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On Optimal Contracts for Central Bankers and Inflation and Exchange-Rate-Targeting Regimes

This paper analyzes the issues of discretion and commitment in monetary policy under an exchange rate-targeting regime. Neither a linear state-contingent inflation contract for the central bank nor an explicit state-contingent inflation target combined with a weight-conservative central bank can now achieve the commitment equilibrium. It is shown that a state-contingent contract conditioned on the exchange rate and past output can implement the commitment equilibrium. Contracts conditioned on the exchange rate and inflation and on inflation and past output can also mimic the optimal rule under commitment.

FROM ITS INITIATION by Kydland and Prescott (1977), and through subsequent development by Barro and Gordon (1983a; 1983b), Backus and Driffill (1985a, b), Canzoneri (1985), Rogoff (1985), and others, the literature on dynamic inconsistency and monetary policy demonstrates that commitment to a policy rule might be systematically better than discretion.[1] The inflationary bias shown to arise under the discretionary equilibrium has led to arguments for greater central bank independence as a means to move closer to the commitment solution. In one of the most influential papers on the subject, Rogoff (1985) shows that delegation of operational independence to a central banker with larger (finite) weight on inflation in the loss function than society, that is, to a Rogoff weight-conservative central bank, would improve the discretionary equilibrium overall. However, the decision rule obtained would imply greater output variability and less inflation variability than would the optimal rule under commitment.

In analyses of the issues involved, Persson and Tabellini (1993) and Walsh (1995) suggest a principal-agent approach, in which costs are imposed on an instrument-independent central bank when inflation strays from target. Walsh (1995) was the first to propose optimal central bank contracts and demonstrates that a linear inflation

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1. Reviews of the literature on dynamic inconsistency and monetary policy can be found in Blanchard and Fischer (1989) and Fischer (1990).

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contract can result in replication of the commitment equilibrium. Should there be persistence in employment, Svensson (1997) establishes that a linear inflation contract continues to yield an equilibrium that mimics the solution under commitment, provided that it includes a state-contingent component.

The work in this paper is motivated by the observations that many developing countries try to peg (or at least strongly influence) the foreign exchange rate value of their currencies (Krugman and Obstfeld 2000) and their central banks have a large responsibility for exchange rate management (Chandavarker 1996; Fry, Goodhart, and Almeida 1996). In the open economy, success at exchange rate stabilization is a convenient means for assessing commitment to low inflation. Many countries use exchange rate stabilization to stabilize inflation and to confirm inflation fighting credibility. The objective in this paper is to examine the issues raised in the literature on dynamic inconsistency in monetary policy under an exchange rate–targeting regime. An exchange rate–targeting regime is taken to mean that society assigns a loss function to an instrument-independent central bank, with a specific foreign exchange rate target, inflation and output targets, and designated relative weights on output, inflation, and exchange rate stabilization.

It is shown that a state-contingent contract for the central bank conditioned on the exchange rate and past output can implement the commitment equilibrium. This is an interesting result since exchange rates are observed faster than prices and exchange rate stabilization is a convenient means for establishing anti-inflation credibility. A linear state-contingent inflation contract will not achieve the commitment equilibrium under an exchange rate-targeting regime. Also, the result noted by Svensson (1997), concerning the ability of an inflation-target-conservative central bank combined with a weight-conservative central bank to mimic the commitment equilibrium, does not apply under an exchange rate-targeting regime.

The model is developed in the next section. Optimal policy under commitment is taken up in section 2. Implementation of the optimal rule is considered in section 3. Section 4 concludes.

1. THE MODEL

Society is assumed to have a loss function quadratic in the deviations of the rate of inflation, of output, and of the rate of change in the price of foreign currency from target levels. The government is assumed to have the same loss function as society. The social loss function is taken to be

$$V = E_0\left[\sum_{t=1}^{\infty} \beta^{t-1} L(x_t, y_t, s_t; x^0, k, s^0, a, c)\right], \tag{1}$$

where E is the expectations operator, $0 < \beta < 1$ is the discount factor, and $L(\ldots)$ is the period loss function. $L(\ldots)$ is defined as

$$L(x_t, y_t, s_t; x^0, k, s^0, a, c) = (a/2)(x_t - x^0)^2 + (1/2)(y_t - k)^2 + (c/2)(s_t - s^0)^2 , \quad (2)$$

where x_t is the rate of consumer price inflation, y_t is the log of domestically produced output relative to the natural level, s_t is change in the log of the spot exchange rate (the price of foreign currency), and $a > 0$, $c > 0$, $k > 0$. The assumption $k > 0$, provides an incentive for the policymaker to try to create inflation surprises. The target rate, or goal, for inflation in consumer prices, is given by x^0. The target rate of change, or "peg," in the domestic price of foreign currency (or the target rate of devaluation) is given by s^0.

The target levels of inflation and the rate of exchange rate depreciation influence the average rate of money growth in the commitment solution. The average rate of money growth is also influenced by the target level of output under discretion. It will be assumed that the target for consumer price inflation, x^0, is the same as the target for producer price inflation and that it satisfies a condition implied by purchasing power parity given by $x^0 = s^0 + \Pi^f$. This restriction allows the inflation-targeting and exchange rate-targeting regimes to be consistent and will simplify the expression for the average rate of money growth.[2]

The exchange rate targeting regime represented in equation (2) captures the attempt by many countries to peg the foreign exchange rate of their currencies. A dominant theme in explanations for this behavior concerns the importance of exchange rate stabilization in influencing inflation and output, the principal variables of interest to society. Krugman and Obstfeld (2000) argue that concern by governments in developing countries about excessive exchange rate volatility, with associated implications for instability in other markets, has led to efforts at exchange rate stabilization. Adoption of an exchange rate targeting regime is seen by many researchers as a way of raising anti-inflation credibility (for example, Frankel and Chinn 1995, Fischer 1996, Cukierman, Rodriguez, and Webb 1998, and Herrendorf 1999). Obstfeld and Rogoff (1996, p. 648) point out that "most developing countries have made exchange rate stability the centerpiece of their inflation stabilization attempts." In the open economy, exchange rate stabilization is a convenient means for evaluating commitment to low inflation. For this reason a term capturing exchange rate volatility is included in the period loss function in equation (2).[3]

The specification for determination of the foreign exchange rate follows that in Romer (1993). It is assumed that domestically produced goods and foreign produced goods are imperfect substitutes. Higher domestic production will be assumed to force down the relative price of domestically produced goods. If s_t represents the change in the log of the domestic price of a unit of foreign currency, Π_t is the change in the log of the price of domestically produced goods, and Π^f is the change in the

2. If $x^0 \neq s^0 + \Pi^f$, the expected rate of money growth under optimal commitment will be a weighted average of x^0 and $s^0 + \Pi^f$ (and will not reduce to x^0).

3. Under simple discretion, inflation bias arises from output being targeted above the natural level. This bias is less the greater the weight placed on exchange rate stabilization. Thus, exchange rate stabilization is a means for immediately evaluating anti-inflation credibility. Agenor and Masson (1999) suggest an additional reason for targeting the exchange rate through use as an intermediate target variable.

log of the foreign price of foreign produced goods (assumed to be constant), the change in the real exchange rate is given by

$$s_t - \Pi_t + \Pi_t^f = \alpha[g^{df} + (y_t - y_{t-1}) - (y_t^f - y_{t-1}^f)] + \varepsilon_t \ , \tag{3}$$

where y_t (y_t^f) is log of supply of domestic (foreign) produced output relative to natural level, g^{df} is the difference between the trend rates of growth in the domestic and foreign sectors, and ε_t is an error term capturing shocks to the terms of trade. To simplify the presentation, g^{df} is taken to be zero. It will be assumed that $y_t^f - y_{t-1}^f$ can be represented by a random term η_t.

The exchange rate in equation (3) now becomes

$$s_t - \Pi_t + \Pi^f = \alpha(y_t - y_{t-1}) + e_t \ , \tag{4}$$

where $e_t \equiv \varepsilon_t - \alpha\eta_t$, an error term representing shocks to the terms of trade and to foreign output, is taken to be independently and identically distributed with zero mean and variance σ_e^2. It is assumed that expectations are formed (and wage contracts determined) before e_t is known. It will be assumed that the central bank can observe the error term, e_t, in the real exchange rate equation prior to setting policy.[4]

If μ represents the share of imports in GDP, then the rate of consumer price inflation is given by

$$x_t = (1-\mu)\Pi_t + \mu(\Pi^f + s_t) \ . \tag{5}$$

The log of supply of domestically produced output relative to the natural level is given by a Lucas supply function

$$y_t = b(\Pi_t - \Pi_t^e) + u_t \ , \tag{6}$$

where $b > 0$, Π_t^e is the public's expectation of Π_t, and u_t is a supply shock assumed to be independently and identically distributed with zero mean and variance σ_u^2. It is assumed that expectations are formed (that is, wage contracts are signed) before u_t can be observed, but that the central bank can set its policy instrument after observing u_t (and e_t).

I will follow Walsh (1995) in assuming that the rate of growth in a monetary aggregate, m_t, is the central bank's policy instrument. The rate of inflation is given by

4. This assumption simplifies the analysis. It would be more realistic to assume that the monetary authority observes signals subject to measurement error about the underlying random shocks. However, note that even if the signals are imperfect, exchange rate targeting will remain useful in trying to establish anti-inflation credibility by reducing average money growth under discretion.

$$\Pi_t = m_t + v_t \,, \tag{7}$$

where v_t, either a velocity shock or a control error, is an exogenous white-noise process whose realization occurs after m_t is set.

Given that there is only one instrument to achieve the multiple objectives in the loss function it is worthwhile briefly summarizing the network of influences in the model. The instrument m_t, subject to the control error in influencing producer prices in equation (7), influences output by the Phillips curve and the exchange rate through dependence of the real exchange rate on the relative growth rate. The money growth rate affects the rate of consumer price inflation through influence on the price of domestically produced goods and on the exchange rate. Money growth rules under commitment and discretion are obtained in the next section. The organization of the discussion owes a great deal to the analysis presented in Svensson (1997).

2. OPTIMAL POLICY UNDER COMMITMENT

The optimal policy under commitment is obtained by minimizing expected social loss in equation (1) with respect to m_t and m_t^e (expected money growth) given that the government internalized the effects of its decision rule on expectations. The government chooses m_t and m_t^e given that expectations are rational. Given the above setup, we anticipate that m_t will depend on e_t, u_t, and y_{t-1}. The optimal rule under commitment is derived from the Bellman equation,

$$Z^*(y_{t-1}) = \min_{m_t, m_t^e} E_{t-1} \left\{ \begin{array}{l} (a/2)(x_t - x^0)^2 + (1/2)(y_t - k)^2 + (c/2)(s_t - s^0)^2 \\ + \beta Z^*(y_t) \end{array} \right\} \tag{8}$$

subject to the constraint that $m_t^e = E_{t-1} m_t$, where an asterisk indicates values under commitment. After elimination of the Lagrangian associated with this constraint, the first-order condition becomes:

$$E_{e,u} \left\{ \begin{array}{l} (1+\alpha\mu b)a(x_t - x^0) + b(y_t - k) + c(1+\alpha b)(s_t - s^0) + b\beta Z^{*\prime}(y_t) \\ - E_{t-1}[\alpha\mu b a(x_t - x^0) + b(y_t - k) + \alpha b c(s_t - s^0) + b\beta Z^{*\prime}(y_t)] \end{array} \right\} = 0 \,. \tag{9}$$

In equation (9), $E_{e,u}$ refers to expectation conditional on e and u, and E_{t-1} refers to unconditional expectation. The first three terms in equation (9) represent the marginal current costs from increasing inflation, output, and the rate of foreign exchange depreciation. The fourth term is the marginal discounted future loss of greater output. The last terms capture the marginal loss from an increase in expected inflation.

The rule for money growth under commitment is given by

$$m_t^* = m_t^{e*} - [\alpha\mu a(1+\alpha\mu b) + b(1+\beta\psi_2^*) + \alpha c(1+\alpha b)]u_t / \Delta^*$$
$$- [\mu a(1+\alpha\mu b) + c(1+\alpha b)]e_t / \Delta^* , \qquad (10)$$

where $m_t^{e*} = x^0 + (c+a\mu)\alpha y_{t-1}/[a+c]$, $\Delta^* \equiv [a(1+\alpha\mu b)^2 + b^2(1+\beta\psi_2^*) + c(1+\alpha b)^2]$, $\psi_1^* = 0$, and $\psi_2^* = ac\alpha^2(1-\mu)^2/(a+c)$. Here, use has been made of $Z^*(y_{t-1}) = \psi_0^* + \psi_1^* y_{t-1} + (1/2)\psi_2^*(y_{t-1})^2$. It is clear from equation (10) that a supply shock that raises output, $u_t > 0$, and a shock to the terms of trade or to foreign output that tend to depreciate the domestic currency, $e_t > 0$, reduce the rate of money growth. Expected money growth is state contingent because the real exchange rate depends upon the growth rate of output.

3. IMPLEMENTATION OF COMMITMENT SOLUTION

Policy under discretion is obtained by minimizing expected social loss in equation (1) with respect to m_t for given expectations about money growth, m_t^e. It can be shown that expected money growth under discretion contains an inflation bias term and varies more than under commitment for a given value of y_{t-1}. This latter effect leads to excessive stabilization of output under discretion. Also, when $c > 0$ money growth response under discretion is too large (small) to shocks to productivity (terms of trade or foreign output).

It is shown in this section that a contract conditioned on the exchange rate and on lagged output can be used to implement the commitment equilibrium. This is an interesting possibility since exchange rates are observed instantly and the central bank is instrument-independent [as defined by Debelle and Fischer (1994)]. The period loss function given by $L(x_t,y_t,s_t;x^0,k,s^0,a,c) + (f_0+f_1y_{t-1})(s_t-s^0) + (g_0+g_1y_{t-1})y_{t-1}$ yields the money growth rule:

$$m_t^B = m_t^{eB} - [\alpha\mu a(1+\alpha\mu b) + b(1+\beta\psi_2^B) + \alpha c(1+\alpha b)]u_t / \Delta^B$$
$$- [\mu a(1+\alpha\mu b) + c(1+\alpha b)]e_t / \Delta^B , \qquad (11)$$

where the superscript B indicates that a contract for the central banker is in operation, $m_t^{eB} = x^0 + [b(k-\beta\psi_1^B) - (1+\alpha b)f_0]/\Omega + [\alpha\mu a(1+\alpha\mu b)+\alpha c(1+\alpha b) - (1+\alpha b)f_1]y_{t-1}/\Omega$, and $\Delta^B \equiv [a(1+\alpha\mu b)^2 + b^2(1+\beta\psi_2^B) + c(1+\alpha b)^2]$. ψ_1^B and ψ_2^B will depend on parameter values, including g_0 and g_1. $\Omega \equiv [a(1+\alpha\mu b)+c(1+\alpha b)]$.

Selection of $f_0 = b(k-\beta\psi_1^B)/(1+\alpha b)$ and of $f_1 = ac\alpha^2 b(1-\mu)^2/[(a+c)(1+\alpha b)]$ will eliminate average and state-contingent money growth bias and thus equate m_t^{eB} with m_t^{e*}. Matching the coefficients of y_{t-1} and y_{t-1}^2 in the Bellman equation yields: $\psi_1^B = [(1+\alpha b)(a+c)g_0 - bka\alpha(1-\mu)]/\Theta$, $\Theta \equiv [(a+c)(1+\alpha b) - \beta ba\alpha(1-\mu)] \neq 0$; and $\psi_2^B = [ac\alpha^2(1-\mu)^2/(a+c)]\{1 - 2[a\alpha b(1-\mu)/(a+c)(1+\alpha b)]\} + 2g_1$. The solution for ψ_1^B implies that $f_0 = b(a+c)(k-\beta g_0)/\Theta$. Any combination of f_0 and g_0 that satisfy this condition will result in elimination of average money growth bias.

The money growth rule in equation (11) will be equivalent to the optimal money growth rule, m_t^*, if $\psi_2^B = \psi_2^*$. Selection of $g_1 = a^2c(\alpha(1-\mu))^3b/[(a+c)^2(1+\alpha b)]$ will make $\psi_2^B = \psi_2^*$. Thus, a contract in terms of the exchange rate and past output that will allow implementation of the optimal solution under commitment is given by $((b(a+c)(k-\beta g_0)/\Theta)+f_1y_{t-1})(s_t-s^0) + (g_0+g_1y_{t-1})y_{t-1}$, where f_1 and g_1 have been defined above and g_0 can be arbitrarily chosen. Selection of $g_0 = 0$ reduces the latter part of the contract to $g_1(y_{t-1})^2$. A contract conditioned solely on the exchange rate (or on inflation of the form $(h_0+h_1y_{t-1})(x_t-x^0)$) will not replicate the commitment equilibrium since $g_1 \neq 0$. It can be shown that state-contingent contracts conditioned on either the exchange rate and inflation or on inflation and past output also implement the commitment equilibrium.

A major contribution of the paper by Svensson (1997) is analysis of an inflation-targeting regime for improvement of the equilibrium under discretion. Svensson shows that an "inflation-target-conservative" central bank (the target is state-contingent) combined with a weight-conservative central bank is capable of mimicking the equilibrium under the optimal rule under commitment. This result will not hold when $c > 0$. In the presence of an exchange rate term in the loss function, the weight conservativeness required to eliminate stabilization bias from supply shocks will not be the same as that required to eliminate stabilization bias from shocks to the terms of trade or to foreign output.

4. CONCLUSION

This paper considers the issues of discretion and commitment in monetary policy under an exchange rate-targeting regime. It is assumed that exchange rate stabilization is undertaken as a strategy to gain anti-inflation credibility. A state-contingent inflation contract cannot achieve the commitment equilibrium under such a regime. An explicit state-contingent foreign exchange rate target (or the equivalent, an explicit state-contingent inflation target) combined with weight conservativeness is also not sufficient to achieve the commitment equilibrium.

A state-contingent contract for the central bank conditioned on the exchange rate and past output can implement the equilibrium directed by the optimal rule under commitment. This is an interesting result since the central bank has instrument independence and in an open economy exchange rate stability is a convenient (and immediately observable) means for assessing commitment to low inflation.

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