Finally, recall that the gross nominal interest rate is equal to the product of the gross real rate of return, R, and the gross rate of inflation, π. In the optimal steady state, $R = G/\beta$ and $\pi = \beta/G$ so that the gross nominal interest rate is equal to one

and the net nominal interest rate is equal to zero.

Having presented the policy package which allows the competitive economy to achieve the social optimum, several remarks are in order:

(1) The prescription for optimal monetary growth, $\mu = \beta$, is independent of the production function and is independent of the particular specification of the individual utility function. However, the optimal fiscal transfer depends on both individual preferences and the production function, in general.

(2) The result that the optimal gross rate of monetary growth is equal to β is the same as in two other capitalistic monetary models with money in the utility function. Dornbusch and Frenkel (1973) have shown that $\mu = \beta$ is optimal in the Sidrauski model where β is the discount factor in the utility function of the representative infinitely-lived consumer. Also McCallum (1983) has shown that in an overlapping generations model with money in the utility function and a fixed rate of return on capital (rather than a neoclassical production function), the optimal rate of monetary growth is β. The prescription that $\mu = \beta$ is also obtained for endowment economies by Brock (1975) and Townsend (1980).

(3) If money is not in the utility function, then the first-best social optimum is described by the Atemporal Allocation condition (20a) and the Intertemporal Allocation condition (20b). In this case, the optimal steady state policy package is simply $\mu = \beta$. Fiscal policy — more specifically the choice of τ — is irrelevant in the steady state, provided that aggregate saving is large enough to absorb the Modified Golden Rule capital stock and some positive level of real balances. However, if aggregate saving is smaller than or equal to the Modified Golden Rule capital stock (i.e., if $Gk^* \geq s(\ ,\ ,\ ,\ )$), then a decrease in τ is required to raise aggregate saving so that the Modified Golden Rule capital stock and some real balances will be willingly held in private portfolios. The applicability of the results in this remark to monetary policy must be judged in light of McCallum's (1983) argument that, in this case, M_t is only a store of value,

and if M_t is only a store of value then it is not appropriate to interpret M_t as money.

(4) If $\beta = 1$, so that the objective of the policy authority is to maximize steady state individual utility (8), as in Weiss (1980), then the optimal policy package calls for a constant nominal money supply and a level of τ which leads to a zero nominal interest rate in the long run.[5] Why do these results differ from Weiss's finding that "the maximum sustainable utility level will require positive growth in the money supply" (p. 566) and that Friedman's "full liquidity" rule does not hold in the presence of consumers with finite lives? The sources of the difference are: (1) in his analysis of policy, Weiss assumes that the marginal utility of money, U_m, is everywhere positive, which implies that the real rate of return on capital must exceed the (pecuniary) real rate of return on money; and (2) Weiss restricts his analysis to second-best policy. Under the assumption that U_m is everywhere positive, it should not be surprising that the Friedman rule (zero nominal interest rate) is not the optimal policy; it is not even a feasible policy! If is specified U_m is specified to be strictly decreasing in the level of real balances, and to become zero at some level of real balances, so that the Friedman rule is feasible, then as shown above, the Friedman full liquidity rule is part of a first-best optimal policy package. Even if I do not assume that the policy authority has a value of β equal to one, but alternatively has a value of β less than one, the first-best optimal policy package is to set $\mu = \beta$ and to choose τ to peg a zero nominal interest rate in the steady state.

IV. The Government's Budget Constraint

In previous sections of the paper I ignored the link between the government's fiscal deficit and money creation. I modeled the tax and transfer system as being run by a fiscal authority that is constrained to run a balanced budget in every period. The monetary authority increases the nominal supply of money simply by giving the money to people as if dropping it from a helicopter (Friedman (1969), p. 4). The first best optimal policy package requires a reduction in aggregate nominal balances, and to implement this reduction "we substitute a furnace for the

helicopter" (Friedman (1969), p. 16). The use of the helicopter and the furnace, rather than government transactions in goods markets and/or assets markets, to change the nominal money supply has a long tradition in monetary economics and monetary growth models in particular (For example, Friedman (1969), McCallum (1983) and Sidrauski (1967)). Nevertheless, because the helicopter (and furnace) abstraction does not capture the *quid pro quo* nature of an open market purchase or of monetization of a deficit, the interpretation of monetary policy is somewhat strained. The previous section of this paper used the helicopter (and furnace) abstraction in order to be directly comparable to the large and well-known literature that uses this abstraction. In this section, however, I dispense with the helicopter and furnace, and model the government's budget constraint.

The government's budget constraint requires that the rate of creation of claims against the government is equal to the fiscal deficit. I will maintain the assumption that the government does not participate in the capital market so that the rate of creation of nominal money balances is equal to the nominal fiscal deficit. In order to allow for a nonzero deficit I relax the assumption that the aggregate transfers to the old are equal to the taxes levied on the young. Let z_t be the real lump-sum transfer received by each old consumer in period t and, as before, let τ_t be the real lump-sum tax levied on each young consumer in period t. Recalling that H_t is the creation of aggregate nominal balances in period t, the government's budget constraint is

$$H_t = p_t[N_{t-1}z_t - N_t\tau_t] \tag{22}$$

Using the definition of real per capita money creation in (6), the government's budget constraint in real per capita terms can be rewritten as

$$h_t = z_t/G - \tau_t \tag{23}$$

In this modified environment, the budget constraint of an individual consumer differs from that in (11). An old consumer in period t+1 has available his gross capital income, his real balances and the fiscal subsidy so that

$$x_{t+1} = [s_t - G\pi_{t+1}m_{t+1}]R_{t+1} + Gm_{t+1} + z_{t+1} \qquad (24)$$

Using the definition of saving in (9), equation (24) can be rearranged to obtain the lifetime budget constraint

$$R_{t+1}c_t + x_{t+1} + (R_{t+1}\pi_{t+1} - 1)Gm_{t+1} = R_{t+1}(w_t - \tau_t) + z_{t+1} \qquad (25)$$

The budget constraint in (25) is identical to the budget constraint in (11) except that z_{t+1} rather than $G(h_{t+1} + \tau_{t+1})$ is the second-period non-portfolio income on the right hand side.

The optimal saving of a young generation t consumer is given by

$$s_t = s(w_t - \tau_t, z_{t+1}, \pi_{t+1}, R_{t+1}) \qquad (26)$$

where the function $s(\ ,\ ,\ )$ is identical to that in (14) except that the second argument, which represents net lump-sum transfers received in the second period, is z_{t+1} rather than $G(h_{t+1} + \tau_{t+1})$.

I can now examine optimal monetary and fiscal policy in this modified economy taking account of the government's budget constraint. The socially optimal allocation in the steady state is still described by the Atemporal Allocation Condition, the Intertemporal Allocation Condition, and the Optimal Quantity of Money Condition (20a, b, c). The optimal steady state is characterized by the Modified Golden Rule level of capital intensity, k^*, such that $R(k^*) = G/\beta$ and by the optimal level of real balances m^*. The optimal (gross) rate of monetary growth is equal to β and the fiscal tax-transfer system must be such that desired savings is exactly large enough to absorb the Modified Golden Rule capital stock and the Optimal Quantity of Money

$$\beta m^* + Gk^* = s(w(k^*) - \tau, z, \beta/G, G/\beta) \qquad (27)$$

The level of fiscal transfers to old consumers in the steady state can be calculated from the government's budget constraint (23) using the steady state relation $h = (\mu - 1)m$ to obtain

$$z = G[(\mu - 1)m + \tau] \qquad (28)$$

Using (28) to substitute for z in (27), and recalling that optimal policy calls for $\mu = \beta$, yields

$$\beta m^* + Gk^* = s(w(k^*) - \tau, G[(\beta - 1)m + \tau], \beta/G, G/\beta) \qquad (29)$$

Note that (29) is identical to (21b) so that in the presence of the government's budget constraint optimal monetary and fiscal policy in the steady state are given by (21a,b). The only difference is that when it is recognized that the rate of money creation is identical to the nominal fiscal deficit, the optimal lump-sum fiscal transfer to old consumers is $G[(\beta-1)m^* + \tau]$ rather than simply $G\tau$, as in section III. In either formulation, each old consumer receives a total transfer of $G[(\beta-1)m^* + \tau]$. Using the helicopter/furnace abstraction, this transfer consists of a monetary transfer of $G(\beta-1)m^*$ and a fiscal transfer of $G\tau$. Alternatively, if I rule out monetary transfers and specify money creation to be equal to the fiscal deficit, then the entire transfer to old consumers $G[(\beta-1)m^* + \tau]$ is a fiscal transfer. In this case if $\beta < 1$, then the optimal policy requires monetary contraction, which implies that the fiscal authority should run a surplus in the steady state.

In the stylized model of this paper, the distinction between lump-sum monetary transfers and lump-sum fiscal transfers is somewhat artificial. The formulation of the government's budget constraint in this section captures the *quid pro quo* nature of the transactions by which money is injected or withdrawn from the economy. However, I have shown that the prescription for optimal policy is essentially the same whether money creation is effected through transfers or the financing of fiscal deficits.

V. Concluding Remarks

In this paper I have analyzed optimal monetary and fiscal policy in a competitive economy populated by overlapping generations of finitely-lived consumers who obtain utility from real balances. I have shown that maximum sustainable utility requires a constant nominal money supply and that lump-sum balanced-budget fiscal transfers must be set a a level that induces consumers to be satiated with real balances. Thus, optimal policy will lead to a zero nominal interest rate. More generally, maximization of a weighted average of utility of all future

generations requires contraction of the nominal money supply at the rate at which the utility of one generation is discounted relative the utility of the previous generation. However, even with this more general criterion function, the Friedman full liquidity rule remains part of the first-best optimal policy package. This characterization of the optimal policy package holds regardless of whether money creation occurs via lump-sum transfers to consumers or occurs as the means of financing fiscal deficits.

Some readers will undoubtedly object to the presence of money in the utility function.[6] If such readers are willing to analyze policy in an economy in which M_t is purely a store of value, despite McCallum's argument about the need to model the transactions services of money, they may apply the results of this paper and set $U_m \equiv 0$. The optimal policy package in this case will require only one instrument and indeed is quite simple: set the rate of nominal monetary growth equal to β. Therefore, steady state utility of the representative consumer is maximized by a constant nominal money supply.

A second response to readers who object to putting money into the utility function is first to point out that this formulation is intended to be a short-hand way of modelling the transactions services of money but then to acknowledge that a more satisfactory modelling strategy would aim at modelling the transactions services more directly, perhaps by including leisure in the utility function. Indeed, I think that a useful extension of the research in this paper would be to analyze monetary and fiscal policy in a model with a more complete specification of transactions services.

The result that the optimal rate of monetary growth is equal to β is quite robust along several dimesions. It does not depend on the particular specificiation of technology or preferences; it does not even depend on whether money is in the utility function. However, this result must be modified in the presence of uncertainty. An analysis of optimal policy in the presence of uncertainty appears to be an important topic for future research.

Footnotes

1. In a recent paper, Weil (1986) shows that if there is a continual influx of infinitely-lived new consumers into an economy, and if these consumers do not receive transfers from existing consumers, then the economy will not display superneutrality of money even though all consumers have infinite horizons.

2. If the utility of old consumers, U_{t-1}, were not included in the period t criterion function, then the social planner would set $x_t = 0$, despite the fact that in period t-1 the social planner had optimally planned for x_t to be positive.

3. See Calvo (1978) for an analysis of the case in which the government cannot levy lump-sum taxes but can levy distortionary taxes.

4. I follow Diamond (1965) and assume that preferences and technology are such that for given τ and μ there is a unique steady state.

5. Wallace (1985) describes a policy package which allows an endowment economy with perfectly perishable endowments to maximize steady state utility of the representative consumer. Consistent with the results presented above, the optimal policy package has a constant stock of nominal fiat money ($\mu = \beta = 1$) and a zero nominal interest rate.

6. See Kareken and Wallace (1980), Bryant (1983) and Wallace (1983).

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