THE ADVANTAGE OF TRANSPARENCY IN MONETARY POLICY INSTRUMENTS*

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ABSTRACT

Monetary policy instruments differ in *tightness*—how closely they are linked to inflation—and *transparency*—how easily they can be monitored. Tightness is always desirable in a monetary policy instrument; when is transparency? When a government cannot commit to follow a given policy. We apply this argument to a classic question: Is the exchange rate or the money growth rate the better monetary policy instrument? We show that if the instruments are equally tight and a government cannot commit to a policy, then the exchange rate's greater transparency gives it an advantage as a monetary policy instrument.

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> By the simple virtue of being a price rather than a quantity, the exchange rate provides a much clearer signal to the public of the government's intentions and actual actions than a money supply target. Thus, if the public's inflationary expectations are influenced to a large extent by the ability to easily track and continuously monitor the nominal anchor, the exchange rate has a natural advantage [Calvo and Végh, 1999, p. 1589].

> True, the exchange rate has some special properties. In particular, it is easily observable, so the private sector can directly monitor any broken promises by the central bank. But we know of no convincing argument that turns these properties into an explanation for why it would be a more efficient method to achieve credibility to target the exchange rate rather than, say, the money growth rate [Persson and Tabellini, 1994, p. 17].

A classic question in international economics is whether the exchange rate or the money growth rate is the better instrument of monetary policy. A common answer—offered, for example, by Calvo and Végh [1999]—is that the exchange rate has a natural advantage over the money growth rate as an instrument of monetary policy because the exchange rate is easier for the public to observe; it is more *transparent*. Skeptics of this view agree that the exchange rate is easier for the public to monitor. Still—as Persson and Tabellini [1994] point out—no clear theoretical argument has been made that explains why the transparency of the exchange rate gives it a natural advantage as a monetary policy instrument. We provide such a theoretical argument here.

We build on the analyses of Canzoneri [1985], Zarazaga [1995], and Herrendorf [1997] using a simple model of sustainable monetary policy similar to that of Kydland and Prescott [1977] and Barro and Gordon [1983]. In our model, each period, the government chooses one of two regimes for monetary policy: an exchange rate regime or a money regime. Under the *exchange rate regime*, the government picks as its monetary policy instrument the rate of depreciation of the exchange rate of its currency with that of some foreign country. By choosing this exchange rate, the government sets the mean inflation rate, and realized domestic inflation varies with shocks both to the inflation rate in the foreign country and to the real exchange rate.[1] Under the *money regime*, the government picks as its instrument a money growth rate, thus setting the mean inflation rate, and realized inflation varies with domestic inflation shocks. Hence, under both regimes, the government sets the mean inflation rate, and realized inflation varies with exogenous shocks. Under both regimes, then, the government is targeting inflation; it is just using different instruments to attempt to hit its target.

The instruments that define these regimes differ in two respects: their tightness and their transparency. One instrument is *tighter* than another if it is more closely linked to inflation.[2] In our setup, the relative tightness of the instruments depends on the relative variance of the foreign and domestic shocks.[3] One instrument is more *transparent* than another if it is more easily observed by the public. In our setup, we assume for simplicity that the exchange rate is perfectly observed while only a noisy signal of the money growth rate is observed. We thus refer to the exchange rate as the *transparent instrument* and the money growth rate as the *opaque instrument*.

Tightness is desirable in an instrument because the government dislikes variability in inflation. We show that transparency is desirable in an instrument only because this characteristic helps mitigate the credibility problems that arise when a government cannot commit to follow a given monetary policy.

To emphasize this point, we compare the relative desirability of the two types of instruments in two types of environments. We first consider an environment in which the government can commit to its policies and, hence, has no credibility problems. We show that with commitment, the relative desirability of instruments does not depend on their transparency: the tighter instrument is always preferred. We then consider an environment in which the government has credibility problems because it cannot commit to its policies. In this environment, we show that the relative desirability of instruments depends on both their tightness and their transparency. Tightness is desirable without commitment for the same reason it is desirable with commitment: a tighter instrument leads to less variable inflation. Transparency is desirable without commitment because it helps alleviate credibility problems. To illustrate this point, we show that the transparent instrument, the exchange rate, may be preferred to the opaque one, the money growth rate, even if money growth is the tighter instrument.

The intuition for our results is straightforward. Under either regime, when there is no commitment, the government has a temptation to surprise the public with higher than expected inflation in order to decrease unemployment. In order to achieve a good outcome, the equilibrium strategies must have two features simultaneously. The strategies must ensure that the government gets a high payoff when it chooses low inflation and a low payoff when it deviates to high inflation. With a transparent instrument, any deviation is perfectly detectable, there is no conflict between these two features, and the economy need never experience periods with low payoffs for the government. With an opaque instrument, however, these two features conflict. To deter deviations to high money growth, the equilibrium strategies must ensure that high realizations of inflation are followed by low payoffs for the government. Since high realizations of inflation will occur even if the government does not deviate, with such strategies at least some period of low payoffs for the government must be realized in equilibrium.

The result about the advantage of transparency is easiest to show under the assumptions that inflation is the only signal of money growth and that money growth is never observable. But we show that our results hold even when agents see other signals or when they observe money growth after a lag.

We show that a certain price, the exchange rate, has a natural advantage over a certain quantity, the money growth rate, as a monetary policy instrument. A natural question is, does this analysis extend to the relative advantage of another price, the interest rate, over the money growth rate as a monetary policy instrument? Our analysis suggests that the answer depends on exactly how the interest rate is used in monetary policy. We discuss the application of our model to interest rates after presenting our main results.

Our analysis builds on the seminal contribution of Canzoneri [1985], who assumes that a private information problem arises under a money regime because the money growth rate is an opaque instrument. Canzoneri [1985] discusses what might occur in the best equilibrium with transparent or opaque instruments when a government has credibility problems. Here we extend his analysis. Most interesting to us is what happens when the opaque instrument, here money growth, is the preferred one. This will be true when money growth is sufficiently tight. With such an instrument, agents cannot tell whether unexpectedly high realized inflation is the result of the government's choice of a high money growth rate or is simply the result of a large domestic inflation shock. Because of this lack of transparency, the optimal outcome necessarily oscillates at random between two extreme phases, with low and high average inflation. This random oscillation along the equilibrium path is analogous to the outcomes obtained by Green and Porter [1984] and Abreu, Pearce, and Stacchetti [1986] in their analyses of equilibrium price wars among oligopolists.[4]

Our work here is most closely related to the work of Stokey [2003] and Herrendorf [1997]. Stokey [2003] builds on our analysis, but focuses on using simple two-state Markov perfect equilibria and shows how to solve for the best equilibria in this class under either a money regime or an exchange rate regime. Herrendorf [1997] considers an optimal taxation game in which the monetary authority must finance a given amount of spending with a combination of direct taxes and inflation taxes. The monetary authority can choose a transparent fixed exchange rate regime in which it must set some fixed suboptimal exchange rate peg or an opaque money regime in which it is free to choose any rate of money growth. Herrendorf gives an intriguing example in which if the signal of money growth is sufficiently noisy, then the only equilibrium in the money regime is the repeated one-shot equilibrium. Thus, with sufficiently noisy signals, the money regime can be worse than the fixed exchange rate regime with a fixed suboptimal peg.[5]

Here we have used a simple reduced-form model of money. Chang [1998] and Phelan and Stacchetti [2001] use recursive methods to analyze some general equilibrium macroeconomic models with perfect monitoring.

I. Two Monetary Policy Instruments

We start by presenting a model of monetary policy in which, each period, the government selects either an exchange rate regime, in which it uses the rate of depreciation of the exchange rate as its policy instrument, or a money regime, in which it uses the rate of growth of the money supply as its policy instrument.

In the model, time is discrete, and time periods are denoted $t = 0, 1, 2, \ldots$. The economy consists of a continuum of private agents and a government. Agents choose the rate of change of their individual wages before inflation is realized. Agents dislike unemployment, inflation, and changes in real wages due to unexpected inflation. The government chooses monetary policy to maximize the agents' utility.

The timing of actions within each period is as follows. At the beginning of a period, the government chooses a regime for monetary policy, namely, whether it will use the rate of depreciation of the exchange rate or the rate of growth of the money supply as its policy instrument in the current period. If it chooses the (crawling peg) exchange rate regime, the government opens a trading desk at which it trades domestic and foreign currency. If it chooses the money regime, the government does not open this desk. The presence or absence of the trading desk is thus an observable indicator of the current regime. After the government's choice of regime, agents choose their nominal wages. Finally, depending on the regime, the government chooses either the specific rate of depreciation of the exchange rate or the specific rate of growth of the money supply. The government is free to switch regimes at the beginning of each period.

For convenience, we will describe the economy for a given period t starting at the end of the period and working backward to the beginning. At the end of the period, when the government chooses the specific level of either the rate of depreciation of the exchange rate or the money growth rate, it takes as given the average rate of wage inflation x set by agents earlier in the period. Unemployment u is equal to a constant U plus the gap between average wage inflation x and realized inflation π.

Under the two regimes, realized inflation is a function of monetary policy as follows. Under the exchange rate regime, the government chooses a rate of change in the exchange rate denoted $e_t = s_t - s_{t-1}$, where s_t is the level of the exchange rate. For simplicity, however, we refer to e_t as the *exchange rate*. Inflation in the home country is given by

$$(1) \qquad \pi = e + \pi^*,$$

where π^* has a normal distribution with mean 0 and variance $\sigma^2_{\pi^*}$. The variable π^* reflects a combination of inflation in foreign countries and shocks to the real exchange rate. For simplicity, we refer to π^* as *foreign inflation*. Thus, by choosing an exchange rate, the government sets the mean domestic inflation rate to be e, while the variance of domestic inflation is determined by shocks in the foreign country which are outside the domestic government's control. Foreign inflation π^* is observed only after the exchange rate is chosen. We let $g(\pi|e)$ denote the density of realized domestic inflation given the choice of exchange rate e.

Under the money regime, the government chooses a money growth rate μ. Given μ, realized inflation π is given by

$$(2) \qquad \pi = \mu + \varepsilon,$$

where ε represents domestic inflation shocks which are normally distributed with mean 0 and variance σ^2_ε. Thus, by choosing the money growth rate, the government sets the mean domestic inflation rate to be μ, and the variance of domestic inflation is determined by domestic shocks outside of the government's control. We interpret the imperfect connection between money growth and inflation as arising from some combination of the government's imperfect control over actual (as opposed to desired) money growth and a noisy relation between money growth and inflation. We let $f(\pi|\mu)$ denote the density of realized domestic inflation given the choice of money growth rate μ.

We say that the money growth rate is a *tighter instrument* than the exchange rate if and only if $\sigma_\varepsilon^2 < \sigma_{\pi^*}^2$. To model the idea that exchange rates are more transparent than money growth rates in that they are easier for the public to monitor, we assume that under both regimes, agents can see the exchange rate e and the inflation rate π but not the money growth rate μ. Thus, under an exchange rate regime, agents directly see the actions of the government, while under a money regime, they do not. In the money regime, inflation serves as a noisy signal of the government's actions. We refer to the exchange rate as the *transparent instrument* and the money growth rate as the *opaque instrument*.

Under both regimes, equations (1) and (2) both hold. In the exchange rate regime, e is the choice variable and the money growth rate μ is endogenously determined, while in the money regime, μ is the choice variable and the exchange rate e is endogenously determined. In these regimes, the government's choice of either e or μ determines the mean inflation rate. In this sense, in both regimes, the government is targeting inflation.

In the middle of each period, each agent chooses the change in the agent's own wage rate from period $t-1$ to period t, where this change is denoted z_t. For simplicity, we refer to z_t as *individual wages* and let x_t denote the corresponding average rate of wage change. An agent's payoff for a given value of z, x, and a realization of π is

$$(3) \qquad r^A(z,x,\pi) = -\frac{1}{2}\left[(z-\pi)^2 + (U+x-\pi)^2 + \pi^2\right],$$

where on the right side, the first term in the brackets reflects unexpected changes in this agent's real wages, the second term is unemployment, and the third is realized inflation. Each agent can choose z differently depending on whether the regime is an exchange rate regime or a money regime. We denote these choices by z_e and z_μ and the corresponding average wage rates by x_e and x_μ. An agent's expected per period payoff under an exchange rate regime with exchange rate e is

$$(4) \qquad S^A(z_e,x_e,e) = \int r^A(z_e,x_e,\pi)g(\pi|e)\,d\pi,$$

while this agent's analogous expected per period payoff under a money regime with money growth rate μ is

$$(5) \qquad R^A(z_\mu,x_\mu,\mu) = \int r^A(z_\mu,x_\mu,\pi)f(\pi|\mu)\,d\pi.$$

Notice that under either regime, agents aim to choose wages equal to mean inflation, either e or μ, depending on the regime.

In what follows, we focus on equilibria which are symmetric; all agents choose the same individual wages, so that $x_e = z_e$ and $x_\mu = z_\mu$. Thus, all agents have the same utility. The government's expected payoffs are $S(x_e, e) = S^A(x_e, x_e, e)$ and $R(x_\mu, \mu) = R^A(x_\mu, x_\mu, \mu)$ under the exchange rate and the money regime, respectively. With our functional forms, these become

$$(6) \qquad S(x, e) = -\frac{1}{2}\left[(U + x - e)^2 + e^2\right] - \frac{3}{2}\sigma_{\pi^*}^2 \text{ and}$$

$$(7) \qquad R(x, \mu) = -\frac{1}{2}\left[(U + x - \mu)^2 + \mu^2\right] - \frac{3}{2}\sigma_{\varepsilon}^2.$$

Notice that the government's expected payoffs in the two regimes are symmetric with respect to the policy variables e and μ. In particular, the functions S and R differ only with respect to the uncontrollable variances $\sigma_{\pi^*}^2$ and σ_{ε}^2, which are constants. Clearly, from (6) and (7), we know that tightness is a desirable characteristic of an instrument. We ensure that the government's payoffs are bounded by assuming that the policies e and μ are bounded above and below by some arbitrarily large constants.

The government's objective function is the discounted value of its expected per period payoffs

$$(8) \qquad (1 - \beta)\sum_{t=0}^{\infty} \beta^t[(1 - i_t)S(x_{et}, e_t) + i_t R(x_{\mu t}, \mu_t)],$$

where $0 < \beta \leq 1$ is the discount factor and i_t is a variable that indicates the regime chosen in period t, where $i_t = 0$ for the exchange rate regime and $i_t = 1$ for the money regime. Here x_{et} denotes the average wages chosen in period t if an exchange rate regime is chosen and $x_{\mu t}$ denotes the average wages chosen in period t if a money regime is chosen. The discounted payoffs for the agents are written similarly.

II. Two Environments

Now we examine the relative desirability of tightness and transparency in two environments: when the government can commit to its monetary policy and when it cannot. We conclude that tightness is desirable in both environments, but transparency is desirable only when the government cannot commit.

A. With Commitment

We first suppose that the government can commit to a monetary policy once and for all in period 0. We show that when the government can commit to its policy, the relative desirability of instruments does not depend on their transparency: the tighter instrument is always preferred. Here this means that an exchange rate regime is preferred to a money regime if and only if the volatility of foreign inflation shocks is less than that of domestic inflation shocks. Thus, with commitment, exchange rates derive no advantage as a monetary policy instrument from their transparency.

In this environment with commitment, at the beginning of period 0, the government chooses the sequence $\{i_t, e_t, \mu_t\}_{t=0}^{\infty}$ indicating the regime it will follow and the exchange rate or money growth rate it will implement under that regime in each period. After this, in each period t, agents choose wages z_{et} or $z_{\mu t}$, depending on the regime. Given (4) and (5), the optimal choices for agents are clearly $z_{et} = e_t$ and $z_{\mu t} = \mu_t$; hence, in equilibrium, average wages satisfy

(9) $\quad x_{et} = e_t$ and $x_{\mu t} = \mu_t$.

Here the optimal policies and allocations solve the Ramsey problem of choosing sequences $\{i_t, e_t, \mu_t, x_{et}, x_{\mu t}\}_{t=0}^{\infty}$ to maximize the government's discounted payoff (8) subject to the equilibrium condition on agents' average wages (9). This problem reduces to a sequence of static problems of choosing e and μ to solve $\max_e S(e, e)$ and $\max_\mu R(\mu, \mu)$ and then choosing the regime that leads to the higher payoff. Since the government's payoffs are symmetric with respect to the policy variables, the optimal exchange rate and money growth rate are identical (both 0), and the government simply picks the regime with the lower variance of inflation. We denote this maximum payoff as v^R and refer to it as the *Ramsey payoff.* We summarize this result as

Proposition 1. Only Tightness Matters With Commitment.

When the government can commit to its monetary policies, the tighter instrument is preferred regardless of its transparency. Thus, with commitment, the exchange rate regime is preferred to a money regime if and only if $\sigma_{\pi^*}^2 \leq \sigma_{\varepsilon}^2$.

Here the optimal policy in both regimes is a constant. This occurs only because, for simplicity, we have abstracted from any source of shocks that would make the policies vary.

B. Without Commitment

Now we suppose that the government cannot commit to its policies. In each period, it chooses a regime; then, after agents set their wages, the government chooses the level of its monetary policy instrument. For this environment, we show that transparency is a desirable feature for an instrument. Specifically, we show that if the exchange rate and the money growth rate are equally tight instruments, then, given any equilibrium in which the government chooses a money regime in some period t, we can construct another equilibrium in which the government chooses instead an exchange rate regime in period t and obtains a strictly higher payoff. Thus, even if money growth is the tighter instrument, an exchange rate regime is preferred because of its transparency. We say, therefore, that the exchange rate's greater transparency gives it a *natural advantage* as a monetary policy instrument.

In this environment, both the government and the agents choose their actions as functions of the observed history of aggregate variables: the choice of regime, the exchange rate, and inflation. In period t, this history is given by $h_t = (i_0, e_0, \pi_0; \ldots; i_{t-1}, e_{t-1}, \pi_{t-1})$. A strategy for the government is a sequence of functions $\sigma^G = \{i_t(h_t), e_t(h_t), \mu_t(h_t)\}_{t=0}^{\infty}$ that map histories into the choice of regime i_t and corresponding exchange rates e_t or money growth rates μ_t. A strategy for agents is a sequence of functions $\sigma^A = \{z_{et}(h_t), z_{\mu t}(h_t)\}_{t=0}^{\infty}$ that map histories into actions z_t, where $z_{et}(h_t)$ is only relevant if $i_t(h_t) = 0$ and $z_{\mu t}(h_t)$ is only relevant if $i_t(h_t) = 1$. We also define a sequence of functions $\sigma^X = \{x_{et}(h_t), x_{\mu t}(h_t)\}_{t=0}^{\infty}$ that record the average wages chosen by agents after each history. Let $\sigma = (\sigma^G, \sigma^A, \sigma^X)$ denote the strategies of the government, the strategies of the agents, and the average wages. Notice that in the histories, we need not record the history of average wages since a deviation by any one agent cannot affect this average. (For details on this point, see, for example, Chari and Kehoe [1990].) Notice that in any history h_t in which the exchange rate is chosen in period t, the inflation rate in that period is simply a public random variable that gives no strategic information. For notational simplicity, we assume that strategies following any such history do not depend on the realized inflation rate under the exchange rate regime in period t. Likewise, if the money regime is chosen in period t, the exchange rate in that period is a public random variable that gives no strategic information beyond the information contained in inflation π_t. We assume that strategies following such a history do not depend on the realized exchange rate in period t.

A *perfect equilibrium* in this environment is a collection of strategies σ such that (i) after every history h_t, the agents' strategy σ^A is optimal given the government's strategy σ^G and the average of agents' wages σ^X; (ii) after every history h_t, the government's strategy σ^G is optimal given the average of agents' wages σ^X; and (iii) after every history h_t, σ^A and σ^X agree.

Clearly, given agents' payoffs (4) and (5), after any history h_t, the agents' best response to the government strategy σ^G is to choose wages $z_{et}(h_t) = e_t(h_t)$ or $z_{\mu t}(h_t) = \mu_t(h_t)$, depending on the regime. Thus, in any perfect equilibrium, average wages must satisfy

$$x_{et}(h_t) = e_t(h_t) \text{ and } x_{\mu t}(h_t) = \mu_t(h_t).$$

That is, in equilibrium, wage inflation must equal expected inflation.

To prove our main result, we formulate the incentive constraint of the government recursively, by drawing on the work of Abreu, Pearce, and Stacchetti [1986, 1990]. Their basic idea comes from a simple insight. A strategy is a prescription for current actions and all future actions that follow every possible history. To evaluate the government's incentive constraints, however, we need not specify the whole sequence of future actions for the government and agents that follow every possible current action that the government might take. Rather, all we need specify is how the government's payoff from the next period on—its *continuation value*—will vary as the government's current action varies. This simple observation forms the basis for a recursive approach to describing the incentive compatibility constraints for the government.

To formulate the incentive constraint of the government recursively, we first show how strategies induce continuation values. Fix a collection of strategies $\sigma = \left(\sigma^G, \sigma^A, \sigma^X\right)$. In any period t, let $V_t(h_t; \sigma)$ be the expected discounted payoff to the government following history h_t under the strategies σ. (Note that $V_t(h_t; \sigma)$ is essentially (8) evaluated from period t on, with expectations over future histories taken with respect to the conditional distribution over these histories induced by σ.)

We now define continuation values under a money regime and an exchange rate regime. Suppose that, in period t following history h_t, the government has chosen a money regime $\big(i_t(h_t) = 1\big)$ and agents have chosen wages $x_{\mu t}(h_t)$. Since agents observe only inflation $\pi_t = \mu_t + \varepsilon_t$, which is a noisy signal of μ_t, the equilibrium following period t as specified in a collection of strategies σ cannot depend on the government's choice of μ_t directly; it can vary only with inflation π_t. Hence, the government's continuation value from next period on can be summarized by a *continuation value function under a money regime* $w_{\mu t}(\pi, h_t)$. This function equals the payoff $V_{t+1}(h_{t+1}; \sigma)$ for the government that occurs under σ following the history $h_{t+1} = \big(h_t, i_t(h_t) = 1, e_t = \pi_t - \pi_t^*, \pi_t\big)$. Likewise, the *continuation value function under an exchange rate regime* $w_{et}(e_t, h_t)$ equals the payoff $V_{t+1}(h_{t+1}; \sigma)$ for the government that occurs under σ following the history $h_{t+1} = \big(h_t, i_t(h_t) = 0, e_t, \pi_t = e_t + \pi_t^*\big)$.

In each period, the government has three incentive constraints, two for the choice of policy within each regime and one for the choice of regime. Consider first the *incentive constraint for money growth* in the money regime in period t. The strategy σ^G specifies that the government choose $\mu_t(h_t)$ in the current period. Given the current wage chosen by the agents $x_{\mu t}(h_t)$ and the continuation value function $w_{\mu t}(\pi, h_t)$, the incentive constraint requires that there be no other money growth rate $\mu_t' \neq \mu_t(h_t)$, such that the government could benefit by deviating to μ_t' in the period t and then acting according to its strategy σ^G from period $t+1$ on; that is,

$$\text{(10)} \quad (1-\beta)R\big(x_{\mu t}(h_t), \mu_t(h_t)\big) + \beta \int w_{\mu t}(\pi, h_t) f\big(\pi | \mu_t(h_t)\big)\, d\pi \geq$$
$$(1-\beta)R\big(x_{\mu t}(h_t), \mu_t'\big) + \beta \int w_{\mu t}(\pi, h_t) f(\pi | \mu_t')\, d\pi$$

for any possible μ_t'. Notice that here a deviation μ_t' from the specified current action $\mu_t(h_t)$ affects the government's expected discounted payoff only by shifting the distribution of inflation from $f\big(\pi|\mu_t(h_t)\big)$ to $f(\pi|\mu_t')$.

Consider next the *incentive constraint for the exchange rate* in the exchange rate regime in period t. Given the wages $x_{et}(h_t)$ chosen by agents, this incentive constraint is

$$\text{(11)} \quad (1-\beta)S\big(x_{et}(h_t), e_t(h_t)\big) + \beta w_{et}\big(e_t(h_t), h_t\big) \geq (1-\beta)S\big(x_{et}(h_t), e_t'\big) + \beta w_{et}(e_t', h_t)$$

for any possible e_t'.

Finally, consider the incentive constraint for the choice of regime. In period t, after history h_t, the money regime is chosen, $i_t(h_t) = 1$, only if

$$\text{(12)} \quad (1-\beta)R\big(x_{\mu t}(h_t), \mu_t(h_t)\big) + \beta \int w_{\mu t}(\pi, h_t) f\big(\pi | \mu_t(h_t)\big)\, d\pi \geq$$
$$(1-\beta)S\big(x_{et}(h_t), e_t(h_t)\big) + \beta w_{et}\big(e_t(h_t), h_t\big).$$

Likewise, the exchange rate regime is chosen, $i_t(h_t) = 0$, only if (12) holds with the reverse weak inequality.

Notice that in (10), (11), and (12) we are only considering one-shot deviations, that is, changes in the current actions, holding fixed the future strategies. A standard result in game theory says that since the payoffs of the government are bounded, these recursive incentive constraints are both necessary and sufficient for full incentive compatibility.

The following proposition establishes the precise advantage of the transparent instrument when the government cannot commit to its policies.

Proposition 2. The Advantage of Transparency.

> When two monetary policy instruments have equal tightness and the government cannot commit to its monetary policies, the transparent instrument is preferred to the opaque instrument in the following sense. In any equilibrium σ in which the money regime is chosen in some period t, there is an equilibrium $\tilde{\sigma}$ with higher welfare in which the exchange rate regime is chosen in period t and in other periods agrees with the original equilibrium.

The idea of the proof of this proposition is the following. To achieve a good outcome, the continuation payoff must have two features simultaneously. It must deter the government from deviating from the prescribed policy, and it must give the government a high continuation payoff when the government does not deviate. With a transparent instrument, any deviation is perfectly detectable, and these two features do not conflict. The continuation payoff function can specify the lowest possible continuation when there is any deviation and the highest possible continuation when there is none. With an opaque instrument, however, the continuation payoff function can depend only on a noisy signal of the policy, so these features do conflict. If the continuation payoff function specifies the highest payoff regardless of the observed noisy signal, then the payoff has no deterrence value and results in the one-shot equilibrium outcome. If this function builds in any deterrence value by prescribing lower continuation values for some inflation rates, then with positive probability the lower continuation value must be realized even if the government pursues the desired policy. This feature necessarily leads to lower payoffs along the equilibrium path. In this sense, the advantage of transparency arises from the ability to tailor the continuation payoff function precisely to deviations: it can give high payoffs only when exactly the right policy is being pursued, and it can give low payoffs when any other policy is used.

Proof of Proposition 2. Let σ be equilibrium strategies in which the money regime is chosen along the equilibrium path. Let t be the first period in which a money regime is chosen. Let h_t be the history of actions along the equilibrium path prior to period t, with agents' wages $x_{\mu t}(h_t)$, a money growth rate $\mu_t(h_t)$, and the continuation value $w_{\mu t}(\pi, h_t)$. We construct the better equilibrium $\tilde{\sigma}$—that is one with higher welfare than σ—as follows. First set $\tilde{\sigma}$ so that the actions of the agents and the government in every period and history before period t are the same as those specified in the original set of equilibrium strategies σ. Next, after history h_t, let $\tilde{\sigma}$ specify that the exchange rate regime is chosen, and let $\tilde{e}_t(h_t) = \mu_t(h_t)$ be the exchange rate. Let agents' wages be $\tilde{x}_{et}(h_t) = \tilde{e}_t(h_t)$ to ensure that the agents' incentive compatibility constraint is satisfied. Let $\tilde{\sigma}$ specify that for the (unchosen) money regime, $\tilde{\mu}_t(h_t) = \mu_t(h_t)$ and $\tilde{x}_{\mu t}(h_t) = \mu_t(h_t)$. For all other histories that are possible in period t and for all future periods following these histories, set the actions specified under $\tilde{\sigma}$ equal to those specified under σ.

Let $\bar{w}_t(h_t)$ and $\underline{w}_t(h_t)$ denote the highest and the lowest continuation values following h_t under the equilibrium σ, so that $\bar{w}_t(h_t) = \max_\pi w_{\mu t}(\pi, h_t)$ and $\underline{w}_t(h_t) = \min_\pi w_{\mu t}(\pi, h_t)$, where $w_{\mu t}(\pi, h_t)$ is the continuation value from the original equilibrium in which money is used as an instrument in period t. Let the continuation value under $\tilde{\sigma}$ be

$$\tilde{w}_{et}(e_t, h_t) = \left\{ \begin{array}{c} \bar{w}_t(h_t) \text{ if } e_t = \tilde{e}_t(h_t) \\ \underline{w}_t(h_t) \text{ if } e_t \neq \tilde{e}_t(h_t) \end{array} \right\},$$

and let the future strategies under $\tilde{\sigma}$ correspond to the strategies under σ that support these continuation values. Thus, $\tilde{w}_{et}(e_t, h_t)$ specifies that if the government chooses the prescribed exchange rate $\tilde{e}_t(h_t)$, then it receives the highest value that it would have received in the original equilibrium in which it chose the money regime, while if it chooses any other value, it receives the lowest value that it would have received in the original equilibrium.

Clearly, to show that our constructed strategies are an equilibrium, we need to show that they satisfy the incentive constraint for the government following h_t when the exchange rate regime is chosen. To see that this is true, rewrite the incentive constraint when the exchange rate is used as

$$(13) \quad (1-\beta)\big[S\big(\tilde{x}_{et}(h_t), e_t'\big) - S\big(\tilde{x}_{et}(h_t), \tilde{e}_t(h_t)\big)\big] \leq \beta\,[\bar{w}_t(h_t) - \underline{w}_t(h_t)]$$

and the incentive constraint when money is used as

$$(14) \quad (1-\beta)\big[R\big(x_{\mu t}(h_t), \mu_t'\big) - R\big(x_{\mu t}(h_t), \mu_t(h_t)\big)\big] \leq \beta \int w_{\mu t}(\pi, h_t)\big[f\big(\pi|\mu_t(h_t)\big) - f(\pi|\mu_t)\big]\, d\pi.$$

By construction, the inherited wages in the exchange rate regime equal those in the money regime, $\tilde{x}_{et}(h_t) = x_{\mu t}(h_t)$, and since the two instruments are equally tight, the functions S and R coincide. Also by construction,

$$\int w_{\mu t}(\pi, h_t)\big[f\big(\pi|\mu_t(h_t)\big) - f(\pi|\mu_t)\big]\, d\pi \leq \bar{w}_t(h_t) - \underline{w}_t(h_t),$$

so that if (14) holds for any deviation μ_t', then (13) holds for any deviation e_t'.

Along the equilibrium path, the payoffs under our constructed strategies $\tilde{\sigma}$—the left side of (11)—are weakly higher than those under σ—the left side of (10)—since

$$(15)\quad w_{et}\big(\tilde{e}_t(h_t), h_t\big) = \bar{w}_t(h_t) \geq \int w_{\mu t}(\pi, h_t) f\big(\pi|\mu_t(h_t)\big)\; d\pi.$$

Suppose first that $\mu_t(h_t)$ is strictly less than the static Nash money growth rate. Then (15) is a strict inequality, and $\tilde{\sigma}$ strictly improves welfare. Suppose next that (15) is an equality, so that $\tilde{\sigma}$ does not strictly improve welfare. Then there is an alternative variation that does. In this alternative variation, in period t the government chooses an exchange rate regime and an exchange rate that is below static Nash, which is supported by the infinite reversion to static Nash following any deviation. As long as $\beta > 0$, such an equilibrium exists.

Next we verify that the new strategies satisfy (12). We have constructed $\tilde{\sigma}$ so that the payoff under a money regime in period t following history h_t is the same as the payoff under strategy σ. By the arguments above, the constructed strategies $\tilde{\sigma}$ are such that the payoff in period t following history h_t is strictly higher under an exchange rate regime than under a money regime. Hence, (12) is satisfied with this history.

Finally, we show that our constructed strategies $\tilde{\sigma}$ are incentive compatible in periods other than t and at t for histories other than h_t. Note that we have chosen t so that the government follows an exchange rate regime prior to period t. Hence, the equilibrium path h_t occurs with probability one. The constructed strategies $\tilde{\sigma}$ before period t are clearly incentive compatible because they raise the value to the government of taking the actions along the equilibrium path h_t and leave the values after deviations from this path unchanged. Our strategies $\tilde{\sigma}$ are incentive compatible after period t by construction. *QED*

We have shown that for any equilibrium in which the money growth rate is used as an instrument in some period, there is an equilibrium in which the exchange rate is used as an instrument in that same period which leads to higher welfare. Since our construction works for any equilibrium, the following is an immediate corollary: Along the equilibrium path of the best equilibrium, the government chooses the exchange rate as the policy instrument with probability one at all times. (We thank a referee for pointing this out.) (It turns out that when the two instruments are equally tight, this equilibrium path is supported by reversion to a money regime following deviations. We discuss this feature of the equilibrium in Section IV below.)

We next illustrate graphically how the results differ with and without commitment. In Figure

I, we show how the optimal regime varies with the relative tightness of the instruments, which here correspond to the variances of foreign and domestic shocks. When the government can commit to its policies, the transparent instrument—that is, the exchange rate regime—is preferred if and only if the transparent instrument is the tighter one, so that $\sigma^2_{\pi^*} < \sigma^2_{\varepsilon}$. This is the region labeled A in the figure. When the government cannot commit to its policies, the transparent instrument is preferred even if the two instruments are equally tight. Thus, the region for which the exchange rate regime is preferred expands to include the region labeled B as well as region A.

In proving our result, we have imposed no restrictions on strategies besides the natural ones that arise from the environment. If we restrict strategies in the same way in both regimes, say, to Markov strategies (as does Stokey [2003]) or to strategies that allow only reversion to the one-shot equilibrium (as does Canzoneri [1985]), then we obtain similar results when we compare the best equilibria within these restricted classes. The logic is identical to that for our main result for an environment with no such restrictions.

In interpreting Proposition 2, note that we are ranking different equilibria. The model has many equilibria, and in any given one, the government bank is choosing its regime optimally taking as given the behavior of private agents. We have left unspecified the mechanism by which any particular equilibrium is implemented. Rather, we have simply shown that in the best equilibrium, the exchange rate regime is chosen when both instruments are equally tight. Only in this particular sense have we shown that exchange rates have an advantage over money growth rates as a monetary policy instrument.

III. Relaxing Some Assumptions

In modeling the idea that exchange rates are easier to monitor than money growth rates, we have made the simple but extreme assumptions that inflation is the only signal of the money growth rate and that money growth rates are never observed. Here we show that we can relax those assumptions—allow for multiple signals or for the money growth rate to be observed with a lag—and still find an advantage for transparency.

To see this, suppose first that, besides inflation, agents also observe another noisy signal of money growth, denoted η. In an environment in which the government has imperfect control over money growth, we might interpret this signal η as the realized money growth rate. Let $f(\pi, \eta|\mu)$ be the density of inflation π and the noisy signal η given the money growth rate μ. Here the government's continuation value can vary only with π and η and can be written as $w(\pi, \eta)$. The government's incentive constraint now becomes

$$(1-\beta)R(x_\mu, \mu) + \beta \int\int w(\pi, \eta) f(\pi, \eta|\mu)\, d\pi d\eta \geq$$

$$(1-\beta)R(x_\mu, \mu') + \beta \int\int w(\pi) f(\pi, \eta|\mu')\, d\pi d\eta$$

for any possible μ'. Proving the analog of Proposition 2 in this environment is straightforward.

Suppose next that while inflation is the only signal of the money growth rate that agents can observe in the current period, the money growth rate is perfectly observable with a lag; for simplicity, assume the lag is one period. Specifically, assume that the money growth rate μ_{t-1} is observed after agents set their wages in period t. Here, the history on which agents condition their actions is

$$h_t = (i_0, e_0, \pi_0; i_1, e_1, \pi_1, \mu_0; \ldots; i_{t-1}, e_{t-1}, \pi_{t-1}, \mu_{t-2}),$$

and the history for the government is

$$H_t = (i_0, e_0, \pi_0, \mu_0; i_1, e_1, \pi_1, \mu_0; \ldots; i_{t-1}, e_{t-1}, \pi_{t-1}, \mu_{t-1}).$$

The strategies for the agents and the government are defined as functions of these histories in the standard way.

The intuition for why transparency is desirable in this environment is clear. Under the money regime, any deviation in period t is not directly observed in that period. Thus, in period $t+1$, agents can react only to a noisy signal of that action. Of course, by period $t+2$, agents have observed the government's period t action, and agents then can precisely react to any deviation in period t. This lag in the ability to react precisely leads to a tighter incentive constraint under the money regime and thus gives the transparent exchange rate regime its advantage.

The proof for the result that transparency has an advantage in this environment is similar to that for Proposition 2, with the exception that if the government discounts the future sufficiently little, then the incentive constraint in both regimes is slack, and both regimes can attain the Ramsey payoff. When the incentive constraint in both regimes is slack, there is no time inconsistency problem and, hence, no gain to transparency.

IV. The Best Equilibria Without Commitment

In this section, we discuss the equilibrium outcomes implied by our recursive characterization of the best equilibrium. This best equilibrium outcome differs depending on the tightness of the two monetary policy instruments. When money growth is sufficiently tight, the best equilibrium outcome is implemented with a money regime. Otherwise, it is implemented by an exchange rate regime. In Atkeson and Kehoe [2003], we formally characterize the outcomes for this environment.

When the exchange rate regime is the preferred regime, the equilibrium outcome is simple. In each period, the government chooses an exchange rate regime and sets the exchange rate equal to the best exchange rate policy. If the government deviates from this policy, then the government and agents revert to the actions that implement the worst equilibrium payoff. These actions may correspond to either an exchange rate regime or a money regime, depending on the variances of the shocks. In equilibrium, of course, there are no deviations; hence, the exchange rate is set to the best exchange rate policy in every period, and inflation randomly fluctuates around this exchange rate.

When the money regime is the preferred regime, the equilibrium outcome looks quite different. Under this regime, the government starts by setting the money growth rate equal to some low growth rate μ^b (where b indicates *best*) and sticks to that rate as long as low inflation is realized. Specifically, the government sets the money growth rate to μ^b as long as the domestic inflation shock ε is small enough so that $\mu^b + \varepsilon \leq \pi^b$, where π^b is some cutoff rate of inflation. In equilibrium, eventually a large enough domestic inflation shock must occur so that realized inflation exceeds π^b. After such a shock, the government and agents revert to the actions that implement the *worst* equilibrium payoff v^w. Thus, under the money regime, the actions that implement the worst equilibrium payoffs eventually occur.

The worst equilibrium payoff v^w can occur under either an exchange rate regime or a money regime, depending on the variances of domestic and foreign inflation shocks. This worst equilibrium payoff is the larger of two payoffs. One of these is the worst payoff v_e^w that be achieved as an equilibrium of the subgame starting from a history (possibly off the equilibrium path) in which the government has chosen an exchange rate regime. The other potential worst equilibrium payoff is the corresponding worst payoff v_μ^w starting from a history in which the government has chosen a money regime. That is, $v^w = \max\{v_e^w, v_\mu^w\}$. The worst equilibrium payoff is the larger of these two payoffs because, at the beginning of each period, the government can choose which regime it prefers.

It turns out that when the variances are such that a money regime implements the best payoff, that regime also implements the worst payoff. In this worst regime, the government starts by setting the money growth rate equal to some high growth rate μ^w and continues to do that as long as the domestic inflation shock ε is small enough so that $\mu^w + \varepsilon \leq \pi^w$, where π^w is the relatively high cutoff rate of inflation used in the worst money regime. When a sufficiently large domestic inflation shock occurs so that realized inflation exceeds π^w, the government and agents revert to the actions that implement the best equilibrium payoff. In this sense, when the worst equilibrium is implemented by a money regime, extremely high inflation must be realized before average inflation can fall.

In Figure II, we illustrate a typical path of money growth and inflation outcomes that occur in the best equilibrium over time when the money regime is used in both the best and the worst equilibria. In period 0, agents choose low wages $x_\mu = \mu^b$, the government chooses a low money growth rate μ^b, and realized inflation is this low money growth rate plus the domestic inflation shock $\pi_0 = \mu^b + \varepsilon_0$. In the figure, we assume that realized inflation π_0 is lower than the critical value π^b. Hence, in period 1, agents again choose wages $x_\mu = \mu^b$, the government again chooses a low money growth rate μ^b, and realized inflation is $\pi_1 = \mu^b + \varepsilon_1$. The outcomes continue in this fashion, with agents choosing low wages and the government choosing a low money growth rate, until the domestic inflation shock is large enough so that realized inflation exceeds the critical value π^b. In the figure, this occurs in period 4. Then, in period 5, agents choose high wages $x_\mu = \mu^w$, the government chooses a high money growth rate μ^w, and realized inflation is $\pi_5 = \mu^w + \varepsilon_5$. This pattern continues until the domestic inflation shock is large enough so that realized inflation exceeds the high critical value π^w. In the figure, this occurs in period 7. Then, in period 8, the outcome reverts back to the pattern of agents choosing low wages and the government choosing a low money growth rate. After that, the outcome cycles stochastically between these two phases, depending on the realizations of the domestic inflation shocks.

We use an argument similar to that in Proposition 2 to characterize the regions of the parameter space in which the exchange rate regime and the money regime are used in the best and worst equilibrium outcomes. When the variances of domestic and foreign inflation shocks are the same, $v_e^w < v_\mu^w$. This is because here the current period payoff functions R and S are the same, and the incentive constraint is looser under an exchange rate regime than under a money regime. Hence, when these variances are the same, the worst equilibrium payoff $v^w = v^w_\mu$. Clearly, increasing the variance of foreign inflation shocks above that of domestic inflation shocks reduces v^w_e and leaves v^w_μ unchanged. Hence, $v^w = v^w_\mu$ when the variance of foreign inflation shocks exceeds that of domestic inflation shocks.

In Figure III, we combine this result with that in Proposition 2 to characterize which regimes are used in the best and the worst equilibria in each part of the parameter space. If the variance of foreign inflation shocks is sufficiently high relative to that of domestic inflation shocks, as in region C of the figure, then the government follows a money regime in both the best and the worst equilibria. If the variance of foreign shocks is sufficiently low relative to that of domestic shocks, as in region E, then the government follows an exchange rate regime in both the best and the worst equilibria. When the variances of the two inflation shocks are similar, as in region D, then the government uses an exchange rate regime in the best equilibrium and a money regime in the worst equilibrium. In regions D and E, the best outcome is an exchange rate regime with a constant e in every period. In region C, the best outcome stochastically cycles between high and low inflation as discussed above.

V. Transparency and Tightness of Interest Rates

We have focused on two instruments of monetary policy, money growth and exchange rates. Many central banks often describe their monetary policy in terms of nominal interest rates. Here we discuss the transparency and tightness of monetary policy under two different interpretations of what an interest rate policy might mean.

We add interest rates to our model by appending to it a Fisher equation for the nominal interest rate i_t:

(16) $\quad i_t = \bar{r} + E_t \pi_{t+1},$

where $\bar{r}$ is the constant real interest rate and E_t denotes conditional expectation at t. Using (16) in (1) and (2), we can write nominal interest rates in terms of exchange rates and money growth:

(17) $\quad i_t = \bar{r} + E_t e_{t+1}$, and

(18) $\quad i_t = \bar{r} + E_t \mu_{t+1}.$

One interpretation of an interest rate policy is that the government actually uses either exchange rates or money growth as its instrument and the interest rate is merely a convenient statistic (or *target*) to convey to the private agents its plan for expected inflation. Under this interpretation, the government's strategy in the game is the same as before. In each period, the government chooses the regime and then the specific level of either e_t or μ_t in that regime. This government strategy then implies a sequence of interest rates i_t from (17) and (18). If the government wants a different sequence of interest rates, it can choose a different strategy for e_t or μ_t.

Here the interest rate adds nothing to the transparency of either regime. In particular, under a money regime, since money growth is unobserved, when inflation is not what was expected, or $\pi_t \neq E_{t-1}\pi_t$, private agents cannot tell whether this is because of the shock ε_t or because the government has deviated from the equilibrium path in its choice of μ_t. Note that observing interest rates does not help the public sort out why $\pi_t \neq E_{t-1}\pi_t$. Under an exchange rate regime, agents can already figure out why $\pi_t \neq E_{t-1}\pi_t$, using $e_t = \pi_t - \pi_t^*$, because they see e_t. Knowledge of the interest rate adds no information. The interest rate also adds nothing to the tightness of either regime because inflation is still determined by (1) and (2)

An alternative interpretation of an interest rate policy is that the government uses the interest rate as more than a target statistic. Under this interpretation, the government sets up a desk that buys and sells bonds for money at some fixed price (or borrows and lends reserves at some fixed rate). Private agents then determine the amount of money in circulation—and, hence, inflation—endogenously. Under this interpretation, the instrument of monetary policy is what interest rate to set. We call this formulation of an interest rate policy an *interest rate regime*. We can model this regime by having the government choose the interest rate and having the private agents determine the money growth rate μ. Agents each choose the growth of their own individual money holdings ν, and the aggregate money growth rate μ is then the average of these rates.

Such an interest rate regime is transparent in the same way that an exchange rate regime is. In particular, private agents can see immediately if the government deviates from its strategy of trading at a particular price. Moreover, each agent knows that when $\pi_t \neq E_{t-1}\pi_t$, the discrepancy is not because the government has deviated.

It is not at all clear, however, how tight such an interest rate regime would be. For the standard reasons, in such a regime, the private agents' choice of money growth is indeterminate—

its conditional mean is pinned down by the interest rate set by the government in conjunction with (18), but the state-by-state realizations are otherwise free. This feature corresponds to the standard indeterminacy problem associated with choosing interest rates as instruments in general equilibrium models. (The literature abounds with analyses of the indeterminacy issue in models in which the government can commit to its policy. Seldom addressed, however, is the much thornier issue of what happens when the government cannot commit.)

In practice, how do central banks actually use interest rates in the conduct of monetary policy? In recent years, in the United States, our first interpretation of an interest rate policy seems to apply. The FOMC sets a target for the federal funds rate, and then the trading desk at the New York Federal Reserve Bank chooses quantity adjustments to reserves to implement this target. In this sense, we think of the Fed's policy as having the interest rate as a target but using quantities (of money) as the instrument. That is, the interest rate target is a convenient summary statistic to inform the public about what is actually a very complicated state-contingent money growth rule. Central banks in other countries, however, such as Canada, Australia, and New Zealand, seem to use an interest rate desk similar to that in our second interpretation.

In their study of U.S. monetary history, Friedman and Schwartz [1963, Section 10.3] discuss an interesting mid–20th century episode in which the United States seemed to be using the interest rate as an instrument. During that period, that instrument was transparent, but it did not seem to be tight. From August 1945 to August 1948, nominal interest rates were quite low, ranging from 1 percent to 3 percent, while annual inflation was quite high, about 16 percent. (Note that some of this inflation was from the end of wartime price controls.) Friedman and Schwartz argue that during this period, the Fed was following a policy of providing all the high-powered money demanded at a fixed rate, so that the Fed had no direct control over the money supply. In this sense, the interest rate policy was transparent, but it was certainly not tight.

VI. Concluding Remarks

We have shown that transparency is a desirable characteristic for a monetary policy instrument when a government cannot commit to follow a given policy. In such an environment, a transparent instrument has a natural advantage: it gives the public the ability to detect policy deviations, and that ability mitigates the government's credibility problem.

Here we have also shown that a certain price, the exchange rate, has a natural advantage over a certain quantity, the money growth rate, as a monetary policy instrument. A natural question is, does this analysis extend to the relative advantage of another price, the interest rate, over the money growth rate as a monetary policy instrument? As we have discussed, our analysis suggests that the answer depends on how the interest rate is used in the conduct of monetary policy.

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Notes

[1]In assuming that the rate of depreciation of the exchange rate is the instrument of policy, we are allowing for any type of crawling peg in an exchange rate regime. Hence, in no sense are exchange rates necessarily fixed in the exchange rate regime. Moreover, our work here is about the choice of two types of instruments and is silent on any issues concerning the choice of fixed versus flexible exchange rates.

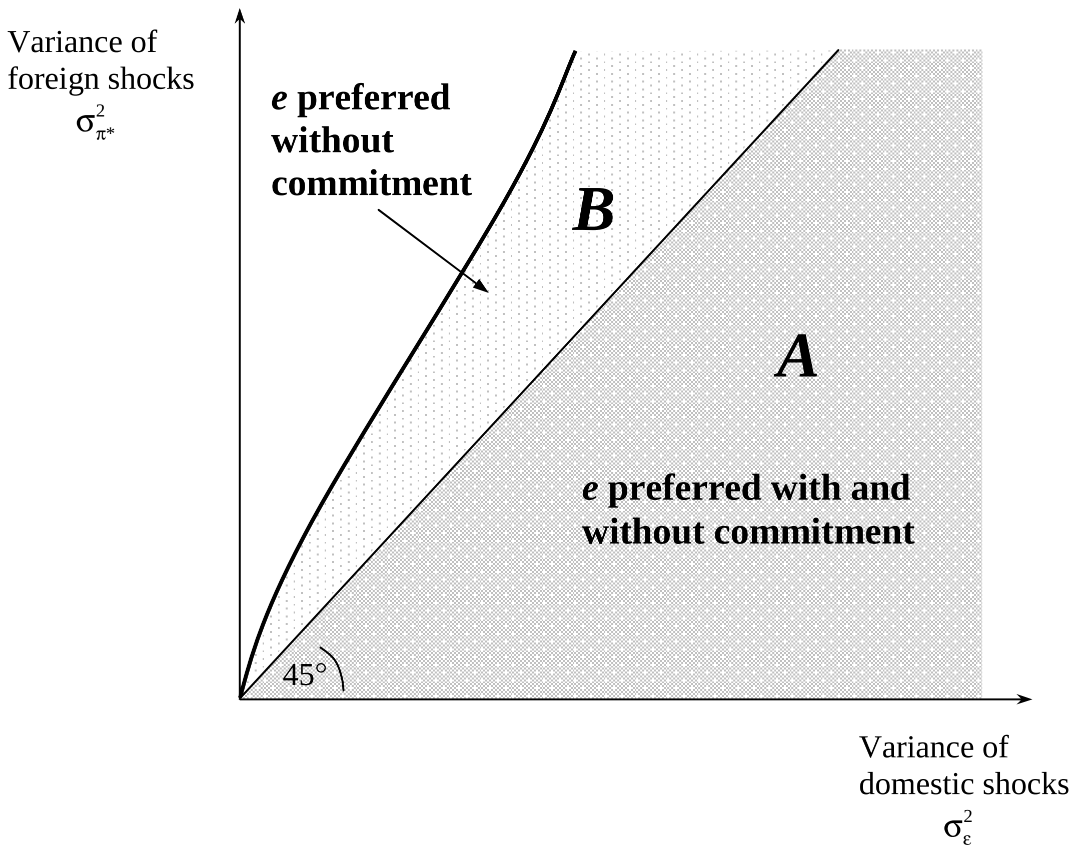
[2]We thank Stokey [2003] for this terminology.

[3]In this regard, our model builds in a stylized way the classic Mundellian tradeoff between using the money growth rate and using the exchange rate as the monetary instrument. For a recent model with such a tradeoff, see the work by Alesina and Barro [2002] on currency unions.

[4]Canzoneri [1985] was the first to use the logic of Green and Porter [1984] to explain periodic bouts of high inflation. See also the work of Zarazaga [1995], who extends this logic, and Albanesi, Chari, and Christiano [2001], who use multiple Markov equilibria to obtain similar outcomes.

[5]A related literature uses signaling models to look at the issue of transparency somewhat differently. Herrendorf [1999] considers an environment with two types of monetary authority: one with and one without a commitment technology. The monetary authority must choose between a transparent fixed exchange rate regime and an opaque floating exchange rate regime. Herrendorf shows that if the public has sufficiently strong beliefs that the monetary authority can commit, then both types choose the fixed exchange rate regime. We think of Herrendorf's model as applying to countries with governments that are likely to have the power to commit and, hence, do not face significant time inconsistency problems in monetary policy. In contrast, we think of our model as applying to countries with governments that have had chronic problems committing to good policies. Canavan and Tommasi [1997] explore a theme similar to that of Herrendorf [1999] in a model with unobserved types that are required to choose linear strategies. For related work in a domestic context, see the analysis of Backus and Driffill [1985].

There is also some work in this literature on the issue of transparency in monetary policy. Cukierman and Meltzer [1986] and Faust and Svensson [2001, 2002] explore linear signaling outcomes in models with unobserved types.



*With commitment, exchange rate regimes are preferred in region *A*, where the variance of domestic inflation shocks is greater than the variance of foreign inflation shocks. With no commitment, exchange rate regimes have an additional advantage; they are preferred in both region *A* and region *B*.

Figure I

Regions for Which an Exchange Rate Regime Is Preferred to a Money Regime With and Without Commitment*

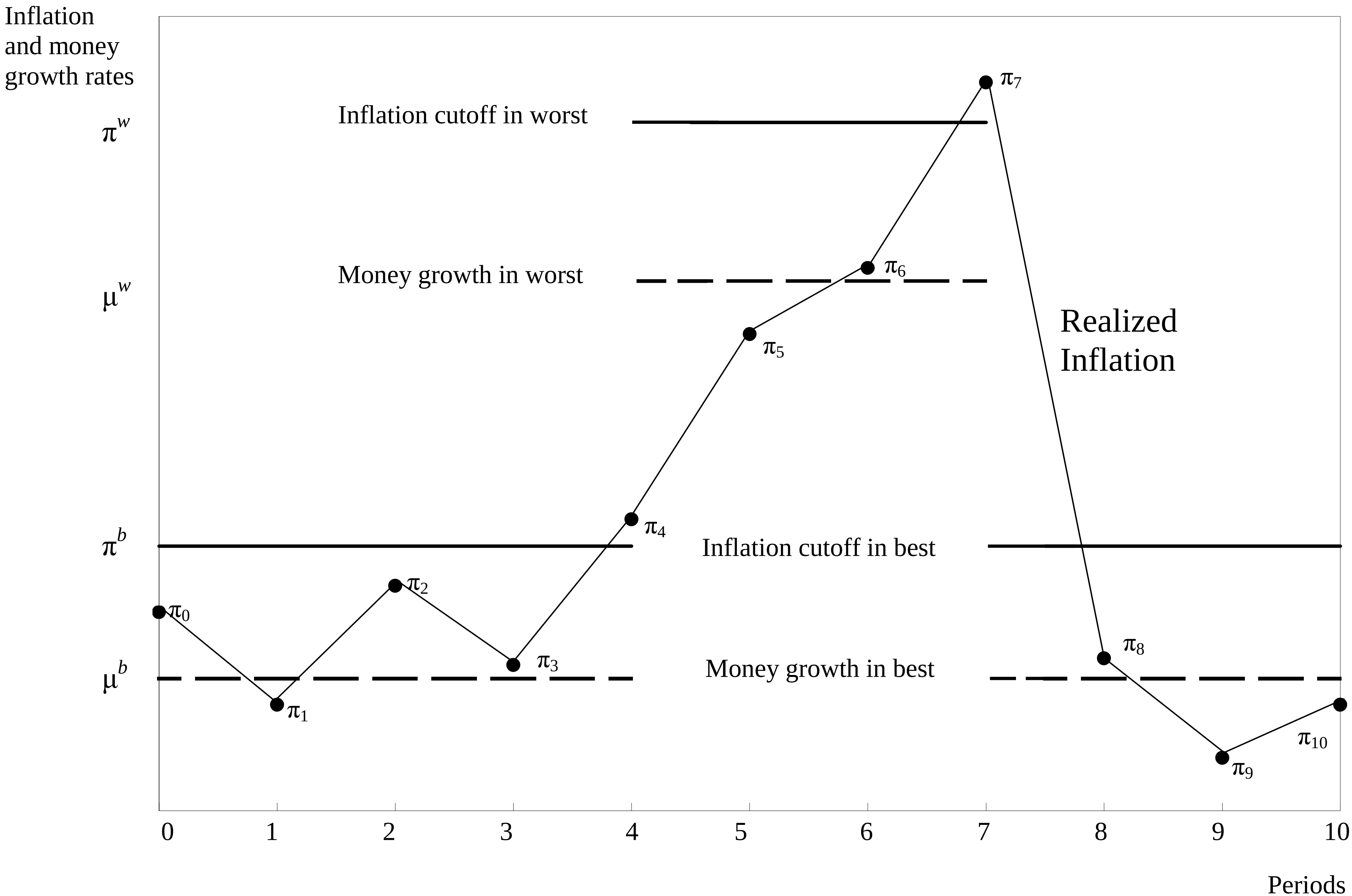
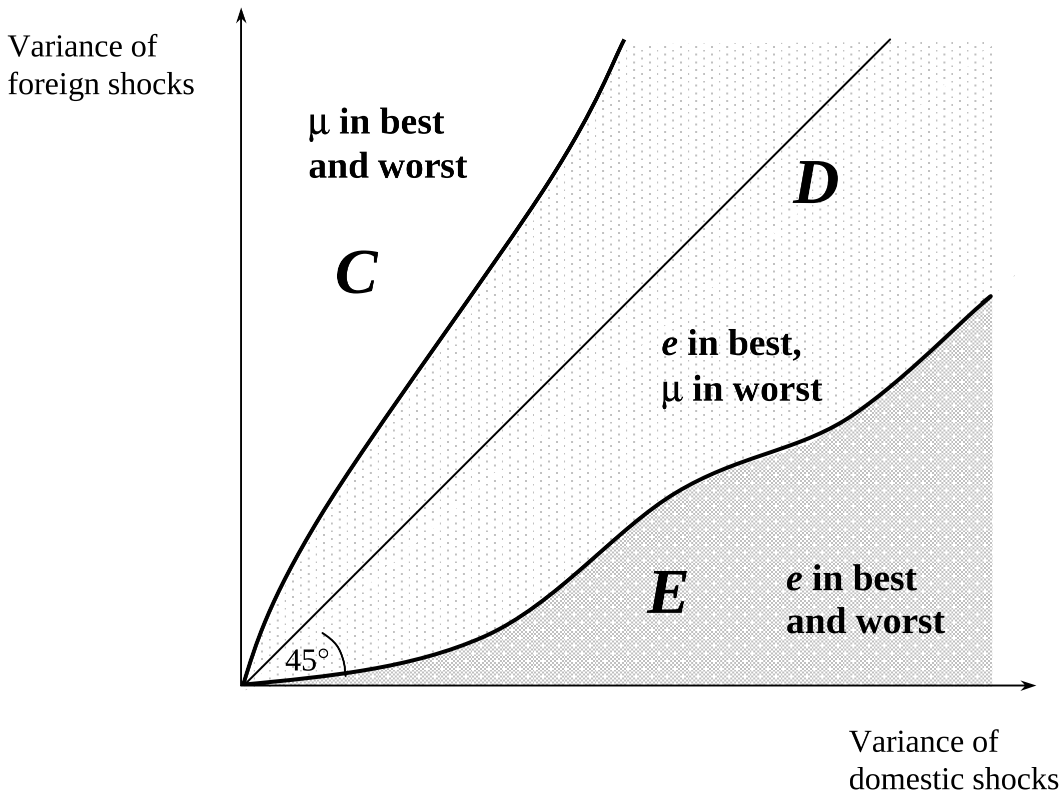


Figure II

A Typical Path of Money Growth and Inflation Outcomes with a Money Regime in the Best and Worst Equilibria



*In region *C*, the money regime is followed in both the best and the worst equilibria. In region *E*, the exchange rate regime is followed in both. In region *D*, the exchange rate regime is followed in the best equilibrium and the money regime, in the worst.

Figure III

Preferred Regimes in the Best and Worst Equilibrium Outcomes