Dynamic Commitment and Incomplete Policy Rules

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DYNAMIC COMMITMENT AND INCOMPLETE POLICY RULES

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ABSTRACT

Considering the dynamics of commitment highlights, some neglected features of time inconsistency problems. We modify the standard rules-versus-discretion question in three ways: (1) A government that does not commit today retains the option to do so tomorrow, (2) the government's commitment capability is restricted to a class of simple rules, and (3) the government's ability to make irrevocable commitments is restricted.

Three results stand out. First, the option to wait makes the incumbent regime (rules or discretion) relatively more attractive. Second, the option to wait means that increased uncertainly makes the incumbent regime more attractive. Third, because the commitment decision takes place in "real time," policy choice displays hysteresis.

KEYWORDS:. Rules, discretion, commitment

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1. Introduction

When monetary policy is subject to dynamic inconsistencies, optimal policy requires some precommitment by the central bank. Despite a proliferation of mechanisms designed to address this problem, work in this area has continued to assume a once-and-for-all-choice between rules and discretion. This paper asks two closely related questions: First, what happens if commitment decisions are made in "real time" so that failure to commit today does not rule out the possibility of commitment tomorrow? Second, if governments can make only commitments that are difficult, but not impossible, to reverse, what determines the dynamics of commitment and reversal?

The assumption of once-and-for-all choice enforces simplistic dynamics on the policy process; if the standard models are interpreted literally, for example, the commitment problem for U.S. monetary policy is moot, having been resolved with the founding of the Fed in 1914, if not at the Constitutional Convention in 1789. Much of the interest in dynamic inconsistency, however, arises precisely because we believe that we still can and, perhaps, should commit to a policy rule, be it zero inflation, a k-percent rule, or a zero tax on capital gains. Once it is admitted that a government that does not commit today retains the capability to commit tomorrow, it immediately brings up both positive and normative questions of timing: When *should* a government commit? Why *did* Canada and New Zealand (for example) adopt price-level rules?

Furthermore, once the timing of commitment is considered, the next step is to realize that governments can rarely, if ever, make fully irrevocable commitments, raising the question of when the government would move from rules back to discretion. Actually implementing a policy rule requires limiting the number of contingencies for the same reasons that private contracts limit the list of contingencies. A government committed to such an incomplete or "simple" rule may then find its rule undesirable in some states and regret its commitment. When is it optimal to renege on that commitment?

In this paper, we analyze these problems using an approach originally developed in the literature on investment under uncertainty. Indeed, many of our results have natural analogues in the "real options" approach to investment, so that choosing discretion today has an option value, in that the government may still choose rules in the future. Careful consideration of this option value provides new insights into the commitment problem and distinguishes our dynamic approach from the more static "escape clause" models such as Flood and Isard (1989) and Lohmann (1992).

The remainder of this paper develops these themes in two main variations. Section 2 briefly reviews the baseline case of the standard, simple model of monetary policy traditional in the time consistency literature. In Section 3 we explore our first variation, dropping the assumption that commitment is a once-and-for-all decision. We trace the consequences when only simple (incomplete) rules are feasible and when choosing discretion today does not rule out choosing commitment in the future. Commitment, however, once made, remains irrevocable. Section 4 removes the rigid and unrealistic assumption that irrevocable commitment is feasible. It provides a general way of thinking about policy, allowing costly commitment with costly reversal. We illustrate how decisions to commit or renege depend on the commitment and reneging costs and on uncertainty in the environment.

Section 5 concludes by emphasizing three general results. First, in the absence of commitment, the option to wait, which we have restored to the policymaker's decision problem, makes discretion relatively more attractive, suggesting a partial explanation for the customary reluctance of policymakers to commit to simple rules. The same logic implies that they will be similarly reluctant to abandon existing rules. Second, the option to wait means that increased uncertainty makes discretion (or a preexisting rule) even more attractive. This is the "bad news principle" of irreversible investment applied in a policy context. Third, by allowing the commitment decision to take place in real time, we note that the policy choice process displays hysteresis; the policy in force at a given time depends on history, not just the prevailing state.

2. Discretion, Simple Rules, and Optimal Rules

Most of the debate about rules versus discretion has taken place in the arena of monetary economics using simple monetary misperceptions models. We continue this tradition, and in this section set out the basic model. Though slightly specialized to highlight the main points, it derives from a fairly general framework based on Flood and Isard (1989). Perhaps because of its simplicity, it remains the standard vehicle for exploring questions about the political economy of discretion and rules (Cho and Sargent, 1996; Jensen, 1997; Svensson, 1997). Before returning to the main focus of the paper, we use the model to highlight the distinctions between monetary policy under optimal rules, simple rules, and discretion.

2.1 Basic Specification

The growth of base money determines the inflation rate, π_t. Output depends on unexpected inflation, which causes output to deviate from a natural level:

$$y_t = \bar{y} + \alpha(\pi_t - \mathrm{E}_{t-1}\pi_t). \tag{1}$$

Because of distortions (for instance, unemployment insurance or efficiency wages, depending on your inclination), $\bar{y}$ may not be socially optimal.

Policymakers wish to minimize a social loss function that reflects both output deviations and inflation:

$$L(u_t) = (\pi_t - \mathrm{E}_{t-1}\pi_t - K + u_t)^2 + a\pi_t^2. \tag{2}$$

The first term reflects output variation around the socially optimal level, with K measuring the average divergence between the natural level of output and the socially optimal level. The innovation u_t, which is i.i.d. with $\mathrm{E}u_t = 0$, is a real shock. The parameter a measures the weight given to inflation relative to output deviations.

2.2 Discretion

Discretion minimizes the loss function, $L(u_t)$, given u_t, and taking expectations as given. The actual and expected values of inflation under discretion are:

$$\pi_t^D = \frac{K}{a} - \frac{u_t}{1+a}. \tag{3}$$

$$\mathrm{E}_{t-1}\pi_t = \mathrm{E}_{t-1}\pi_t = \frac{K}{a} \tag{4}$$

As in Barro and Gordon (1983), the distortion term K determines the inflationary bias of discretion. From this, we can calculate both the expected and realized social loss using equation (2).

$$\text{Realized Loss:} \qquad L^D(u_t) = \frac{1+a}{a}\left[-K + \frac{a}{1+a}u_t\right]^2 \tag{5}$$

$$\text{Expected Loss:} \qquad \mathrm{E}_{t-1}L^D(u_t) = \frac{1+a}{a}K^2 + \frac{a}{1+a}\sigma_u^2 \tag{6}$$

The first term of equation (6) is the loss from the inflation bias of discretion, while the second is the loss caused by output variance, some of which shows up in the inflation rate via monetary policy.

2.3 Rules

We assume that only simple or incomplete (in the sense of incomplete state contingency) rules are available. Suppose inflation, π_t, cannot respond to u_t, thus restricting the policymaker to rules that are not state-contingent. Then money only causes inflation; it cannot reduce output variance. The best such rule sets $\pi_t = 0$

in all periods. This is the optimal rule without state contingency. The simple rule ($\pi_t = 0$) produces

$$\text{Realized Loss:} \qquad L^R(u_t) = (u_t - K)^2 \tag{7}$$

$$\text{Expected Loss:} \qquad \mathrm{E}_{t-1} L^R(u_t) = K^2 + \sigma_u^2 \tag{8}$$

Equations (7) and (8) show that the rule has a lower inflation bias than does discretion, but a higher output variance. If it were feasible, a better rule would let inflation react to productivity shocks, but also avoid the inflationary bias of pure discretion.[1] (The optimal rule is (3) without the intercept.)

Discretion is better than the simple rule (in the current period) when $L^D - L^R < 0$. Substitution from equations (5) and (7) shows that this is the case when

$$u_t^2 > \frac{1+a}{a} K^2. \tag{9}$$

Notice that discretion is preferable in extreme times (that is, for large values of u_t), when the costs of shocks are especially high.

Similarly, as K increases, discretion is preferred in fewer states. As the distortion worsens, the inflation bias rises and it becomes worthwhile to sacrifice discretion in favor of a rule. The relative return to the rule increases because the higher distortion increases the inflation bias.

There is an important distinction between (9) and the traditional evaluation of simple rules relative to discretion (e.g, Alesina, 1988) which compares (6) with (8). The simple rule is better *on average* if

$$\sigma_u^2 < \frac{1+a}{a} K^2. \tag{10}$$

[1] Of course, by phrasing the issue as rules versus discretion, we are implicitly ignoring the interesting possibility of incentive contracts for central bankers (Walsh, 1995). From a normative perspective, such contracts represent a commitment, and are thus subject (broadly) to the analysis we present here. From a positive point of view, we observe that regime shifts and policy commitments are at least as common as central bank salaries that depend explicitly on inflation or unemployment. For an analysis of the problems with such "high-powered" incentive schemes, see Williamson (1985), chapter 6.

This paper is concerned not with whether simple rules are better on average, but with the optimal time to switch. To that end we later assume (10), but *also* that (9) holds for some values of u_t.

3. Waiting to Commit

When possible policy rules are under consideration, the decision to commit is made in real time: a policymaker must decide whether or not to commit now. Previous work has framed the question in terms of which is better on average, omitting the influence of the current state. In this section we analyze the decision to commit in isolation from the possibility that commitment might be reversed in the future. This allows us to illustrate clearly much of the intuition that is more difficult to fix in the more complicated model of the next section.

Adequately capturing irreversibility requires a number of adjustments to the model. First, it clearly needs more than one period. Second, to better focus on the problems of regret, it is also helpful to revise the within-period time structure. In what follows, we let the government observe the shock before the public does and before it chooses to commit. The new time line, which leaves equations (1) - (8) intact, is as follows:

Government sees u_t
→ Government decides whether to commit, announces
→ Economy revises expectations $\mathrm{E}_{t-1}\pi_t$
→ Government chooses π_t
→ Economy sees u_t, production.

As is typical in this class of models, the government has better information about u_t than the public. Some variant of this assumption appears in much of the literature. In Cukierman and Meltzer (1986), for instance, the government has information on a state variable that the public observes one period later. In Canzoneri (1985), the government observes (perhaps noisily) a random disturbance that the public cannot. The additional assumption for our present purposes is that the period t commitment decision takes place after the government observes the shock, but before the government chooses the setting of the policy instrument.

In general, this new timing sequence will change the public's behavior; seeing what action the government takes provides information about the unseen shock to the economy. In our specific model, however, the quadratic loss function and the symmetry of the shocks mean that the public cannot extract useful information from the government's decision to commit or not.[2] People can infer the size, but not the sign, of the shock, so that $\mathrm{E}(u_t|\text{government commitment choice}) = 0$.[3]

Once the government chooses a simple rule, it must stick with that decision forever, in effect setting $\pi_t = 0$ permanently. By contrast, choosing discretion today does not prevent choosing rules tomorrow. Figures 1 and 2 summarize how the structure of the repeated game between the policymaker and the public changes relative to the standard model.

With a simple rule that is not state-contingent, regret exists in some states; discretion might be preferred today, though not on average. For example, the government might regret committing to zero inflation and wish for discretion. This point does not depend merely on the rule's extreme simplicity. The analysis holds even with a more sophisticated state-contingent rule, as long as the rule is incomplete and there are some states in which discretion is preferred. The possibility of regret thus means that irreversibility introduces an option value whose worth is

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[2] The awkwardness of our timing comes from using i.i.d. shocks. If shocks were autocorrelated, a more natural timing convention could be adopted, with commitment for $t+1$ taking place at the end of t, when both the policymaker and the public know u_t and neither knows u_{t+1}. Consequently, the question of whether commitment reveals information would not arise. However, the additional complication of a model in which autocorrelation of innovations plays a meaningful role (that used by Lockwood and Philippopoulos (1994) or Svensson (1997), for example) is unnecessary for our purposes.

[3] Jensen (1997), who faces a similar problem, directly assumes that expectations will not change when the government's choice is observed.

nonnegative.

To rule out reputational equilibria, we restrict ourselves to nonrandomized policies and to those that depend only on today's shock and whether or not the government has committed in the past. The government begins this period by observing u_t. If it chooses to commit to zero inflation (the optimal simple rule), the loss is

$$V^R(u_t) = L^R(u_t) + \beta \mathrm{E} V^R(u_{t+1}), \tag{11}$$

from which we arrive at

$$V^R(u_t) = (u_t - K)^2 + \frac{\beta}{1-\beta}(K^2 + \sigma_u^2). \tag{11'}$$

where V^R denotes the present value of losses under rules (the value function for rules). The first term measures today's loss, and the second gives the expected value of the problem tomorrow. Choosing discretion forever yields a loss of

$$V^{DF}(u_t) = L^D(u_t) + \beta \mathrm{E} V^{DF}(u_{t+1}), \tag{12}$$

or

$$V^{DF}(u_t) = \frac{1+a}{a}\left(\frac{a}{1+a}u_t - K\right)^2 + \frac{\beta}{1-\beta}\left(\frac{1+a}{a}K^2 + \frac{a}{1+a}\sigma_u^2\right). \tag{12'}$$

The standard time consistency literature, making the choice before any shocks are observed, asks whether rules are better than discretion by comparing the expected values of (11′) and (12′).

A real-time choice is more complicated because opting for discretion today leaves the door open for choosing rules tomorrow. The value of discretion today is

$$V^D(u_t) = \min\{L^R(u_t) + \beta \mathrm{E} V^R(u_{t+1}), L^D(u_t) + \beta \mathrm{E} V^D(u_{t+1})\}, \tag{13}$$

where the choice shown in (13) is the Fed's choice between "$R|D$" (commit) and "$D|D$" (do not commit) in Figure 2.

Equations (11) – (13) fit quite naturally into the standard dynamic programming formulation of intertemporal choice problems, but it is important to realize that the structure of our problem differs in an important way from previous work, such as Lohman (1992). In that work the central banker minimizes the expected value of future losses. Equations (11) – (13) add in an additional term, today's loss. This reflects the real-time nature of the decision problem, and allows the possibility of regret.

With a few additional assumptions, this simple model generates some insight into the central issues of regret, option value, and delay. Of course, different parameters can make either an incomplete rule or discretion the better choice, but of interest here is what is unique to our model. To this end, we focus on parameter values for which the standard once and for all choice between a simple rule and discretion would favor rules—equation (10) is satisfied. We show that even under this assumption, the possibility of future commitment can make discretion today preferable. noting the importance of regret in that decision. This increase in the attractiveness of discretion induces the government to choose discretion in more states, a policy shift perhaps best interpreted as a delay in commitment.

To rule out the trivial cases, we also need some "regret," so that simple rules do not dominate discretion in every state of the world. If the loss from rules is less than the loss from discretion in every state, it makes no sense to delay commitment or to choose discretion. To have any regret, it must be that for some (but not all) values of u, (9) holds.

Let u_t be i.i.d. with a continuous density $g(u)$ that is symmetric around 0. Because of the symmetry of L^D, L^R, and g, it is easily shown that the set of states for which the policymaker chooses to commit is symmetric around zero:

$\text{CR} = [-u^c, u^c]$. Notice that rewriting the discretion branch in (13) gives

$$\begin{aligned} L^D(u_t) + \beta \text{E}V^D &= L^D(u_t) + \beta \text{E}\big[\min\{V^R(u_{t+1}),\, V^D(u_{t+1})\}\big] \\ &< L^D(u_t) + \beta \text{E}V^R. \end{aligned} \tag{14}$$

The inequality follows from replacing the minimum with its first argument, and strict inequality from fact that $L^R(u) - L^D(u) \to \infty$, as $|u| \to \infty$ (that is, for large enough u, discretion is better). It follows from (14) that $L^R(u) < L^D(u)$ is necessary to induce commitment when the state is u, otherwise a plan to commit tomorrow with certainty is superior. Therefore if $u^0 > 0$ is where the loss functions cross ($L^D(u^0) = L^R(u^0)$), we have $u^c < u^0$; there are states in which *discretion continues even when the today's loss from discretion exceeds todays loss from rules.* The option of committing in the future makes discretion today more valuable and so rules are chosen in fewer states.

When $\text{CR} = [-u^c, u^c]$ is chosen optimally, the two branches of (13) cross at $\pm u^c$, so

$$0 = [L^D(u) - L^R(u)] + \frac{\beta}{1 - \beta(1 - \Pi^c)} \int_{\mu \in \text{CR}} \left[L^D(\mu) - L^R(\mu)\right] g(\mu)\, d\mu \tag{15}$$

is satisfied at $\pm u^c$, where $\Pi^c = \int_{\mu \in \text{CR}} g(\mu)\, d\mu$ is the probability of commitment.

The first term on the right-hand side of (15) is obviously the current net loss from using discretion. The second term, then, is the option value of discretion. At the optimal u^c, the option value is increasing in β—impatience reduces the value of keeping the option of future discretion alive, so $\partial u^c / \partial \beta < 0$. A mean-preserving spread of g that moves probability mass out of CR and into the tails also increases the value of the option and reduces u^c: Π^c decreases and the weight on values of u_t that favor discretion increases. This is the bad-news principle of irreversible investment applied to policy choice.

Since $u^c < u^0$, the government sometimes chooses discretion in states where the one-period return favors rules, raising the possibility of a degenerate case with

CR = $\emptyset$ (that is, $\Pi^c = 0$). This paradox, whereby we delay choosing rules forever even though we prefer pure rules to pure discretion can be ruled out using equation (13). Suppose the government never commits, so that CR = $\emptyset$. Then (13) reduces to

$$\mathrm{E}V^D = \frac{1}{1-\beta}\mathrm{E}L^D.$$

But from (12), we know that the right-hand side is $\mathrm{E}V^{DF}$. We assumed, however, that discretion forever is worse than rules. The fact that $\Pi^c > 0$ also implies that the government eventually commits with probability 1.[4]

3.1 Numerical Example

While our numerical example cannot be called a test, or even a calibration exercise, we try to use plausible values for the effect of unanticipated money and the distribution of output shocks. First differences of log GDP look somewhat like a standard normal. We therefore assume that u_t is drawn from a discrete distribution that approximates a normal.[5] We choose a K value of 1.0, indicating that long-run output differs from the socially optimal level by 1.0 percent. Following Barro (1987, p. 469), we assume that a 1 percent rise in money above expectations increases output by 1 percent. Next, set β, the discount factor, to 0.95; we think of the policymaker as choosing between rules and discretion once a year. Finally, we set $a = 2$.

Figure 3 shows the results of this example using these parameters. The top panel plots the difference between $V^R(u)$ and $V^D(u)$, or between the value of committing to rules and adopting discretion in a given state. Since we use a loss function, a positive value means discretion is better, and a negative value means

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[4] For a very different view of commitment problems using similar stochastic commitment techniques, see Roberds (1987).

[5] For details, see Section 4.2, where we describe how to solve a more general model that encompasses this one.

rules are better.

Notice that for a u shock between -1.02 and $+1.02$, the present value loss from discretion exceeds that from rules. Consequently, the monetary authority should commit to rules. For larger shocks, the monetary authority should choose discretion; 30.1 percent of the time, discretion is preferable to rules.

There are really two vantage points on these numbers. One stresses the large number of states where the government prefers discretion. The bottom panel shows the importance of considering option value. If we compare using rules forever with using discretion forever, we would choose rules in every state. The possibility of future commitment and its associated option value changes discretion from a dominated policy to one preferred in nearly a third of states.

Another perspective is the "delay probability," or the expected time until a commitment is made. For example, decisions are taken annually, the probability that the policymaker will go five years without committing to rules is $(0.301)^5 \approx 0.0025$. To illustrate the bad news principle, we increased the variance of the distribution by ten percent. The commitment region shrinks to the range of -0.957 to $+0.957$, so that rules are adopted only 64.6 percent of the time. The probability of delaying for five years rises to 0.0055.

Intuition might suggest that the introduction of serial correlation in u_t would partly reconcile the two viewpoints because the economy might remain for a long time in states where discretion is preferred. However, the underlying model here (a Lucas aggregate supply curve) does not allow monetary policy to provide more than a short-run offset to persistent deviations from $u_t = 0$. In an application where discretion continues to be beneficial for as long as u_t is far from zero, the intuition is in fact correct (Haubrich and Ritter, 1995).

4. Entering and Exiting Commitment

So far we have allowed only inescapable commitment. McCallum (1995) and others have emphasized the impossibility of inescapable commitment by sovereign authority. This calls for a more sophisticated approach to modeling commitment, but not an abandonment of the insights generated by the time inconsistency literature.

Although mechanisms allowing governments to commit irrevocably are almost impossible to imagine, it is not difficult to think of mechanisms that make it costly for a government to alter its policy. A constitutional amendment, for example, is difficult to put into place and difficult to repeal. Ordinary legislation has lower costs at both ends. Governments can, in effect, tie their hands loosely or tightly, but can always escape, if they have the will to bear the corresponding levels of pain. In this section we allow the policymaker to enter and exit commitment, but impose costs at both ends. We stop short of modelling the policymakers choice of commitment mechanism, which would take us far afield.

It is important to understand that the possibility of reneging on commitment does not make "commitment" a vacuous concept. First, in simply mechanical terms, the model forces commitment to remain in place for at least one period; it is impossible to "fool" the public by announcing a commitment that will never bite. More importantly, reneging is costly, both because of the direct cost we impose, and because the direct cost of *committing*—should that become desirable once again—imparts an option value to continuing the rule.[6]

We maintain the traditional semantics of commitment and discretion, but we wish to highlight a bias in tone that creeps into the discussion when commitment

[6] This does not exclude the possibility that the commitment cost may be some sort of bond posted for credibility. But the foregoing analysis does say that if another commitment technology exists that does not require such a costly bond, it benefits the economy.

is not irrevocable. This innovation forces us into the use of words like "renege" and "weasel" with clear negative connotations which we regard as unfortunate. (The latter term proves notationally convenient, as we have already reserved 'R' to denote rules.) We interpret the results of this section as a model of optimal behavior and tolerate the terminology only to fit our paper into the literature on rules and discretion.

Thinking about the problem as entering or exiting commitment deepens the analogy to irreversible investment. Our extended model now resembles Dixit's (1989) model of firm entry and exit. For these kinds of questions, the continuous time approach generally proves more convenient, but the unanticipated money model does not easily generalize to continuous time. Fortunately, the discrete time approach, though less elegant, suffices here. In this we follow Lambson (1992) who used discrete time to model entry-exit decisions.

4.1 The Model with Commitment and Reneging Costs

We modify the model of Section 3 by adding costs for entering and exiting commitment.[7] A policymaker committing to rules in period t pays a cost C. Once committed, a policymaker may renege or "weasel out of" rules and return to discretion by paying cost W. The structure of the model is shown in Figure 4. Mathematically, the problem is to find the boundaries where the policymaker switches between discretion and rules. The model produces four boundaries: an upper and a lower boundary for moving from discretion to rules, and an upper and a lower boundary for moving from rules to discretion. With i.i.d. shocks, the zero mean of

[7] Allowing the policymaker to exit commitment adds a component similar to the "escape clause" models of Flood and Isard (1988) and Lohman (1992). In one sense we generalize those models by allowing a positive cost of recommitment and allowing delay in recommitment. In another sense, those models are more general in that they use more general state contingent rules. Such rules can be embedded in our dynamic framework. We consider simple rules in order to focus on the dynamics. We discuss this more fully in section 4.5.

u_t and the quadratic loss function again conspire to produce boundaries centered on zero. As before, the current losses from discretion exceed those for the rule when the shocks are small, while losses from the rule are larger when shocks are large. This means that the policymaker will tend to prefer discretion when the shock is large and rules when it is small. The interesting part of the solution is the intermediate area.

The problems to be solved by the policymaker when discretion and rules, respectively, are in place are:

$$V^D(u_t) = \min\left\{L^D(u_t) + \beta \mathrm{E}V^D,\ C + L^R(u_t) + \beta \mathrm{E}V^R\right\}$$

$$V^R(u_t) = \min\left\{L^R(u_t) + \beta \mathrm{E}V^R,\ W + L^D(u_t) + \beta \mathrm{E}V^D\right\}.$$

The minimum is taken over the actions "don't commit" and "commit" in the first case and "don't renege" or "renege" in the second case.

As in the previous section, let CR be the set of states that induce the policymaker to commit to the rule. CR is either an interval, $[-u^c, u^c]$, or $\emptyset$. Let RR $= [-u^w, u^w]$ be the set of states for which policymakers *retain* the rule (that is, they renege if $|u_t| > u^w$). If C is too large, we may have CR $= \emptyset$; the option to commit is worthless if its exercise price is too high. Thus positive commitment cost destroys the result that commitment will happen in finite time with probability one.

Suppose instead that CR $\neq \emptyset$. We must have $u^w > u^c$ so that CR $\subset$ RR, otherwise some states induce commitment that is immediately regretted. Furthermore, we must have $u^w > u^0 > u^c$. To see this, first suppose that $u^c \geq u^0$. Then $L^R(u^c) \geq L^D(u^c)$. A policymaker facing $u_t = u^c$ would be made better off by planning to commit with certainty in $t+1$, thus reducing the current loss (or not increasing it, if $u^c = u^0$) and delaying payment of the commitment cost C. Since this alternate plan is feasible, $u^c \geq u^0$ cannot be optimal. If $u^w \leq u^0$, the policymaker currently using the rule and now facing $u_t = u^w$ would similarly prefer delay.

Were there no cost of switching between regimes, the boundaries would coincide, with $u^w = u^c = u^0$. Adding commitment and weasel costs drives a wedge between the two regimes. The policymaker can only be induced to commit, liquidating the option to retain discretion, by a strictly *negative* difference $L^R(u^c) - L^D(u^c)$. This means moving u^c farther into the area where rules are better, that is, closer to zero. Similarly, a cost to backing out of rules means shifting u^w into the area where discretion has lower cost, that is, away from zero.

4.2 Numerical Solution

To solve the model with switching costs we use a discrete state space approach. The shock is drawn from a distribution with n states μ_i. The probability of state i is

$$g_i = \begin{cases} \Phi(\mu_i), & i = 1 \\ \Phi(\mu_i) - \Phi(\mu_{i-1}), & 1 < i < n \\ 1 - \Phi(\mu_{n-1}), & i = n \end{cases}$$

where Φ is the normal cumulative density function with mean 0 and variance σ_u^2. We set the range of possible states to include $6\sigma_u^2$ on each side of 0.

The policymaker is faced with a problem that has two state variables, the current policy regime (rules or discretion) and u_t. Thus the value function for this problem is an $n \times 2$ matrix, where the columns correspond to rules and discretion. Denote the columns by V^D and V^R. To solve the model we choose an initial value function and iterate on the following mappings:

$$V^D(\mu_i) = \min\left\{L^D(\mu_i) + \beta\sum_{j=1}^{n} g_j V^D(\mu_j),\ C + L^R(\mu_i) + \beta\sum_{j=1}^{n} g_j V^R(\mu_j)\right\}$$

$$V^R(\mu_i) = \min\left\{L^R(\mu_i) + \beta\sum_{j=1}^{n} g_j V^R(\mu_j),\ W + L^D(\mu_i) + \beta\sum_{j=1}^{n} g_j V^D(\mu_j)\right\}.$$

The minimum is taken over the actions "don't commit" and "commit" in the first case and "don't renege" or "renege" in the second case.

Since the distribution of u_t is discrete, the following rules determine the regime switching points. The upper commitment boundary u^c is the largest μ such that

$$V^R(\mu) + C \leq V^D(\mu).$$

The lower commitment boundary $-u^c$ is the smallest μ such that

$$V^R(\mu) + C \leq V^D(\mu).$$

The upper weasel boundary u^w is the smallest μ such that

$$V^D(\mu) + W \leq V^R(\mu).$$

The lower weasel boundary $-u^w$ is the largest μ such that

$$V^D(\mu) + W \leq V^R(\mu).$$

To solve the model in the case of Section 3 (irrevocable commitment at zero cost), we set C to zero and W to an extremely large number.

Starting from a baseline of: $K = 1$, $a = 2$, $\sigma_u = 1$, $C = W = 1$, and $\beta = 0.95$, Figures 6 to 8 depict the solutions as we vary parameters one at a time. The state space has 401 nodes evenly distributed from $-6\sigma_u^2$ to $+6\sigma_u^2$. Before varying parameters, however, it is useful to examine the baseline solution in detail.

4.3 Regime Switching

Figure 5 shows one sample path using baseline parameter values. The shading highlights the periods when the policymaker is using discretion. Figure 5 highlights a key point: the importance of history. Because the commitment and weasel boundaries differ, in some states of the economy (levels of u) current policy depends on past policy. For anything above u^c and below u^w, a policymaker committed to rules sticks with rules and a policymaker using discretion sticks with discretion. Quite apparently, then, the current policy differs from past optimal policies at a similar state of the economy or stage of the business cycle. In a word, our model predicts hysteresis in monetary policy.

Implicit in the hysteresis is something so obvious as to possibly escape attention: The policymaker switches from rules to discretion, and from discretion to rules, over time. Regimes shift. Discretion, commitment, and reneging, will all occur. This shifting reemphasizes a point stressed by Flood and Garber (1984) in their work on the gold standard: to evaluate a policy rule, the entire dynamic policy sequence must be analyzed, including those periods where discretion reigns.

Discretion is relatively rare and short-lived in Figure 5 because u_t is not autocorrelated, and Prob$[|u_t| \geq u^w]$ is small while Prob$[|u_t| \leq u^c]$ is relatively large. As mentioned above, there is not much to be gained by adding autocorrelation to a simple unanticipated money model.

A model with stronger propagation mechanisms would result in longer periods of discretion, however. If such a model changed the timing convention to put the commitment/renege choice at the end of the period when u_t is known to all (see footnote 2), the current loss would already be in the past when the regime choice is made, but u_t would tell the policymaker something about u_{t+1}, so (13) would look like

$$V^D(u_t) = \min\{\mathrm{E}V^R(u_{t+1}|u_t), \mathrm{E}V^D(u_{t+1}|u_t)\}.$$

Note that even though the current loss no longer appears, the decision would still depend on u_t, so it is still important that the decision is made in real time.

4.4 Parameter Variation

Figure 6 plots the commitment and reneging (weasel) thresholds $\pm u^c$ and $\pm u^w$ as the commitment cost C changes, keeping $W = 1$. The probability of being outside the area where rules are better for the current period does not change as C

increases. Thus as the cost of committing to rules increases, the range over which the policymaker is willing to commit shrinks. As we mentioned above, it disappears altogether if C is high enough.

Not surprisingly, as W increases, the weasel boundaries ($\pm u^w$) move out, as Figure 7 demonstrates. It is somewhat more surprising that the commitment boundaries are insensitive to W. This is because eventually crossing $\pm u^w$ is a low probability event which therefore has little impact on the decision to commit.[8]

As shown in Figure 8, increasing the variance of the shocks σ_u^2 causes the policymaker to narrow the commitment ranges because it lowers the probability that later periods' shocks will fall in the range where the rules loss is less than the discretion loss and thus increases the value of the waiting option. Two things can happen (depending on parameter values) when the variance gets large: (1) Rules may suddenly become inferior to discretion forever, meaning the commitment range CR collapses to $\emptyset$, or (2) the commitment range gradually disappears. We show the latter case in Figure 8. The weasel boundaries tend to be relatively insensitive to changes in the variance mostly because reneging is a low-probability event.

4.5 Dynamics and Complex Rules

Most observers would take regime shifts in monetary policy as a fact of life, even without formal econometric evidence of the sort provided by Evans and Wachtel (1993). Our model interprets these as shifts between rules and discretion, but another interpretation interprets them as state-contingent rules with "opt-out" clauses. The two approaches are hard to distinguish at some level, in that a fully state-contingent rule depending on the entire past history of outcomes can replicate any dynamic strategy. But we argue in this section that our "commit and renege"

[8] The commitment boundaries are completely flat in the figure only because the state space is not fine enough; the commitment boundaries narrow slightly with a very fine state space.

interpretation offers a complementary, and sometimes more natural explanation of the facts.

For example, Bordo and Kydland (1995), interpret the gold standard as a rule containing contingencies in cases of wars and financial panics. Even with such contingencies, they recognize the possibility of regret, because a fully contingent rule would create "a lack of transparency and possible uncertainty among the public regarding the will to obey the original plan." One advantage of a simple rule like Bordo and Kydland's interpretation of the gold standard is that the contingencies—wars and financial panics—are readily verified. This makes credible commitment easier. A complicated rule may lose some of the benefits of commitment because it is more costly to verify the government's compliance.

In our framework, the gold standard can have two slightly different interpretations. Because the gold standard did not bind the hands of governments during times of war, these could be seen as times when the government abandoned the rule in favor of discretion, returning to rules with the resumption of convertibility. Our own view is that the lack of constraints during war suggests the abandonment of a standard, and thus to the sort of entry and exit considerations we have analyzed in this paper. Thus, it seems more natural to explain the Resumption Act of 1875, which committed the U.S. to return to the gold standard by 1879, as returning to the rule of the gold standard after the discretion of the Civil War.

Alternatively, the gold standard may be seen as an imperfectly state-contingent rule that has been abandoned in favor of discretion since the advent of the Bretton Woods system after the second World War.

A more modern example is the Reserve Bank of New Zealand Act, which instructs the central bank to provide for "stability in the general level of prices." Section 12, however, gives the Treasury an override provision, a clear case of an opt-out provision. Still, it would be be straining the meaning of state contingency to explain New Zealand's Act of 1989 or Canada's adoption of explicit inflation targets in December of 1993 as provisions of a long extant policy plan, rather than as commitment in real time.

A slightly different example, emphasizing the hysteresis aspect, is the Volcker disinflation of 1979-1982. It took fairly high inflation levels—nearly 9 percent during 1978, for example—to produce the shift to disinflation and monetary targeting, but the policy did not stop once inflation was brought just below those levels, but instead continued until price increases had stabilized at much lower level of around 4 percent in 1982. This sort of hysteresis is just the sort predicted by our model, and the sort not predicted by current escape clause models, which do not include the option value of waiting.

5. Conclusion

Sometimes, the right answer is inherent in asking the right question. The standard analysis of the choice between rules and discretion, however, has not asked the right question. The decision regarding rules versus discretion takes place in real time, not at some mythical starting date. That means the state of the economy today matters for the choice between rules and discretion. Federal Reserve Governor Martha Seger expressed this point at a Federal Open Market Committee meeting in February of 1990: "Congressman Neal may still be holding hearings on the need for zero inflation but 434 other people in Congress in the House and 100 people in the Senate are going to be dragging us down there to explain why in an election year they're facing rising amounts of unemployment back in their districts." The real-time aspect of the choice of policy-regime means that opting for discretion today leaves open the possibility of adopting rules later on, making discretion often the better choice. Previous work, by ignoring this option, has ignored an important advantage of discretion. Rules in place have an analogous advantage over discretion.

The option to wait, like other options, increases in value as uncertainty increases—and so the value of discretion (or existing rules) increases as well. Policy, then, has a "bad news principle" because the ability to avoid regret leads policymakers to wait, either to commit or to renege. But while the option-value perspective may explain delay and refusal to adopt simple monetary targets or tax reforms during recessions or wars, option values do not generally justify permanently abandoning such rules. Eventually, when the time is right, the government should commit—at least for a while.

With commitment to rules no longer an irrevocable choice made at the beginning of time, optimal policy looks more dynamic. Periods of rules alternate with periods of discretion, depending both on the state and history of the economy. Policy at a given point in the business cycle may look quite different from policy at a similar point in an earlier cycle. Such seeming confusion may nevertheless reflect a coherent, optimal, policy choice.

In principle, the notion of commitment as irreversible investment can be applied to other areas, such as tariff agreements, deficit reduction, or tort reform. We take up a broader range of applications in another paper (Haubrich and Ritter, 1995). This work complements recent studies focusing on the political economy of resistance to reforms (Fernandez and Rodrick, 1991), as well as on the delay in their implementation (Alesina and Drazen, 1991). Our approach emphasizes delay and resistance as an optimal response to an uncertain future. It also suggests the possibility of hysteresis as a result of optimal policy choice.

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Figure 1

One-Time Choice of Irreversible Policy Rules in $t = 0$

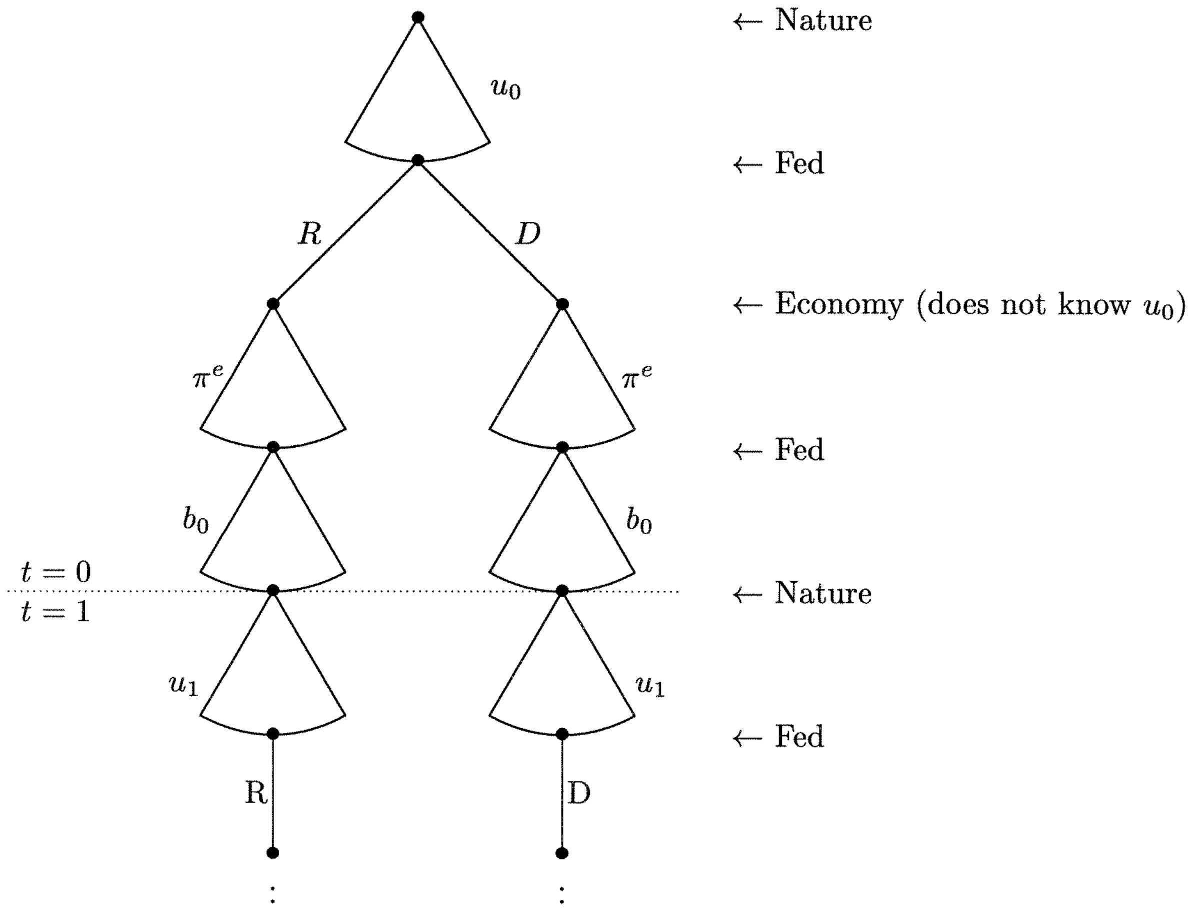
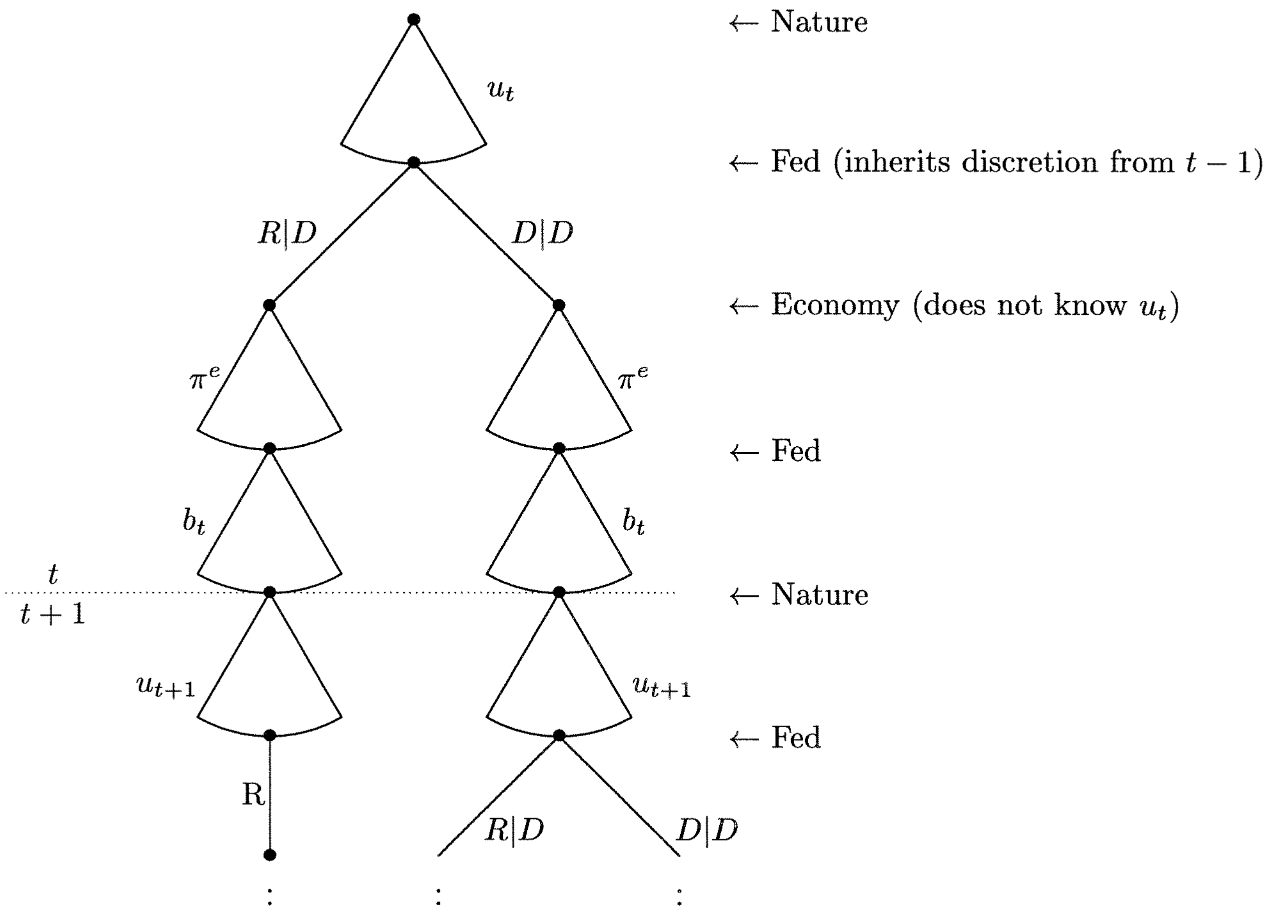


Figure 2

Irreversible Policy Rules in Real Time



$R|D =$ choose rules given discretion now (commit).
$D|D =$ choose discretion given discretion now (do not commit).

Figure 3

Discretion with and without an Option to Wait

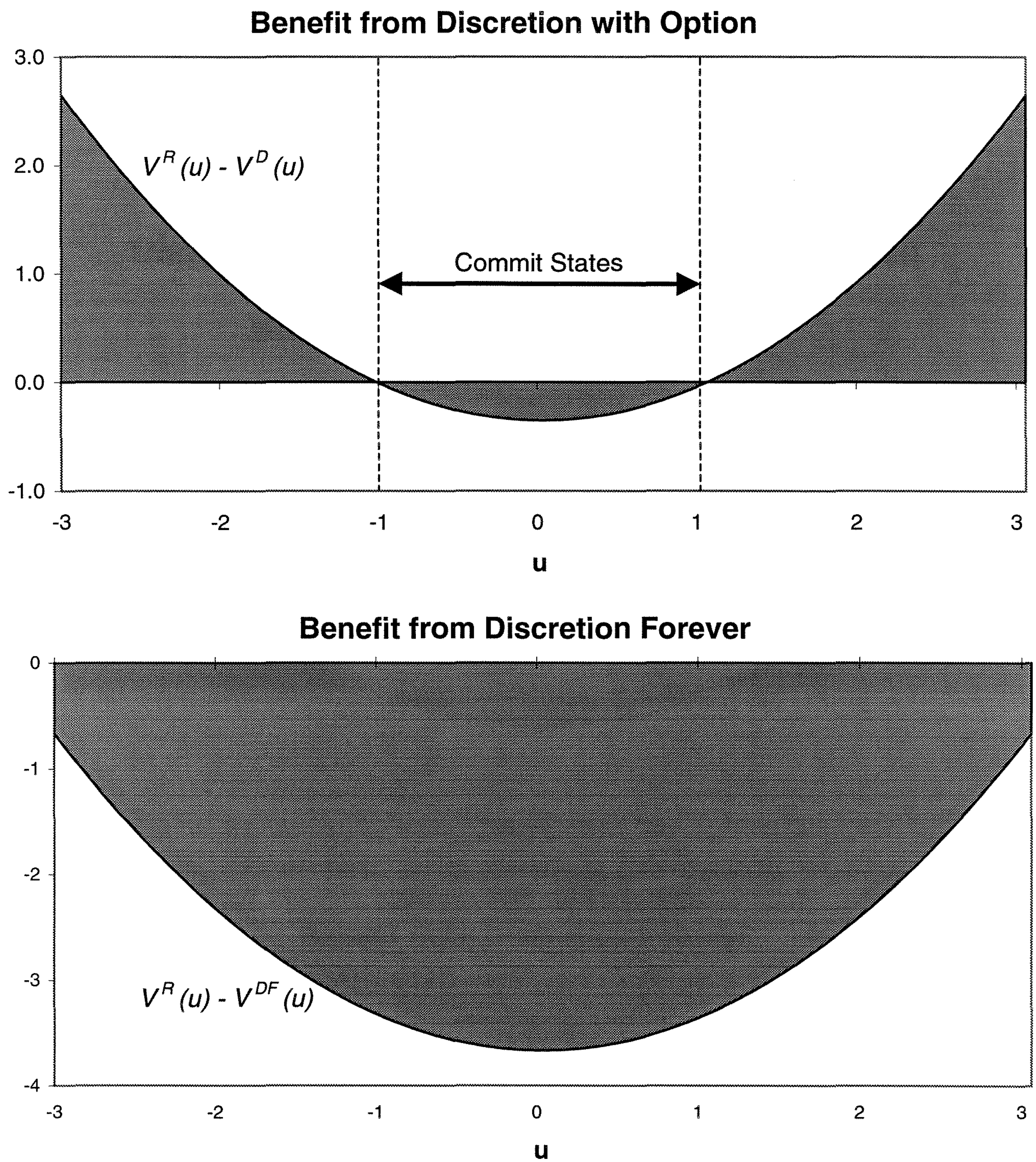
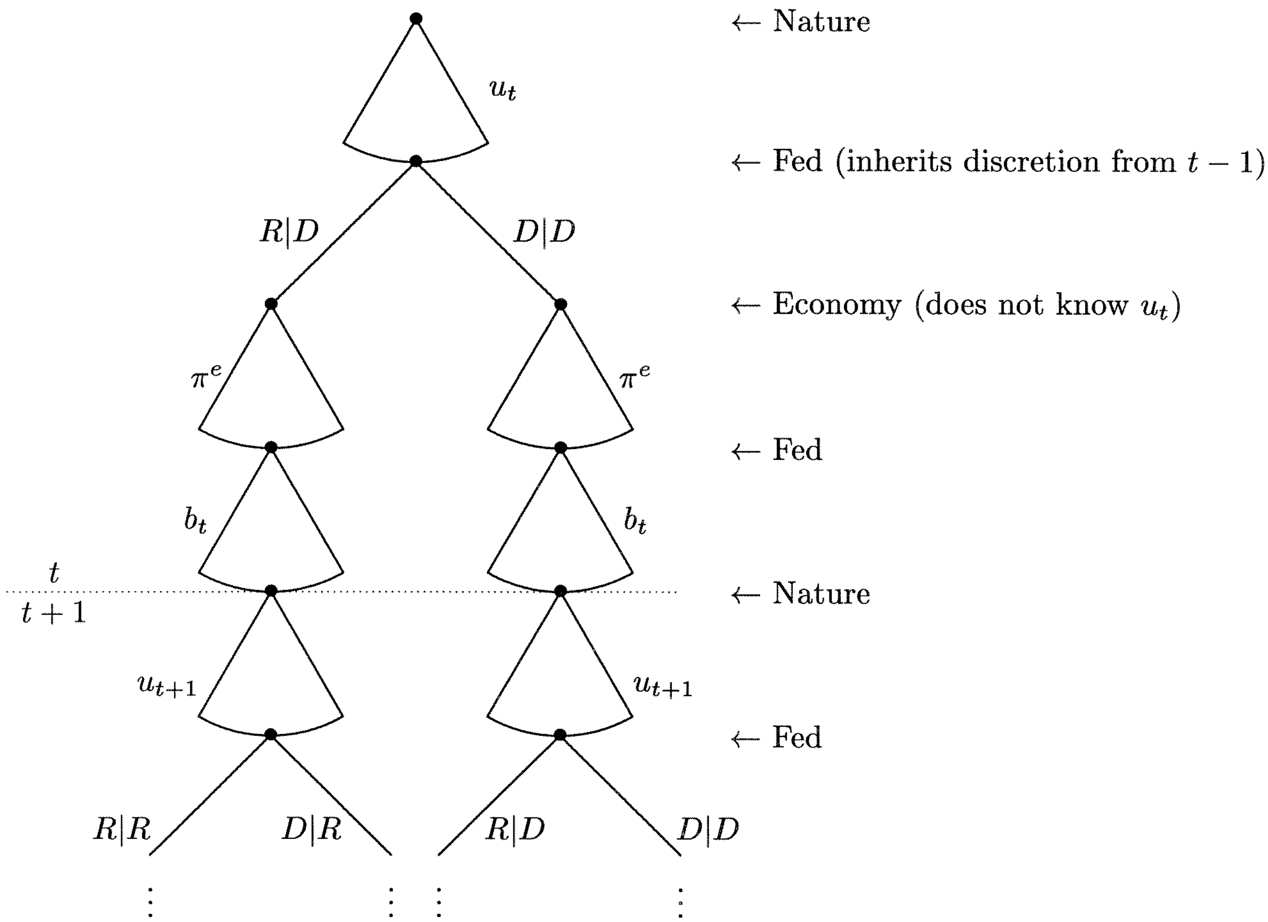


Figure 4

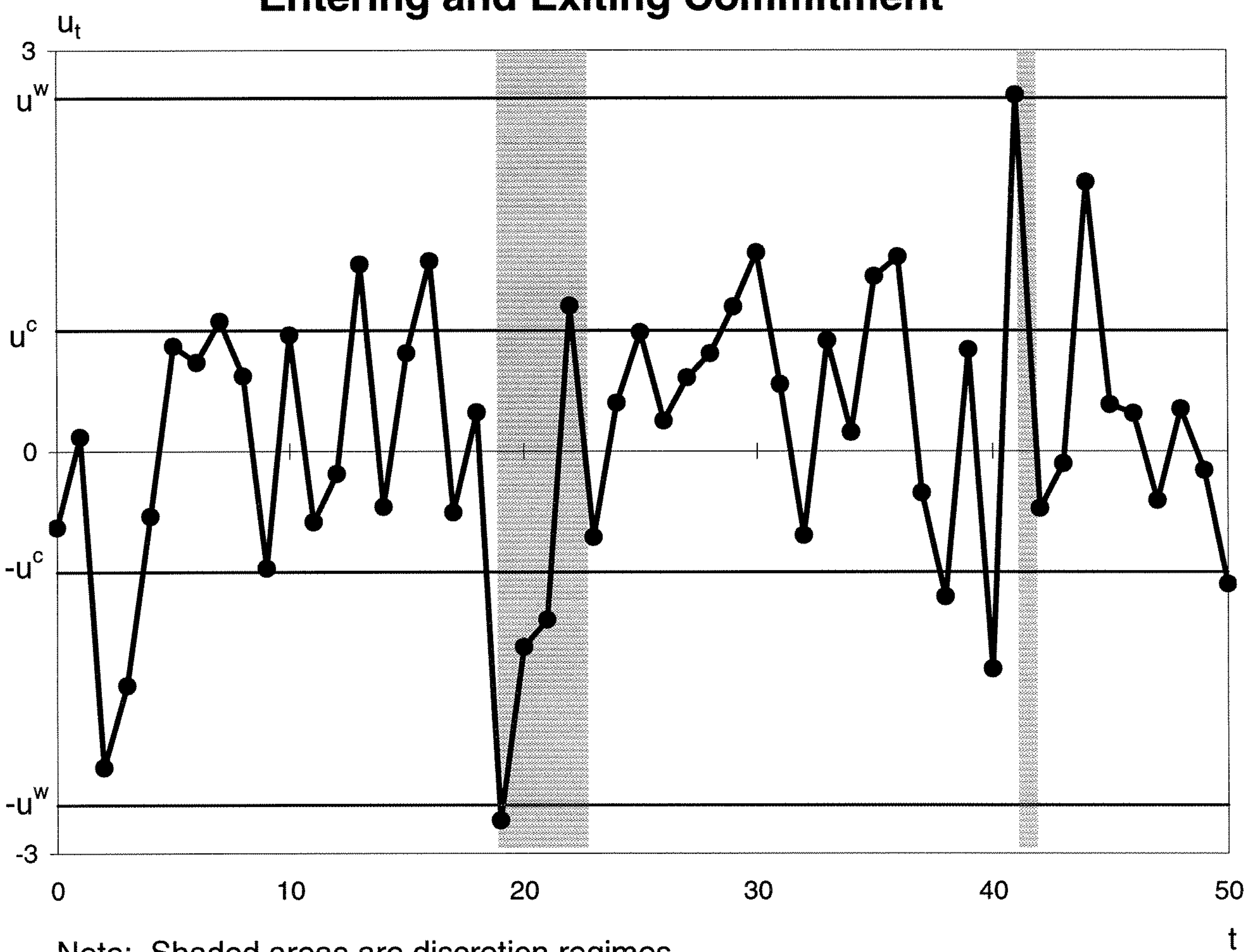
Reversible Policy Rules



$R|D$ = choose rules given discretion now (commit).
$D|D$ = choose discretion given discretion now (do not commit).
$D|R$ = choose discretion given rules now (renege).
$R|R$ = choose rules given rules now (do not renege).

Figure 5

Entering and Exiting Commitment



Note: Shaded areas are discretion regimes.

Figure 6

Effect of Commitment Cost Changes

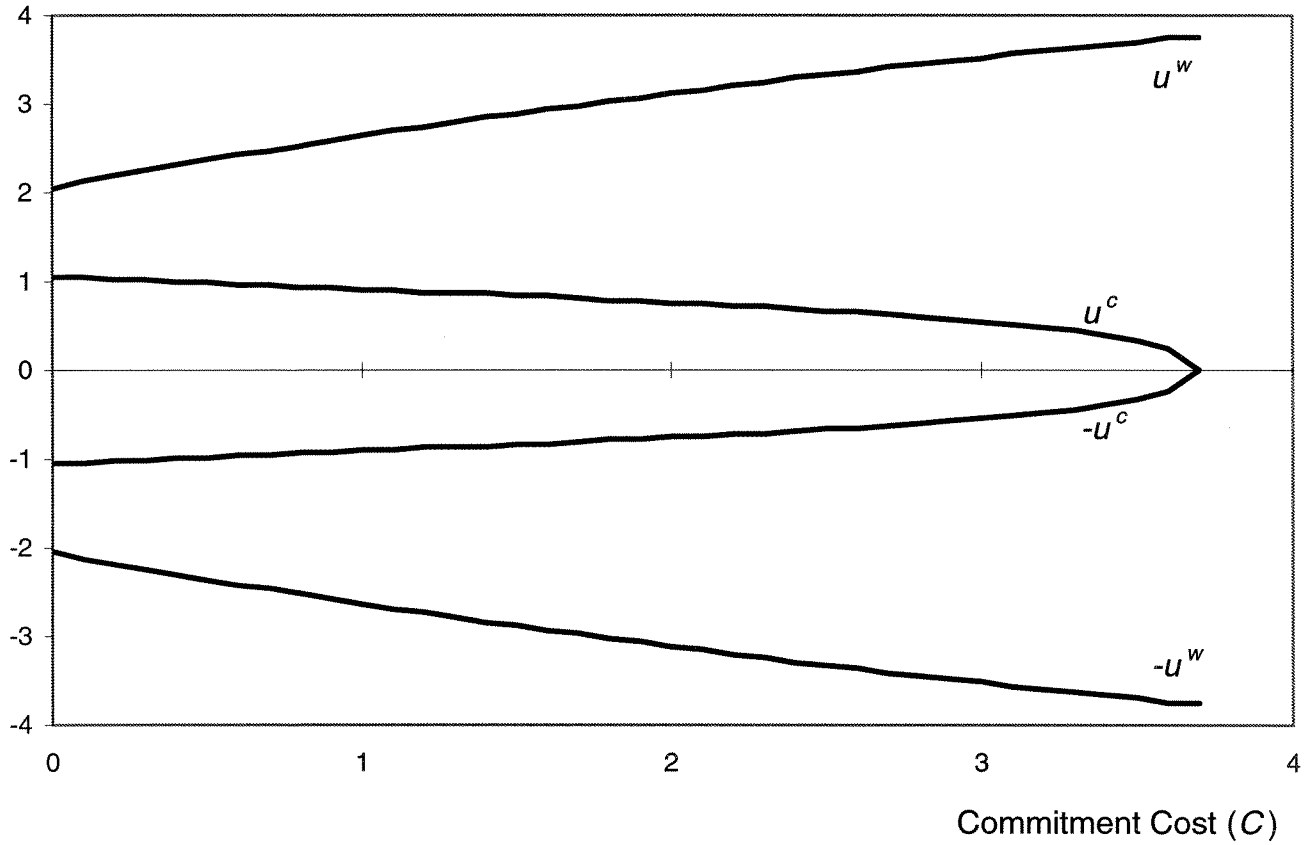


Figure 7
Effect of Reneging Cost Changes

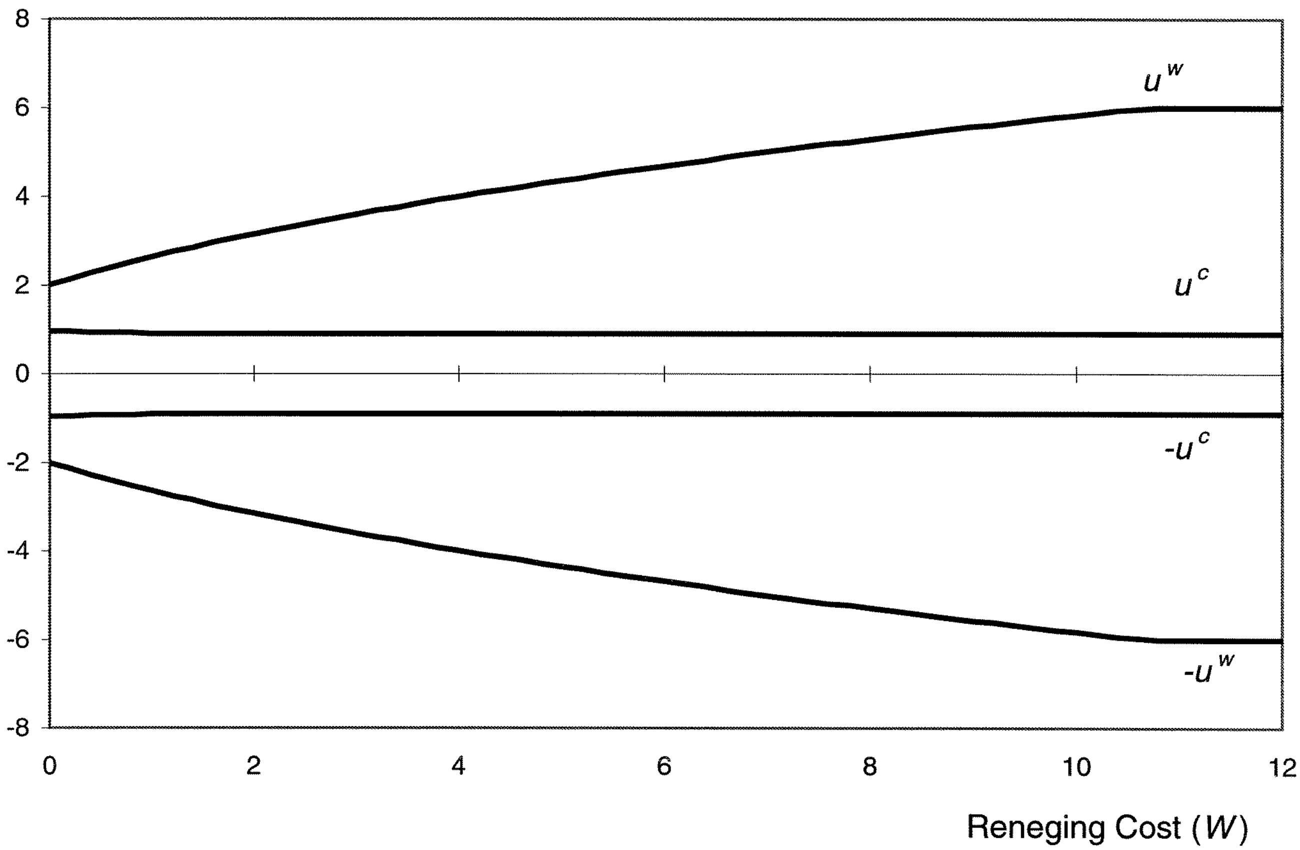


Figure 8
Effect of Variance Changes