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OPTIMAL MONETARY POLICY DELEGATION TO CONSERVATIVE CENTRAL BANKS

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Optimal Monetary Policy Delegation To Conservative Central Banks

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Abstract

This paper re-examines the role of conservatism in the delegation of monetary policy to an independent central bank. We develop a tractable framework featuring multiplicative instrument uncertainty and generalized quadratic policy objectives. The key insight of the model is that the conservative-central-banker approach need not imply an artificial trade-off between monetary policy credibility and flexibility. We propose two new concepts of conservatism, show that these can reproduce the second-best, and suggest interpretations in terms of the practice of inflation targeting and the penchant of central banks for stability. The model further justifies a strong version of the free lunch result of delegation and illustrates that any second-best delegation mechanism, which removes the credibility problem, at the same time reduces the variability of output. (JEL E50)

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Uncertainty about what monetary policy can do and disagreement about what it should do have always complicated the task of policy makers. In particular, uncertainty about the transmission mechanism and disagreement about the optimal form of monetary policy delegation have led to the development of different strands of research and, similarly, to a variety of policy regimes observed over time and across countries.

The uncertainties surrounding the making of monetary policy received considerable attention during the 1960's and early 1970's. Important contributions include those of William Brainard (1967) on the effectiveness of policy under multiplicative uncertainty, Milton Friedman (1968) on the merits of fixed rules when lags are long and variable, and William Poole (1970) on the choice of an intermediate target under additive uncertainty.

The analysis of monetary policy delegation gained much impetus, about a decade later, with the application of the notion of time-inconsistency (Finn Kydland and Edward Prescott, 1977) to monetary economics (Robert Barro and David Gordon, 1983a), which led to the discovery that lack of credibility produces an inflationary bias in equilibrium. In response, one prominent approach suggests that credibility may be restored by delegating monetary policy to an independent central banker with preferences or incentives distinct from those of the government.[1] Kenneth Rogoff (1985) proposes the delegation of monetary policy to central banks with

[1] Another approach suggests that trigger punishment strategies by the private sector may restore credibility by encouraging the policy maker to develop a reputation (Barro and Gordon, 1983b; Matthew Canzoneri, 1985).

divergent preferences and shows that the appointment of a central banker who is more weight-conservative improves the problem of imperfect credibility. However, given that the notion of weight-conservatism refers to the relative preference for inflation versus output stabilization, complete removal of the inflationary bias would entail too high a cost in terms of output variability. The resulting equilibrium is therefore said to be *third-best.*[2] Carl Walsh (1995a) and Torsten Persson and Guido Tabellini (1993) propose the delegation of monetary policy to central banks with divergent incentives and derive the optimal incentive structure which leads to the *second-best* equilibrium, with full credibility and flexibility simultaneously.

An indisputable virtue of the "credibility literature" is the flexible framework it offers for the analysis of issues of institutional design. However, its validity as a description of, or a prescription for, real-world institutions may be improved in the following two respects.[3] First, the extent to which the role of multiplicative uncer-

[2]The literature generally assumes that there is an exogenous output distortion which drives equilibrium output below its *first-best* level and that policies which target the output distortion directly are either unavailable or infeasible. Given this constraint, the best feasible equilibrium is the *second-best* "commitment" equilibrium. However, if the policy maker cannot commit to refrain from the use of discretionary monetary policy to boost output to its first-best level, an additional distortion arises in the form of an inflationary bias and overall welfare further worsens to the *fourth-best* "discretionary" equilibrium. The *third-best* refers, then, to those equilibria which can be ranked between the commitment and discretionary equilibria. Note that the removal of the inflationary bias does not guarantee the second-best welfare property as the attempt to do so may generate additional distortions (such as suboptimal output stabilization) along the way.

[3]In spirit, the objective of this paper is thus somewhat similar to the call of Bennett McCallum (1995, p. 207) to improve the "interpretive *mappings* between analytical constructs and real-world institutions" (no emphasis added). See also Alan Blinder (1998) for critical comments on the real-world relevance of the credibility literature.

tainty has been downplayed is remarkable, especially given the emphasis it received in earlier research and the attention it continues to draw from a practical policy making perspective (Blinder, 1998). Most of the theory presumes that the transmission mechanism is either deterministic or subject only to additive uncertainty.[4] Second, in their search for optimal delegation mechanisms, recent theories have not re-examined the maintained assumption of the macro welfare function taking the form of an expected quadratic loss function. Although analytically convenient, the quadratic formulation imposes the implicit restriction that the mean-squared bias (MSB) and variance components of the expected loss function are equally important to the policy maker.

This paper contributes to the credibility literature by presenting a tractable framework with the following two features. First, we assume, following Brainard (1967), that the transmission of monetary policy is subject to multiplicative instrument uncertainty. This allows us to break certainty equivalence in the simplest possible manner. Second, we propose a "generalized quadratic" policy objective function which relaxes the restriction of equal weights on the MSB and variance, for both the inflation rate and the output level. This enables us to distinguish policy makers by their aversion to variability.

[4]Notable exceptions are Otto Swank (1994), Wilko Letterie (1997) and Douglas Pearce and Motoshi Sobue (1997), whose contributions focus on the implications of multiplicative uncertainty for the credibility and flexibility of monetary policy. There also exists a growing body of research on learning and optimal control theory in environments with multiplicative uncertainty. See, for example, Bertocchi and Spagat (1993), Lars Svensson (1996) and Volker Wieland (1996).

The model serves two purposes. The first is to provide a simple benchmark model which generates caution in the equilibrium behavior of the policy maker.[5] We derive a motive for caution from the interplay between the degree of multiplicative uncertainty and the policy maker's aversion to variability. Taking the policy maker's preferences as given, we show that the degree of multiplicative uncertainty has profound implications for the credibility and flexibility of monetary policy, and that an increase in such uncertainty may in a second-best world even improve overall welfare. The model formalizes that "monetary policy can prevent money itself from being a major source of uncertainty" (Milton Friedman, 1968, p. 12) and implies that the *credibility* of monetary policy, too, can help reduce the variability of inflation and output.

The second purpose of the model is to re-examine the role of conservatism in delegation mechanisms which allow for divergent preferences on the part of the central banker.[6] The key insight of the paper is that the conservative-central-banker approach can replicate the second-best equilibrium. Inspired by Walsh (1995a), who

[5] The benchmark model presented in this paper extends Schellekens (1998) to allow for a more general description of policy objectives. In this paper, we no longer include additive instrument uncertainty and therefore abstract from the possibility of a nonzero correlation between additive and multiplicative control shocks.

[6] One important reason why attention has shifted away from conservatism is the recent focus on second-best mechanisms which do not entail suboptimal output stabilization. An interesting exception is the contribution of Svensson (1997), who shows that conservatism with regard to the inflation *target* can implement the optimal second-best contract. Furthermore, some authors have argued that *weight*-conservatism can still be useful, even in a second-best world, provided that the inflationary bias is state-contingent and delegation is not (Berthold Herrendorf and Ben Lockwood, 1997; Svensson, 1997).

shows that "the apparent trade-off between stabilization policy and price stability (...) arises only when the contract offered to the central banker is arbitrarily restricted"[7], our contention is that the quadratic policy objective function constrains the delegation mechanism in a similar fashion. The use of generalized quadratic objectives relaxes that constraint and permits the derivation of new notions of conservatism which do not distort output stabilization. We also examine the possibility of imperfect commitment to the delegation scheme and relate the proposed theoretical notions of conservatism to the practice of inflation targeting and the alleged penchant of central banks for stability.

Our findings supports a strong version of the empirical free lunch result of delegation. We demonstrate that conservatism lowers inflation without distorting output stabilization. Moreover, given that the model also implies a negative correlation between credibility and output variability, optimal delegation will in fact reduce the overall variability of output.

The organization of the paper is as follows. Section I develops the baseline model featuring cautious behavior on the part of the policy maker. Section II addresses the role of conservatism in the delegation of monetary policy. Section III applies the framework to the free lunch result of delegation. Section IV concludes.

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[7]Walsh (1995a, p. 158). The arbitrary restriction envisaged by Walsh concerns the implicit constraint that the policy objective function does not contain any additional linear term in inflation. If such a term were allowed, the second-best may be achieved by raising the marginal cost of inflation up to the point that the inflationary bias is removed entirely. As the linear inflation penalty does not affect the relative aversion to inflation and output variability, output stabilization remains optimal throughout.

I. The Standard Model

In this section, we develop a model of discretionary monetary policy which incorporates multiplicative instrument uncertainty and generalized quadratic objectives.

A. Description

We begin with a description of the economic environment. Technology is represented by:

$$y = y^* + b(\pi - \pi^e) + \varepsilon\,, \qquad b > 0, \tag{1}$$

where y is output, y^* is the natural rate of output, π is the inflation rate, π^e is the expected inflation rate, and ε is a temporary aggregate supply shock with mean 0 and variance σ_ε^2. Inflation can be generated through:

$$\pi = s\, i^p\,, \tag{2}$$

where i^p is the planned deviation of the instrument from its neutral level and s is a multiplicative instrument shock with mean 1 and variance σ_s^2.[8] The assumption

[8]The transmission mechanism is kept deliberately simple in order to ensure maximum comparability with the standard framework. The presence of multiplicative instrument uncertainty implies that loose monetary policy is associated with more variable inflation, a result which has strong empirical foundations (John Taylor, 1981; Laurence Ball and Stephen Cecchetti, 1990). At the theoretical level, John Judd and John Scadding (1982) argue that high inflation encourages financial innovation, which can lead to more difficult monetary control. Steven Holland (1993) posits that the interaction between inflation uncertainty and heterogeneity of pricing policies at the firm level leads to worse monetary control at high levels of money growth.

of multiplicative instrument uncertainty marks a first departure from the literature which generally assumes that transmission is either deterministic or subject only to additive uncertainty.[9] All variances in the model are assumed to be strictly positive and finite, and, for analytical convenience, additive supply shocks and multiplicative control shocks are assumed to be independent of each other.

The description of the monetary policy game is completely standard. There are two players: a private sector and a policy maker. Before locking itself into a nominal wage contract, the private sector formulates a prediction (π^e) about the increase in the price level during the duration of the contract. The strategy of the policy maker consists of choosing the level of the policy instrument (i^p). The timing of the game is as follows: at time one, the private sector optimally chooses π^e; at time two, supply shock ε realizes; at time three, the policy maker optimally chooses i^p; at time four, control shock s realizes, and inflation, output and the payoffs of the players are determined. The information set of the private sector at time one only includes the structure of the model, whereas that of the policy maker at time three also includes the realization of the supply shock. At the times of their respective decisions, both players are agnostic with regard to the future realization of the control shock.

[9] Including additive instrument uncertainty is straightforward, but does not affect optimal policy as long as all shocks in the model remain independent of each other. Certainty equivalence would apply even with the more general objective function. If the assumption of independence is dropped, the optimal policy choice will be affected. If additive and multiplicative instrument shocks are, for example, positively correlated, the policy instrument will be set more cautiously (Schellekens, 1998).

What remains to be specified are the criteria according to which the players optimally choose their strategies. Provided that positive and negative forecast errors are equally costly, we follow the literature in that the private sector's assumed objective is to minimize average forecast errors. Optimal prediction requires the private sector to set $\pi^e = E[\pi]$, the mathematical expectation over the rate of inflation.

Turning now to the policy objective function, we make a second departure from previous work, which generally uses the following expected quadratic loss function:

$$\begin{aligned} E[L] &= E\left[A\pi^2 + (y - ky^*)^2\right] \\ &= A\left\{(E[\pi])^2 + Var[\pi]\right\} + (E[y] - ky^*)^2 + Var[y]\,. \end{aligned} \tag{3}$$

Note that the inflation target is set at zero and the output target equals ky^* with k strictly larger than one. Parameter A is nonnegative and captures the degree of weight-conservatism, measuring the policy maker's relative aversion to inflation variability versus output variability around the respective targets. The assumption of quadratic objectives implies that, for both inflation and output, the mean-squared deviation of the variable from its target is equally costly as the variability around its mean.

This paper proposes a generalization to the expected quadratic loss function, which relaxes the implicit constraint of identical weights on the MSB and variance components. The "generalized quadratic" objective function takes the following

form:

$$\begin{aligned}\Omega &= \mu_1 \left(E\left[\pi\right]\right)^2 + \theta_1 Var\left[\pi\right] \\ &+ \mu_2 \left(E\left[y\right] - ky^*\right)^2 + \theta_2 Var\left[y\right] , \end{aligned} \tag{4}$$

where μ_1, μ_2, θ_1 and θ_2 are all nonnegative. Parameters μ_1 and μ_2 measure the policy maker's aversion to systematically missing the inflation and output target, whereas θ_1 and θ_2 denote the aversion to inflation and output variability around their respective means.[10] Furthermore, let $\mu \equiv \mu_1/\mu_2$ and $\theta \equiv \theta_1/\theta_2$, where μ is the policy maker's relative aversion to systematically missing the inflation versus the output target and θ is the policy maker's preference for nominal versus real stability.

The alternative specification of the policy maker's objectives serves two purposes in this paper. First, with regard to the analysis of caution, it makes sense to focus not only on the variance of multiplicative instrument uncertainty but also on the policy maker's valuation of the variability brought about by such uncertainty. Second, with regard to the role of conservatism, policy maker heterogeneity in terms of the parameters in (4) will prove helpful when monetary policy is delegated.

[10]Note that this objective function has the following properties: (i) mean-squared deviations from target are penalized symmetrically; (ii) with additive instrument uncertainty, certainty equivalence continues to hold; (iii) indifference curves in (expected value, standard deviation)-space take the form of ellipses instead of concentric circles as in Brainard (1967, p. 416). Assuming a zero inflation target, this implies, for example, that the policy maker need no longer be indifferent between policy option one, yielding an expected inflation rate of 10% with a standard deviation of 5%, and policy option two, yielding 5% and 10% respectively.

B. Equilibrium

We look for a time-consistent equilibrium, where the policy maker's strategy is described by the following linear policy reaction function:[11]

$$i^p = \lambda_1 + \lambda_2 \epsilon.$$

Given this reaction function, the inflation outcome will be:

$$\pi = s\left(\lambda_1 + \lambda_2 \epsilon\right). \tag{5}$$

Taking rational expectations over (5), the optimal strategy of the private sector will be to predict $\pi^e = \lambda_1$.

As to the optimal strategy of the policy maker, coefficients λ_1 and λ_2 will be chosen such that the objective function in (4) is minimized given the strategy of the private sector, the specification of uncertainty, and Equations (1) and (2). Substituting all relevant equations into the objective function and evaluating expectations at time one yields:

$$\begin{aligned}
\Omega\left(\lambda_1, \lambda_2\right) \;=\; & \mu_1 \left\{ \lambda_1^2 \right\} \\
& + \; \mu_2 \left\{ \left(b\lambda_1 - b\pi^e - z\right)^2 \right\} \\
& + \; \theta_1 \left\{ \sigma_\epsilon^2 \lambda_2^2 \; + \; \sigma_s^2 \left(\lambda_1^2 + \sigma_\epsilon^2 \lambda_2^2 \right) \right\} \\
& + \; \theta_2 \left\{ \sigma_\epsilon^2 \left(1 + b\lambda_2\right)^2 \; + \; b^2 \sigma_s^2 \left(\lambda_1^2 + \sigma_\epsilon^2 \lambda_2^2 \right) \right\},
\end{aligned} \tag{6}$$

[11] Because of the linear-quadratic framework, we can focus without loss of generality on policy reaction functions of this form.

where the contributions of λ_1 and λ_2 to the respective mean-squared biases and variances are displayed on subsequent lines. Note that $z \equiv (k-1)y^*$, the gap between the socially optimal and the natural rate of output.

It is instructive to see how the four components of the policy objective function in (6) are affected by policy non-neutrality.[12] The *credibility* part of the policy rule, λ_1, shows up in all components of the expected loss function (note however that without multiplicative uncertainty only the MSB in inflation and output would be affected). The *stabilization* part of the policy rule, λ_2, matters only for the variances of inflation and output. As in the standard literature, optimal stabilization policy trades off the benefit of lower output variability against the cost of higher inflation variability. But now, with multiplicative uncertainty, the policy maker also needs to take into account that supply shock stabilization creates extra variability in inflation and output.

The first-order conditions for λ_1 and λ_2 are:

$$\mu_1\lambda_1 + \sigma_s^2\left(\theta_1 + b^2\theta_2\right)\lambda_1 = b\mu_2\left(z + b\pi^e - b\lambda_1\right) \times \left(1 - \frac{\partial\pi^e}{\partial\lambda_1}\right), \tag{7}$$

$$\left(1+\sigma_s^2\right)\left(\theta_1 + b^2\theta_2\right)\sigma_\epsilon^2\lambda_2 = -\,b\,\theta_2\sigma_\epsilon^2, \tag{8}$$

where π^e is to be evaluated at λ_1, the optimal strategy of the private sector.

Equation (7) illustrates the problem of time-inconsistency. *Ex ante*, the optimal state-contingent policy is to set λ_1 equal to zero, thereby taking into account the endogeneity of expected inflation with respect to the policy regime ($\partial\pi^e/\partial\lambda_1 = 1$). *Ex post*, however, this concern is no longer relevant to the policy maker as the

[12] Policy is said to be non-neutral, if either λ_1 or λ_2 differ from zero.

private sector is locked into a nominal contract ($\partial\pi^e/\partial\lambda_1 = 0$). Consequently, unless a formal commitment technology exists, optimal policy (with $\lambda_1 = 0$) is time-inconsistent and time-consistent policy is suboptimal (Kydland and Prescott, 1977) with:

$$\lambda_1 = \frac{b\,\mu_2\,z}{\mu_1 + \sigma_s^2\,(\theta_1 + b^2\theta_2)}\,. \tag{9}$$

From Equation (8), optimal supply shock stabilization requires:

$$\lambda_2 = -\frac{b\,\theta_2}{(1+\sigma_s^2)\,(\theta_1 + b^2\theta_2)}\,. \tag{10}$$

Finally, the equilibrium realizations of inflation and output equal:

$$\begin{aligned} \pi &= s\,(\lambda_1 + \lambda_2\epsilon)\,, \\ y &= y^* + (s-1)\,b\lambda_1 + (1 + sb\lambda_2)\,\epsilon\,, \end{aligned}$$

where λ_1 and λ_2 are given by Equations (9) and (10).

C. Properties

We will now study the properties of the equilibrium, with special emphasis on the comparative statics properties of σ_s^2, the variance of multiplicative instrument uncertainty.

The inflationary bias of monetary policy is given by:

$$E\,[\pi] = \frac{b\,\mu_2\,z}{\mu_1 + \sigma_s^2\,(\theta_1 + b^2\theta_2)}\,, \tag{11}$$

and arises from the temptation to achieve real output objectives, which are not feasible in the long run ($z > 0$). The bias would be lower if the policy maker were

more concerned about the inflation target than about that of output (leading to a higher μ). In addition, two other factors moderate the temptation to inflate: the amplification of inflation and output variability by policy non-neutrality (through σ_s^2) and the aversion of the policy maker to such variability (measured by θ_1 and θ_2). The interaction between uncertainty and preferences results in cautious policy making. As this will be rationally understood by the private sector, caution leads to a lower inflationary bias.[13]

Because systematic surprise inflation is ineffective, the expected output level remains at its natural rate: $E[y] = y^*$.

The variance of inflation is:

$$Var[\pi] = \frac{b^2\theta_2^2}{(1+\sigma_s^2)(\theta_1+b^2\theta_2)^2}\sigma_\epsilon^2 + \left(\frac{b\mu_2}{\mu_1+\sigma_s^2(\theta_1+b^2\theta_2)}\right)^2 \sigma_s^2 z^2. \qquad (12)$$

Does greater instrument uncertainty imply a larger variance of inflation? Not necessarily, because two opposing forces are at work: increased uncertainty adds to the unpredictability of inflation for a given policy stance, but also makes the policy stance itself more cautious. In the Appendix, the following results are established. First, introducing instrument uncertainty increases the variance of inflation if:

$$\frac{z}{\sigma_\epsilon} > \frac{\mu}{\theta+b^2},$$

[13]The statement that uncertainty may improve credibility is not new. Michael Devereux (1987) proposes an indirect mechanism: uncertainty induces wage setters to index nominal contracts, which reduces the effectiveness of surprise inflation and also the temptation of the policy maker to surprise. Swank (1994) and Pearce and Sobue (1997) show that uncertainty induces caution into policy making, directly constraining the temptation to surprise. This paper offers an alternative explanation based on the interaction between uncertainty and preferences, and will address delegation mechanisms which remove the temptation to surprise entirely.

where z/σ_ϵ, termed as the "credibility-flexibility ratio", measures the inefficiency of the natural rate of output relative to the degree of output variability. Hence, if credibility is relatively poor, the variance of inflation is likely to increase. Second, if $\mu_1 = 0$, $\mu_2 = 0$ or $\sigma_s^2 > \mu_1/(\theta_1 + b^2\theta_2)$, an increase in instrument uncertainty unambiguously reduces the variance of inflation.[14]

The variance of output is:

$$Var[y] = \frac{\theta_1^2 + \sigma_s^2(\theta_1 + b^2\theta_2)^2}{(1+\sigma_s^2)(\theta_1 + b^2\theta_2)^2}\sigma_\epsilon^2 + \left(\frac{b^2\mu_2}{\mu_1 + \sigma_s^2(\theta_1 + b^2\theta_2)}\right)^2 \sigma_s^2 z^2 , \qquad (13)$$

and the Appendix establishes that $\mu_2 = 0$ or $\sigma_s^2 < \mu_1/(\theta_1 + b^2\theta_2)$ are sufficient conditions for a positive relationship between the degree of instrument uncertainty and the variability of output.[15]

PROPOSITION 1: *Poor credibility enhances the variability of inflation and output at increasing rates.*

PROOF:

This is due to the interaction between the presence of instrument uncertainty and the absence of commitment, and follows from the convex relationship in (12)

[14] Other comparative statics properties include: a higher μ and θ_1 reduce the variance of inflation, whereas θ_2 has an ambiguous effect (trading off the necessity of more aggressive output stabilization against the extra unpredictability created by policy non-neutrality).

[15] With regard to the pure effect of uncertainty, Letterie (1997) also finds that $\sigma_s^2 > 0$ reduces the policy maker's willingness to stabilize output. Other comparative statics properties of the variance of output are that a higher μ reduces the variance of output, whereas θ_1 and θ_2 have ambiguous effects.

between z and $Var[\pi]$. Inspection of (13) shows that poor credibility also exacerbates the variance of output at an increasing rate.

With reference to the earlier quote from Friedman (1968), this result implies that the *credibility* of monetary policy, too, can help preventing money from being a source of variability.

Until now, we have only examined the implications of instrument uncertainty for the individual components of the policy maker's loss function: the MSB in inflation decreases, the MSB in output remains unaffected, and the variances of inflation and output react ambiguously. But what are the overall implications for the policy maker's welfare?

PROPOSITION 2: *In the absence of a credibility (flexibility) problem, multiplicative instrument uncertainty unambiguously reduces (increases) welfare. In the intermediate case, with both a credibility and a flexibility problem, the effect is ambiguous.*

PROOF:

Substituting the equilibrium realizations for the mean square biases and variances into the objective function and differentiating with respect to the variance of instrument uncertainty leads to the following global condition:

$$\frac{\partial \Omega}{\partial \sigma_s^2} > 0 \quad \Leftrightarrow \quad \frac{z}{\sigma_\epsilon} < \frac{\theta_2}{\mu_2} \times \frac{\mu_1 + \sigma_s^2 (\theta_1 + b^2 \theta_2)}{(1 + \sigma_s^2)(\theta_1 + b^2 \theta_2)} . \tag{14}$$

In the absence of a credibility problem ($\mu_2 = 0$ or $z = 0$), instrument uncertainty

leads to an unambiguous drop in welfare. Intuitively, this results from the fact that increased uncertainty renders optimal output stabilization more cautious, thereby distorting the policy maker's previously preferred balance between inflation and output variability. In the absence of a flexibility problem ($\theta_2 = 0$ or $\sigma_\epsilon = 0$), instrument uncertainty leads to an unambiguous welfare improvement. The intuition here is that uncertainty produces only a lower inflationary bias and no distortionary output stabilization. In the intermediate case, where there is both a credibility and a flexibility problem, the effect of instrument uncertainty depends on the condition in Equation (14).

The result that multiplicative instrument uncertainty can improve welfare is an application of the old idea that the introduction of an additional distortion in a second-best world does not necessarily reduce welfare. Of course, this need not imply that such uncertainty should be increased deliberately. There are more efficient ways to improve on the welfare properties of equilibrium and it is to these that we now turn our attention.

II. Delegating Monetary Policy

The model in the previous section contained two agents: a private sector and a policy maker. We implicitly assumed that the policy maker is at the same time the social welfare maximizer. We now depart from this assumption and address the

delegation of monetary policy to an independent agent ("the central bank") with preferences or incentives distinct from those of the principal ("the government").[16]

It is well-known that delegation along those lines can improve the welfare properties of the fourth-best discretionary equilibrium (see Footnote 2). Rogoff (1985) shows that delegation to a central banker who is more weight-conservative than the government can improve welfare to third-best.[17] By diverting the central banker's priorities from output stabilization to inflation stabilization, weight-conservatism can reduce the inflationary bias. But, since this entails a cost in terms of output stabilization, the optimal delegation scheme will not remove the inflationary bias entirely.[18]

Walsh (1995a) and Persson and Tabellini (1993) have subsequently suggested that the apparent trade-off between credibility and flexible output stabilization arises

[16] Fischer (1995) introduces the distinction between goal and instrument independence. It is widely agreed that a central bank should be fully instrument independent. Although the proposed extent of goal independence varies across the different delegation mechanisms (compare, for example, the conservative-central-banker approach with the principal-agent approach), it is commonly accepted that for the purpose of democratic accountability the central bank should be goal dependent in the long run.

[17] Schellekens (1998) confirms the robustness of Rogoff (1985) to settings with multiplicative instrument uncertainty. It is shown that delegation to an independent central banker remains welfare-improving as long as the central banker is more (but not excessively) weight-conservative in comparison with the government. However, the optimal degree of weight-conservatism becomes dependent on the variance of multiplicative instrument uncertainty. Such uncertainty reduces the optimal degree of weight-conservatism, leading to a trade-off between caution and conservatism. The exception to the trade-off arises if ultra-conservatism were optimal initially. Then, caution and conservatism go hand in hand.

[18] Other third-best schemes include the escape-clause proposals by Robert Flood and Peter Isard (1989), Susanne Lohmann (1992) and Maurice Obstfeld (1997).

because the delegation mechanism is restricted to ad-hoc incentive structures. If instead an inflation contract ensuring an optimal incentive structure were introduced, the second-best would prevail with full credibility and flexibility simultaneously. Side payments in the form of a linear penalty on inflation would do the trick but implementation may present practical difficulties.[19]

In this section, we deal with two issues. First, we follow the idea of Walsh (1995a), who shows that the relaxation of an implicit restriction on the delegation mechanism itself (such as the absence of an optimal incentive structure) can improve welfare to second-best. We argue that the conservative-central-banker approach embodies a similar implicit restriction, in that the central banker to whom policy is delegated should care equally about the MSB and the variance of the target variables. By relaxing this restriction, we show that more general delegation mechanisms exist which lead to the second-best in a simple and intuitive fashion.

Second, a number of authors have argued that the second-best mechanisms may fail for a variety of reasons and that in practice an inflationary bias may continue to prevail. If this is the case, we show that our approach still lends itself to natural interpretations of real-world delegation schemes.

[19] See Blinder (1998), Canzoneri, Charles Nolan and Anthony Yates (1995), Charles Goodhart and José Viñals (1994), Mervyn King (1997) and Walsh (1995b). The incentives implied by the optimal contract could also be implemented with a dismissal rule (Walsh, 1995c) and a conservative inflation target (Svensson, 1997). For further extensions, see Michele Fratianni et al. (1993).

A. Alternative Notions of Conservatism

We will now show that the use of conservatism can replicate the second-best equilibrium, once the arbitrary restrictions embodied in the expected quadratic loss function are relaxed. We propose two alternative notions of conservatism which are derived directly from the generalized quadratic objective function. These are termed "pure weight-conservatism" and "stability conservatism".

To begin with the first notion, let the policy objectives of the government and the central bank be represented by:

$$\begin{aligned} \Omega^G &= \mu_1 \left(E\left[\pi\right]\right)^2 + \mu_2 \left(E\left[y\right] - ky^*\right)^2 \\ &\quad + \theta_1 Var\left[\pi\right] + \theta_2 Var\left[y\right] , \qquad (15) \\ \Omega^{CB} &= \mu_1^* \left(E\left[\pi\right]\right)^2 + \mu_2^* \left(E\left[y\right] - ky^*\right)^2 \\ &\quad + \theta_1 Var\left[\pi\right] + \theta_2 Var\left[y\right] , \end{aligned}$$

where both μ_1^* and μ_2^* may differ from μ_1 and μ_2. Furthermore, let $\mu^* \equiv \mu_1^*/\mu_2^*$.

The most straightforward way to the second-best, then, is to delegate monetary policy to a central banker who completely disregards the inconsistent output objective. This would simply amount to setting $\mu_2^* = 0$. As a consequence, the inflationary bias will be removed while optimal output stabilization is retained. In fact, this proposal has already been suggested by various authors. To quote Alan Blinder, for example, "a disarmingly simple solution to the Kydland-Prescott problem [is to] *direct* the central bank to behave as if it prefers $[y^*]$ rather than $[ky^*]$".[20]

[20] Blinder (1998, p. 43), no emphasis added. See also McCallum (1995, p. 208-9): "All that is

Of course, this does not require the absence of the output distortion. Rather, the central bank should simply not care about it.

What we term the degree of "pure weight-conservatism" measures the *relative* disregard of the policy maker for the output target versus the inflation target. This notion allows for the possibility that $\mu_2^* < \mu_2$ and $\mu_1^* > \mu_1$ simultaneously, leading to $\mu^* > \mu$, and will prove particularly useful when $\mu_2^* = 0$ is not possible.

The second notion relies on the distinction between the policy maker's aversion to mean-squared deviation versus variability. The objective function of the government is still represented by (15) but that of the central bank is now given by:

$$\begin{aligned} \Omega^{CB} &= \mu_1 \left(E\left[\pi\right]\right)^2 + \mu_2 \left(E\left[y\right] - ky^*\right)^2 \\ &\quad + \chi \left\{ \theta_1 Var\left[\pi\right] + \theta_2 Var\left[y\right] \right\} , \end{aligned}$$

where χ is nonnegative and measures the central bank's overall concern for stability. The notion of "stability conservatism" reflects the possibility that $\chi > 1$. In its extreme form, stability conservatism leads to an exclusive concern for stability.

PROPOSITION 3: *By delegating monetary policy to an independent central bank with an exclusive concern for stability, the second-best equilibrium can be attained.*

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needed for avoidance of the inflationary bias (...) is for the CB to recognize the futility of continually exploiting expectations (...), and to recognize that its objectives would be more fully achieved on average if it were to abstain from attempts to exploit these temporarily-given expectations."

PROOF:

The proof is straightforward. If $\chi \rightarrow \infty$, the central bank's optimization problem ignores the MSB in inflation and output entirely. There will be no credibility problem ($\lambda_1 = 0$) simply because the central bank does not want to boost y^* to ky^*. Furthermore, given χ does not affect θ, output stabilization remains optimal.

B. Delegation when Second-Best is Not Feasible

A valid criticism to any discretionary delegation scheme is that it may be overturned after the private sector has locked itself into nominal contracts. It is indeed odd that a government can perfectly commit to an institutional regime it puts into existence but not to the optimal monetary policy rule in the first place. This point, put forward by McCallum (1995), has been formalized by Henrik Jensen (1998), who shows that the traditional second-best mechanisms break down when the cost of changing the monetary regime is not prohibitive.[21]

From a practical perspective, the identification of this commitment problem should not be interpreted as a denial of the usefulness of second-best mechanisms in *reducing* the credibility problem.[22] Although the proposed notions of conservatism

[21] McCallum (1995) argues that delegation merely relocates the time-inconsistency problem from one commitment problem (to a rule) into another (to a regime). Ali al-Nowaihi and Paul Levine (1996) show that the Walsh contract does not solve the time-inconsistency problem but relocates the credibility problem as a renegotiation problem. Jensen (1998) shows that a reputational solution to the credibility problem may still exist, although its likelihood becomes smaller when reappointment costs are positive.

[22] In the terminology of Jensen (1998), a time-consistent institutional arrangement leading to

in that case no longer lead to the second-best, they will lend themselves to natural interpretations of real-world institutions.

A natural empirical counterpart of an institutional set-up which induces an increase in the degree of pure weight-conservatism is a regime of inflation targeting. Pure weight-conservatism diverts the attention of the policy maker from the inconsistent output objective towards the inflation target. Moreover, the concept is in concert with the claim by practitioners that inflation targeting need not imply that output is ignored (Ben Bernanke and Frederic Mishkin, 1997; King, 1997). On the contrary, output stabilization may remain optimal throughout. To see this, consider the central bank's reaction function:

$$i^p = \frac{b\,\mu_2^*\,z}{\mu_1^* + \sigma_s^2\,(\theta_1 + b^2\theta_2)} - \frac{b\,\theta_2}{(1+\sigma_s^2)\,(\theta_1 + b^2\theta_2)}\varepsilon\,.$$

Changes in μ_1^* and μ_2^* clearly only affect the inflationary bias, without compromising the necessary flexibility of monetary policy in the response to supply shocks.

The notion of stability conservatism seems to accord with successful monetary policy often being attributed to the penchant of central banks for stability. The model in this paper shows that this feature may indeed be a desirable one. From the central bank's reaction function:

$$i^p = \frac{b\,\mu_2\,z}{\mu_1 + \chi\sigma_s^2\,(\theta_1 + b^2\theta_2)} - \frac{b\,\theta_2}{(1+\sigma_s^2)\,(\theta_1 + b^2\theta_2)}\varepsilon,$$

it follows that a penchant for stability (reflected by $\chi > 1$) yields a lower inflationary

$\mu_2^* = 0$ or $\chi \to \infty$ would require infinite reappointment costs. Provided that reappointment costs remain strictly positive, the use of pure weight-conservatism and stability conservatism still enables us to at least reduce the problem of credibility.

bias, provided that the economic environment features multiplicative uncertainty. Because of the central bank's stronger preference for nominal and real stability, uncertainty is now χ times more costly and this will lead to greater caution in the conduct of policy. Moreover, given that the response coefficient does not alter, a penchant for stability is consistent with optimal output stabilization.

The fact that the central bank may have a penchant for stability must of course be balanced with the possibility that its relative preference for nominal and real stability may in reality differ from that of the government (i.e. $\theta^* \neq \theta$, where $\theta^* \equiv \theta_1^*/\theta_2^*$). This possibility will be discussed in the next section.

III. Application: The Free Lunch Result of Delegation

Empirical studies have suggested that the delegation of monetary policy to an independent central bank is like a free lunch: it lowers inflation without increasing the variability of output.[23] At the theoretical level, this has created an anomaly in the Rogoff (1985) model, which implies that delegation based on the notion of weight-conservatism makes output more variable than optimal. Subsequent research has shown that the free lunch result may be explained by (i) the offsetting interaction between higher "economic variability" due to increased weight-conservatism

[23] See Alberto Alesina and Lawrence Summers (1993), Debelle and Fischer (1994) and Fischer (1995). One caveat applies to the result that central bank independence *causes* low inflation at no real cost. Adam Posen (1993, 1995) argues that correlations between institutions and economic outcomes may be spurious. In the context of this paper, for example, a period of economic instability may trigger a stronger aversion to variability (a higher χ), thereby making the development of institutions supporting that aversion more likely.

and lower "political variability" due to better insulation from the political business cycle (Alesina and Gatti, 1995); (ii) a positive correlation between the degree of central bank independence and the ability to stabilize or the degree of fiscal discipline (Fischer, 1995); (iii) the presence of a second-best delegation scheme (Svensson, 1997).

Our analysis offers a somewhat stronger suggestion. First of all, delegation to a conservative central banker does not entail suboptimal output stabilization if less restrictive notions of conservatism, such as pure weight-conservatism and stability conservatism, are allowed.

Second, *any* delegation scheme which improves or removes the credibility problem of monetary policy reduces at the same time the variability of output (and inflation), if the transmission of monetary policy is subject to multiplicative uncertainty.[24] To see this, consider the delegation to a central banker with a penchant for stability. In equilibrium, the variance of output will equal:

$$Var\left[y\right] = \frac{\theta_1^2 + \sigma_s^2\left(\theta_1 + b^2\theta_2\right)^2}{\left(1+\sigma_s^2\right)\left(\theta_1 + b^2\theta_2\right)^2}\sigma_\epsilon^2 + \frac{b^4\mu_2^2\sigma_s^2}{\left(\mu_1 + \chi\sigma_s^2\left(\theta_1 + b^2\theta_2\right)\right)^2}z^2, \tag{16}$$

which is clearly negatively correlated with χ. (The variance of inflation is affected in a similar fashion.)

The overall theoretical implication is, surprisingly, that optimal delegation should not only lead to lower inflation but also to less variable output.[25] Strictly speaking,

[24] This is the reason why the presence of multiplicative uncertainty enlarges the welfare gap between the second-best and any third- or fourth-best solution. See also Proposition 1.

[25] If the second-best is feasible (with $\chi \to \infty$), the problem of imperfect credibility is entirely removed and the second term in (16) vanishes. With reference to Proposition 2, this implies that

the empirical finding that delegation does not affect output variability could then be taken as evidence that the delegation schemes in place are not optimal (provided that the link between low credibility and high output variability proves to be substantial empirically). Observers may in fact argue that central banks favor nominal stability to real stability ($\theta^* > \theta$), leading to suboptimal output stabilization but possibly identical output variability across institutional regimes.

Similarly, the initial claim that the Rogoff model is inconsistent with the free lunch result may be proven wrong if, in an environment with multiplicative uncertainty, the increase in output variability due to reduced flexibility is offset by a decrease of a similar magnitude due to improved credibility.

IV. Concluding Remarks

This paper presents a simple analytical framework which reconsiders the role of conservatism in the delegation of monetary policy. We develop a tractable model which extends the standard monetary policy credibility literature to allow for multiplicative uncertainty and policy objectives with a flexible aversion to variability.

If monetary policy transmission is subject to multiplicative uncertainty, policy actions introduce extra variability into the system, and this produces caution on the part of the policy maker if such variability is costly. The equilibrium will therefore look different from the one in a world of certainty equivalence and our model suggests

any increase in σ_s^2 becomes unambiguously welfare-reducing.

that there are profound implications for the credibility and flexibility of monetary policy.

The key insight of the paper is that conservatism need not lead to an arbitrary trade-off between credibility and flexibility. With the parameterization of the policy maker's aversion to variability, two novel notions of conservatism are derived which may produce the second-best equilibrium. First, we refine the concept of weight-conservatism while keeping with the common interpretation of conservatism in terms of the relative focus on inflation versus output. What we have termed "pure weight-conservatism" measures the policy maker's relative disregard for the inconsistent output objective. Complete disregard leads to the second-best and lends support to McCallum's (1995) "just-do-it" approach and Blinder's (1998) idea of directing the central bank to behave *as if* it has no inconsistent output objective.

Second, we propose the concept of "stability conservatism", which suggests a somewhat different interpretation of conservatism. Stability conservatism captures the idea of a greater aversion to variability or, to put it in colloquial terms, a stronger preference for the status quo. We show that the second-best can be implemented by the delegation of monetary policy to a central banker with an exclusive concern for stability.

In conclusion, neither type of conservatism distorts output stabilization. In fact, by removing (or at least improving) the problem of credibility, each leads to an overall reduction in output variability, producing a strong version of the free lunch result.

Casual empiricism offers no shortage of suggestions that the making of monetary policy involves a degree of conservatism. Even though real-world monetary arrangements cannot be easily pigeon-holed by any single theory of delegation, the question remains whether the notions of conservatism suggested by this paper are observed in practice. In this respect, we have suggested interpretations in terms of the practice of inflation targeting and the penchant of central banks for stability.

We close with some limitations of the model and ideas for future work. For reasons of comparability, we preferred to keep with the credibility literature and therefore chose the simplest possible description of monetary policy transmission. Adding more structure to the transmission mechanism would be a worthwhile endeavor. Another limitation is that the model features purely exogenous transmission uncertainty and that it abstracts from the issue of learning. We have not developed the model in this direction. Nevertheless, as suggested by Andrew Caplin and John Leahy (1996), the possibility of learning should be kept in mind, especially if systematic search behavior of the policy maker influences the response of the private sector to policy. Furthermore, the model may be extended to allow for asymmetric information. If the central bank has superior information about the degree of multiplicative instrument uncertainty, simple disclosure may not be straightforward.[26] The central

[26] In this respect, the recent tendency towards greater transparency and accountability in many central banks can be given an interesting justification. Increased openness in the decision-making process at the central bank may lead to a better understanding by the private sector of the central bank's perception of uncertainty. This can be achieved, for example, by enhanced reporting requirements, such as the publication of committee minutes and forecasts, and public appearances of bank officials before parliament.

bank may have an incentive to misrepresent the extent of caution, thereby manipulating inflationary expectations. Finally, the model abstracts from the endogeneity of preferences to economic outcomes. Future work could analyze whether the interaction between variability in the past and aversion to variability in the present leads to monetary arrangements designed to foster stability in the future.

APPENDIX: Comparative Statics for Inflation and Output Variability

Differentiating the equilibrium variance of inflation in (12) with respect to σ_s^2 gives the following global condition for a positive relation between $Var[\pi]$ and σ_s^2:

$$\left(\frac{z}{\sigma_\epsilon}\right)^2 \times \frac{\mu_1 - \sigma_s^2(\theta_1 + b^2\theta_2)}{\mu_1 + \sigma_s^2(\theta_1 + b^2\theta_2)} > \left(\frac{\theta_2}{\mu_2}\right)^2 \times \left(\frac{\mu_1 + \sigma_s^2(\theta_1 + b^2\theta_2)}{(1+\sigma_s^2)(\theta_1 + b^2\theta_2)}\right)^2, \qquad \text{(A1)}$$

where a large z/σ_ϵ or a θ_2 close to zero are both conducive to a positive relationship. Given that all parameters are nonnegative, sufficient conditions for a negative relationship follow from $\mu_2 = 0$ and $\mu_1 < \sigma_s^2(\theta_1 + b^2\theta_2)$, e.g. $\mu_1 = 0$ or $\sigma_s^2 > \mu_1/(\theta_1 + b^2\theta_2)$. Finally, setting $\sigma_s^2 = 0$ in (A1) produces:

$$\frac{z}{\sigma_\epsilon} > \frac{\mu}{\theta + b^2},$$

which is the local condition in the main text.

Differentiating the equilibrium variance of output in (14) with respect to σ_s^2 produces the following global condition between $Var[y]$ and σ_s^2:

$$\left(\frac{z}{\sigma_\epsilon}\right)^2 \times \frac{\mu_1 - \sigma_s^2\left(\theta_1 + b^2\theta_2\right)}{\mu_1 + \sigma_s^2\left(\theta_1 + b^2\theta_2\right)} \;>\; -\left(\frac{b^4\theta_2^2 + 2b^2\theta_1\theta_2}{\mu_2^2}\right)\left(\frac{\mu_1 + \sigma_s^2\left(\theta_1 + b^2\theta_2\right)}{\left(1+\sigma_s^2\right)\left(\theta_1 + b^2\theta_2\right)}\right)^2.$$

Evaluation of this condition at $\sigma_s^2 = 0$ shows that the introduction of instrument uncertainty always increases the variance of output. Moreover, there exist threshold levels for σ_s^2, θ_1 and θ_2 below which the correlation is definitely positive. Finally, a high level of μ_1 also ensures that the correlation is positive.

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