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INTERTEMPORAL SUBSTITUTION AND THE ROLE OF MONETARY POLICY: POLICY IRRELEVANCE ONCE AGAIN

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Abstract: Recently Marini (1985) demonstrates that a policy rule with proportional feedback to the current money stock from disturbances dated t-2 or further in the past will be effective at stabilizing output in Barro's (1976) model. This paper questions the robustness and logical consistency of Marini's result. It demonstrates that Marini's claim is overturned when the length of private agents's horizons does not fall short of the length of the lags in the feedback rule, so that private agents correctly incorporate knowledge of the wealth they will receive from future transfers into their decision calculus. Marini assumes that private agents ignore a foreseeable source of change in future money balances. This questionable feature of his analysis is crucial to the policy effectiveness results he obtains.

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Recently Marini (1985) demonstrates that feedback policy is effective in Barro's (1976) model even in the absence of differentially informed agents or non-proportional money transfers.[1] In particular, Marini demonstrates that a policy rule with feedback to the current money stock from disturbances dated t-2 or further in the past will be effective at fully stabilizing output in Barro's model. Marini argues that, "respecting <u>all</u> the rules of the new classical game, output can be stabilized around its full information level by purely conditional monetary growth rules.... These rules do satisfy the joint new classical requirements of strict proportionality of money transfers and absence of long-run anticipated monetary growth." (p.87-88).

This paper demonstrates that Marini's policy effectiveness result is dependant on his specification that the length of private agents's horizon falls short of the length of the lags in the feedback rule. Marini's result is overturned when private agents correctly incorporate knowledge of the wealth they will receive from future transfers into their decision calculus. Marini's analysis alters the money rule to include feedback from disturbances arbitrarily far in the past while not changing the demand and supply specifications employed by Barro, and hence falls victim to the Lucas (1976) critique. He assumes that private agents ignore a <u>foreseeable</u> source of change in future money balances, and this questionable feature of his analysis is crucial to the policy effectiveness results he obtains.

A Multiple Period New Classical Model

Following Marini (1985) and Barro (1976), we specify reasonable but ad-hoc demand and supply equations for an islands economy. We modify Barro's original specification to explicitly include multiple period horizons for economic actors, and Marini's multiple period money feedback rule. We retain an important feature of Barro's model, the lack of an economy-wide bond market. Hence, the nominal interest rate is assumed to be zero. This assumption, while simplistic, is standard in these models, and has the benefit of simplifying the analysis.[2]

Demand and supply in market z, together with the money supply rule and the aggregate productivity process, are given by:

$$(1)\quad Y^s{}_t(z) = \Sigma_{i=1}^{N} \alpha_i^s[P_t(z) - E(P_{t+i}|I_t(z))] - \beta^s[E(M_{t+N}|I_t(z)) - P_t(z)] + u_t^s + \epsilon_t^s(z),$$

$$(2)\quad Y^d{}_t(z) = -\Sigma_{i=1}^{N} \alpha_i^d[P_t(z) - E(P_{t+i}|I_t(z))] + \beta^d[E(M_{t+N}|I_t(z)) - P_t(z)] + u_t^d + \epsilon_t^d(z),$$

$$(3)\quad \Delta M_t = -\Sigma_{i=1}^{N+1} \delta_i v_{t-i},$$

$$(4)\quad u_t = u_{t-1} + v_t,$$

where all variables are natural logarithms, Y(z) is real output in market z, P(z) is the price of output in market z, M is the nominal money stock, u is an aggregate productivity shock, modeled as a random walk, and $\epsilon(z)$ is a transitory shock to market z. The disturbances v and $\epsilon(z)$ are mutually and serially uncorrelated. The expression $E(x|I_t(z))$ represents the mathematical conditional expectation of x given information at time t in market z. Information at time t in market z, denoted $I_t(z)$, consists of $P_t(z)$ plus knowledge of the lagged values (dated t-1 or earlier) of all variables in the model.[3]

This class of model is common in the literature, but several features of equations (1)-(4) bear comment. First, the expected future money balances in period N enter demand and supply. This generalizes Barro's original specification to an N period horizon, and can be justified from the N-period intertemporal budget constraint facing private agents. In the Lucas and Rapping (1969) framework, the intertemporal budget constraint can be written <u>in levels</u> (and without the island index z) as:[4]

$$\Sigma_{i=0}^{N}(b^i P_{t+i} C_{t+i})/P_t = \Sigma_{i=0}^{N}(b^i W_{t+i} L_{t+i})/P_t + [M_t + \Sigma_{i=1}^{N}(b^i \Delta M_{t+i})]/P_t,$$

where C, L represent consumption and labor effort, respectively, W and P represent the nominal prices of labor and consumption, M represents the money stock, and b is the nominal discount factor. This framework can generate the supply and demand equations employed by Barro -- see Kimbrough (1984). In the N-period horizon case without discounting (b=1), it is the level of money balances in period N, appropriately deflated, that measures the wealth constraint facing individuals in their intertemporal budget constraint. Thus, absent discounting, the wealth of agents in market (z) is measured as $E\{[M_t+\Sigma_{i=1}^{N}(\Delta M_{t+i})]/P_t(z)\} = E\{M_{t+N}/P_t(z)\}$. Barro's specification is a special log-linear case for N=1.[5]

A second feature of equations (1) and (2) is the N intertemporal substitution terms entering demand and supply. These capture the intertemporal substitution possibilities available to private agents over an N-period horizon.

Finally, we employ Marini's money supply rule, equation (3). It specifies no stochastic disturbances to the money equation. Also, feedback is from N+1 periods in the past to the current money stock. This allows us to investigate the importance of feedback lags exceeding the horizon of private agents for Marini's policy effectiveness result.

Equations (1) to (4) can be solved for the rational expectations solution. We first solve for the incomplete information solution, where agents form expectations conditioned on $I_t(z)$. Next we solve for the complete information solution, where agents form expectations conditioned on $I_t^*(z)$, where $I_t^*(z)$ is the information set containing values for all variables dated t or earlier. We then discuss the importance of the lag lengths in the feedback rule relative to the horizon of private agents in deriving a policy ineffectiveness result.

The solutions are calculated by the standard method of undetermined coefficients, so we merely sketch the steps in solving the model. For the incomplete information case, the market clearing condition $Y^s{}_t(z)=Y^d{}_t(z)$ yields the equilibrium condition:

$$(5) \quad [\beta + \Sigma_{i=1}^{N}\alpha_i]P_t(z) = \Sigma_{i=1}^{N}\alpha_i E(P_{t+i}|I_t(z)) + \beta E(M_{t+N}|I_t(z)) + u_t + \epsilon_t(z)$$

where $\alpha_i=\alpha_i^d+\alpha_i^s$, $\beta=\beta^d+\beta^s$, $u_t=u_t^d-u_t^s$, $\epsilon_t(z)= \epsilon_t^d(z)-\epsilon_t^s(z)$.

We conjecture a solution for price involving the undetermined coefficients θ and π_j, $j=0,1,\ldots,N$, as follows:

$$(6) \quad P_t(z) = \theta\epsilon_t(z) + \Sigma_{i=0}^{N}\pi_i v_{t-1}$$

Using equations (5) and (6), as well as the money rule specified in equation (3), we can solve for the undetermined coefficients as:

$$(7a) \quad \theta = \pi_0 = [((1/\beta) - \Sigma_{i=1}^{N+1}\delta_i)\phi(\Sigma_{i=1}^{N}\alpha_i) - \phi\beta\Sigma_{i=1}^{N}\alpha_i + 1]/[\beta + \Sigma_{i=1}^{N}\alpha_i]$$

$$(7b) \quad \pi_j = [1 - \beta\Sigma_{i=1}^{N+1}\delta_i)]/\beta, \ j=1,\ldots,N.$$

In deriving (7a) and (7b), use is made of the solution to the signal extraction problem $E(v_t|I_t(z))$, given by:

$$E(v_t|I_t(z)) = \phi[v_t+(\theta/\pi_0)\epsilon_t(z)]; \qquad \text{with } \phi = \pi_0^2\sigma_v^2/(\pi_0^2\sigma_v^2 + \theta^2\sigma_\epsilon^2)$$

These solutions imply the following results for the intertemporal substitution and wealth terms entering demand and supply:

$$(8a) \ P_t(z)-E(P_{t+j}|I_t(z)) = [1-\phi+\beta\phi\delta_{N+1}](v_t+\epsilon_t(z))/[\beta+\Sigma_{i=1}^{N}\alpha_i)], \ j=1,\ldots,N,$$

(8b) $E(M_{t+N}|I_t(z))-P_t(z)= \{[(\beta\delta_{N+1}-1)\phi(\Sigma_{i=1}^{N}\alpha_i)-\beta](v_t+\epsilon_t(z))\}/\{(\beta+\Sigma_{i=1}^{N}\alpha_i)\beta\}$
$-(1/\beta)\Sigma_{i=1}^{N+1}v_{t-i}$

Inspection of these terms indicates the possibility of an effect of the feedback parameter δ_{N+1} on these terms and thereby on real output.

We next demonstrate that the choice of δ_{N+1} can influence full information output, and also the deviation of output from full information output. To proceed, we calculate the full information solution from the equilibrium condition given in equation (5) above, where we have substituted the information set $I_t^*(z)$ for $I_t(z)$. We denote the full information values by a superscript * :

(9a) $\theta^* = 1/[\beta+\Sigma_{i=1}^{N}\alpha_i)]$

(9b) $\pi_0^* = [(1/\beta-\Sigma_{i=1}^{N+1}\delta_i)(\Sigma_{i=1}^{N}\alpha_i)-\beta\Sigma_{i=1}^{N}\alpha_i+1]/[\beta+\Sigma_{i=1}^{N}\alpha_i]$

(9c) $\pi_j^* = \pi_j$, $j=1,\ldots,N$.

These solutions imply the following results for the terms entering demand and supply:

(10a) $P_t^*(z)-E(P_{t+j}^*|I_t^*(z)) = [\epsilon_t(z)+\beta\delta_{N+1}v_t]/[\beta+\Sigma_{i=1}^{N}\alpha_i)]$, $j=1,\ldots,N$,

(10b) $E(M_{t+N}|I_t^*(z))-P_t^*(z) = \{[(\beta\delta_{N+1}-1)\Sigma_{i=1}^{N}\alpha_i)-\beta]v_t-\epsilon_t(z)\}/\{(\beta+\Sigma_{i=1}^{N}\alpha_i)\beta\}$
$-(1/\beta)\Sigma_{i=1}^{N+1}v_{t-i}$

From equations (8a)-(8b) and (10a)-(10b), we can derive the derivation of output from full information output in market z. This depends only on the deviations of the expressions for the intertemporal substitution and wealth terms derived under incomplete information in equations (8a)-(8b) from the intertemporal substitution and wealth terms derived under full information in equations (10a) -(10b). These differences are given by:

$$(11a)\quad [P_t(z)-E(P_{t+j}|I_t(z))] - [P^*_t(z)-E(P^*_{t+j}|I^*_t(z))]$$
$$= \{(\beta\delta_{N+1}-1)[\phi\epsilon_t(z)-(1-\phi)v_t]\}/[\beta+\Sigma_{i=1}^{N}\alpha_i)],\ j=1,\ldots,N,$$

$$(11b)\quad [E(M_{t+N}|I_t(z))-P_t(z)] - [E(M_{t+N}|I^*_t(z))-P^*_t(z)]$$
$$= \{(\beta\delta_{N+1}-1)[\phi\epsilon_t(z)-(1-\phi)v_t](\Sigma_{i=1}^{N}\alpha_i)\}/[\beta+\Sigma_{i=1}^{N}\alpha_i)]$$

Inspection of (11a)-(11b) clearly indicates that the only feedback parameter entering these solutions is the term δ_{N+1}, the term involving feedback from a time further in the past than the horizon of economic agents. This is important, because this term provides the lever by which the current imperfectly extracted disturbance v_t affects wealth at period t+N+1, which is one period further in the future than the horizon of private agents. Since private agents are assumed to ignore this <u>predictable</u> change in their current wealth due to a foreseeable (albeit imperfectly) change in their future money balances, policy has a lever to effect current economic decisions.

An interesting feature of the above result is that it holds when the terms $[P_t(z)-E(P_{t+j}|I_t(z))]$, for $j>1$, all have coefficient $\alpha_j=0$. Inspection of equations (8a) and (10a) confirms this, since there it is clear that $E[P_{t+j}|I_t(z)] = E[P_{t+1}|I_t(z)]$ for $j>1$ in both the complete and incomplete information situations.[6] Thus the only substantive change in Barro's (1976) specification that is required to overturn Marini's claim of policy effectiveness is a respecification of the wealth term to include the foreseeable changes in wealth which occur due to Marini's policy rule.[7]

Conclusion

Marini claims that feedback from two or more periods in the past to the current money stock will invalidate the policy ineffectiveness proposition in Barro's (1976) model. This paper demonstrates that by properly modifying Barro's model to incorporate a more general wealth specification, the policy ineffectiveness property is restored. Marini, by lengthening the feedback process but not altering Barro's wealth specification, has implicitly assumed that private agents ignore foreseeable future money transfers when measuring their current wealth. Marini allows the government to change the wealth of private agents without allowing private agents to use this information when calculating their wealth constraint. This is hardly a situation in which reasonable people would agree that all of the rules of the "new classical game" have been respected.

Notes

1. Various features are known to lead to policy effectiveness in new classical models, including differentially informed agents with access to a market-wide price (Weiss (1980) and King (1982)), non-proportional money transfers (Waldo (1982)), the effect of anticipated inflation on the capital stock (Fischer (1979)), and various nominal rigidities.

Moreover, we are concerned here with policy effectiveness in a new classical model. Sargent and Wallace (1975) demonstrate a policy ineffectiveness result in a textbook Keynesian model. That result is also sensitive to a number of factors, including dating of expectations (Turnovsky (1980)), long term contracts (Fischer (1977)), and real balance effects in aggregate supply (Jansen (1985).

2. Barro (1980) presents a version of this model which includes an economy-wide bond market. King (1983) discusses the role for effective policy in that model, due to differentially informed agents.

3. One analysis of the effect of alternate information structures in this class of model is provided by Bradley and Jansen (1988).

4. One set of microfoundations for Barro's (1976) model is provided by Kimbrough (1984), who extends the framework of Lucas and Rapping (1969). This approach is developed in an appendix (available upon request) for the N-period horizon.

5. Even for N=1, the expected period N money balances in equations (1) and (2) are deflated by $P_t(z)$ instead of Barro's $E[P_{t+1}|I_t(z)]$. Note, however, that Barro's specification for the N=1 case:

(i) $$Y_t^s(z) = \alpha^s[P_t(z)-E(P_{t+1}|I_t(z)] - \beta^s[E(M_{t+1}|I_t(z))-E(P_{t+1}|I_t(z))] + u_t^s + \epsilon_t^s(z)$$

can quite naturally be transformed to an equivalent representation as:

(ii) $$Y_t^s(z) = (\alpha^s-\beta^s)[P_t(z)-E(P_{t+1}|I_t(z)] - \beta^s[E(M_{t+1}|I_t(z))-P_t(z)] + u_t^s + \epsilon_t^s(z).$$

Clearly these two specifications are identical in economic content. Moreover, the same transformation holds for the N-period horizon.

6. This particular feature of the model would be modified, without changing the conclusions on policy ineffectiveness, if the stochastic disturbances were specified as more general stochastic processes.

7. Barro's original paper considered only one period feedback rules, and hence it was appropriate to specify wealth as depending on the forecast of the money stock at time t+1. That is, with one period feedback the money stock will be adjusted at time t+1 based on the disturbance v_t, which private agents can imperfectly foresee from $I_t(z)$. When Marini lets the monetary authority respond at time t to disturbances at, say, t-4, then a disturbance at time t will lead to a change in the money stock at t+4. This prospective change in the money stock is (imperfectly) foreseen by private agents, who therefore alter their estimate of their wealth, with consequent effects on demand and supply. We incorporate this in Barro's model by respecifying wealth to include the money stock expected to exist at t+4.

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Appendix: Microfoundations for the new classical islands model.

The N-period horizon version of the Lucas and Rapping (1969) model is developed by specifying the utility function and budget constraint of a representative agent. This representative agent maximizes utility, written as:

$$U(c_t,\ c_{t+1},\ \ldots,\ c_{t+N},\ l_t,\ l_{t+1},\ \ldots,\ l_{t+N})$$

subject to the budget constraint (in levels) given by:

$$\Sigma_{i=0}^{N} b^i p_{t+i} c_{t+i} = \Sigma_{i=0}^{N} b^i w_{t+i} l_{t+i} + A_t + \Sigma_{i=1}^{N} \Delta b^i M_{t+i}$$

where c_t = consumption at time t,

p_t = price of consumption at time t,

l_t = labor effort at time t,

w_t = nominal wage rate at time t,

b = discount factor,

M_t = nominal money stock at time t.

We assume that the utility function U(.) is well-behaved, that future goods and leisure are substitutes for current leisure, that leisure is not inferior, and that the asset effect is small.

From this optimization we can derive consumption demand and labor supply functions of the form

$$x_t = f_x[w_t/p_t, bw_{t+1}/p_t, \ldots, b^n w_{t+n}/p_t, bp_{t+1}/p_t, \ldots, b^n p_{t+n}/p_t,$$
$$(M_t + b\Delta M_{t+1} + \ldots + b^n \Delta M_{t+N})/p_t],$$

where x is either consumption or labor effort.

In order to proceed we make the standard simplifying assumption that consumption and labor effort have log linear representations of the type used in Lucas and Rapping (1969). This can be justified as a

Taylor series approximation of labor supply and consumption in natural logarithms. We also assume that this representation is the same at all informationally separate "islands," indexed by z. We also assume at this time that the constant discount factor, b, is equal to one. This assumption simplifies the exposition and is in any event necessary for the derivation of supply and demand equations like this employed by Barro (1976). With these assumptions, we have a representation for labor effort given by (A1) below; the analogous equation describing consumption is similar:

$$\text{(A1)} \quad L_t(z) = \alpha_0 + \beta_0(W_t - P_t(z)) - \Sigma_{j=1}^{N}\beta_j[E(W_{t+j}|I_t(z)) - P_t(z)]$$

$$- \Sigma_{j=1}^{N}\gamma_j[E(P_{t+j}|I_t(z)) - P_t(z)] - \delta_0[M_{t+N} - P_t(z)].$$

where all variables are measured in natural logs, L_t is labor supply at time t, W_t is the nominal wage rate, P_t is the price level, and M_t is the nominal money stock. The variable $I_t(z)$ represents information available to agents at time t in market z. We have assumed in writing (1) that real balances are the only component of wealth. This simplifying assumption is in keeping with many of the New Classical (and non-New Classical) macro models which ignore capital and other sources of wealth.

In order to make this approach consistent with the islands paradigm, we assume that the N-period Lucas and Rapping intertemporal optimization problem faces agents on each island. We make the standard assumption that agents on island z have contemporaneous information on their island price $P_t(z)$ and information on the lagged values of all variables in the model.

In writing (A1) it was necessary to specify the price deflator applicable on each island. This turns out to be crucial for deriving a structural Lucas supply curve. Bull and Frydman (1983) assume that agents on island z deflate nominal magnitudes by their conditional expectation of the economy-wide price level, $E(P_t | I_t(z))$. In contrast, Kimbrough (1984) assumes that agents on island z deflate nominal magnitudes by their island's price, $P_t(z)$. We follow Kimbrough's approach, in part because it yields a structural Lucas supply curve (given some additional assumptions). Note too that deflation of nominal magnitudes by $P_t(z)$ is justified by the standard assumption in the islands paradigm that agents on island z are constrained at time t to trade only on island z.

We assume a log linear production function, given here as:

$$\text{(A2)} \quad Y_t(z) = \theta_0 + \theta_1 L_t(z) + \epsilon_t(z) + u_t, \qquad 0 \leq \theta_1 \leq 1,$$

where $Y_t(z)$ is output in market z at time t. The variable $\epsilon_t(z)$ is a zero mean disturbance with variance σ_e^2. This random variable represents temporary island-specific productivity shocks. The variable u_t represents aggregate permanent productivity shocks. We specify this term as $u_t = u_{t-1} + v_t$, where v_t is a zero mean white noise stochastic process with variance σ^2_v.

As Kimbrough demonstrates, an assumption necessary to derive Barro's (1976) new classical model from these microfoundations is the assumption of constant returns to scale in production, or $\theta_1=1$. We therefore make this assumption. The optimizing firm sets employment such that the wage and marginal product of labor are equalized. This condition is given by:

$$\text{(A3)} \quad W_t(z) - P_t(z) = \theta_2 + \theta_3 L_t(z) + \epsilon_t(z) + u_t,$$

where $\theta_2 = \theta_0 + \ln(\theta_1)$ and $\theta_3 = \theta_1 - 1$. Under constant returns to scale, it is clear that $\theta_3 = 0$.

From (A3) we can solve for $E(W_{t+j}|I_t(z))$ by summing $W_t(z)$ across islands z to obtain the economy-wide average nominal wage W_t, and updating the time subscript for time t+j. Maintaining $\theta_3=0$, this yields:

$$\text{(A4)} \quad E(W_{t+j}|I_t(z))=E(P_{t+j}|I_t(z)) + \theta_2 + E(u_{t+j}|I_t(z)).$$

Substituting (A4) into (A1) allows derivation of the labor supply curve, and substituting the labor supply curve into (A2) yields an output supply curve, which we write here as:

$$\text{(A5)} \quad Y_t^s(z) = k - \Sigma_{j=1}^{N}(\beta_j^s+\gamma_j^s)[E(P_{t+j}|I_t(z))-P_t(z)]+\delta^s[E(M_{t+N}|I_t(z))-P_t(z)]$$

$$+ \beta_0^s(\epsilon_t(z)+u_t) + \Sigma_{j=1}^{N}\beta_j^s E(u_{t+j}|I_t(z)).$$

Equation (A5) is similar in many respects to the supply curves specified by Barro (1976, 1980). Obvious differences are that the wealth term in (A5) appears as $M_{t+N} - P_t(z)$, the appearance of terms involving intertemporal substitution between more than just periods t+1 and t, and that (A5) has a term capturing the effect of expectations of the permanent shock u_t.

The demand side of the model is generated in an analogous manner to the supply side. The Lucas and Rapping/islands paradigm yields island specific demand schedules of the form:

$$(A6) \quad Y_t^d(z) = d+\Sigma_{j=1}^{N}(\beta_j^d+\gamma_j^d)[E(P_{t+j}|I_t(z))-P_t(z)]+\delta^d[E(M_{t+N}|I_t(z))-P_t(z)]$$

$$+ \beta_0^d(\epsilon_t(z)+u_t) + \Sigma_{j=1}^{N}\beta_j^d E(u_{t+j}|I_t(z)).$$

Note the similarity of the supply equation (A5) with the demand equation (A6). Clearly (A5) and (A6) can be rewritten to look like equations (1) and (2) in the text. The only difference in these two specifications is that the term involving expectations of the aggregate shock u_{t+j} as of time t does not appear in equations (1) and (2) of the text. This omission does not affect any of the policy irrelevance conclusions derived in the text, and is instead made to make the N=1 version of the model in the text correspond directly to Barro's (1976) model.

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