

Optimal accommodation by strong policymakers under incomplete information*

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This paper examines the optimal behavior of a policymaker who is able to precommit (labelled 'strong') when the public entertains the possibility that he is either strong or weak (unable to precommit). The main result is that, in the presence of doubts about their type, it is optimal, even for strong policymakers, to partially accommodate inflationary expectations. This contrasts with Vickers (1986) who finds that when strength is conceived in terms of the relative concern for employment the strong policymaker inflates less under incomplete than under full information. The paper also provides a theory of endogenous announcements.

1. Introduction

It is well known, by now, that when policymakers lack the ability to precommit their actions, the rate of inflation is higher than its socially optimal level [Kydland and Prescott (1977), Barro and Gordon (1983)]. The problem arises because the tradeoffs faced by policymakers change before and after inflationary expectations (or nominal contracts) have been set. Before the setting of expectations, the policymaker is motivated to announce

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the optimal (zero) rate of inflation. However, once expectations have been set, he picks a discretionary (positive) rate. When policymakers possess the ability to precommit their actions prior to the setting of expectations, and the public is aware of this fact, the problem disappears. Prior to the setting of expectations, the policymaker possesses the correct incentives. He, therefore, credibly commits to the socially optimal low inflation, as a result of which both inflation and inflationary expectations remain at their low optimal levels.

As stressed in Barro's (1986) important paper, the problem partially reappears when the public is not perfectly informed about the precommitment ability of policymakers and horizons are finite. In such cases, policymakers lacking the ability to precommit (referred to as 'weak') have an incentive to emulate the behavior of policymakers able to precommit (referred to as 'dependable' or 'strong') for a while. But as time goes by and the policymaker approaches the end of his fixed horizon, the weak policymaker is more and more likely to revert to the suboptimal discretionary rate of inflation.

In spite of the social cost generated by the negative surprise inflation, the strong policymaker, as described in Barro (1986) and related papers, continues to adhere stubbornly to the zero inflation policy. Such behavior is unreasonable on theoretical grounds and inconsistent with many practical examples. At the applied level, we often observe that in disinflation programs even dependable policymakers compromise their ideal targets of full stability in order to avoid excessive costs in terms of unemployment. At the theoretical level, the adherence by the dependable policymaker to a zero-inflation target is deficient because it does not enable him to strike the right balance between the advantages of low inflation and the social cost generated by credibility problems.

Barro actually recognizes the difficulty with the zero-inflation rate. Thus, he states that 'zero inflation is optimal ... if commitments are not only made but are also believed. In the present context credibility is tempered by the possibility that the policymaker is type 2 (i.e., weak). In this case the best value to commit need no longer be zero inflation. ... However, I have not made much progress in figuring out the properties of the resulting path of π_t^* (i.e., the inflation set by the strong policymaker)' [Barro (1986, p. 17)].

This paper proposes a resolution to this problem by allowing the strong policymaker to react optimally to adverse expectations. As expected, this induces him to compromise on his full-information target of zero inflation. The degree of accommodation by the strong policymaker depends on his credibility. In particular, zero inflation is optimal only under full credibility.

The strong policymaker can improve objectives by taking advantage of his ability to stand behind his commitment and by relying on the fact that this ability is common knowledge. This requires the preannouncement of a policy

target prior to the conclusion of nominal wage contracts. The difference between the strong and the weak policymaker is that the first adheres to the announced policy while the second does only if it is *ex post* expedient. The potential presence of a weak policymaker who may mimic the policy announcement (without being bound by it) makes announced policy targets only partially credible, a fact that has to be taken into account by the strong policymaker. Indeed, it is the partial credibility of the policy announcement, under imperfect information, which induces the strong policymaker to compromise. Thus, imperfect credibility turns out to be partially self-fulfilling in the sense that the strong policymaker does not deliver the zero inflation it would have delivered under perfect credibility. On the other hand, in spite of his imperfect credibility, the strong policymaker is better off announcing (and delivering) a target below the discretionary rate.

The recent literature on the Barro–Gordon (1983) model with incomplete information about the nature of the policymaker interprets this difference in two alternative ways. In one case, as in Rogoff (1985), Vickers (1986), and Hoshi (1988), the two types have different relative preferences for employment and price stability. In the other case, as in Barro (1986), both types have identical preferences but differ in their ability to precommit to a *zero* rate of inflation. Provided strength in the first sense is interpreted as concern only about inflation, the ‘strong’ policymaker always sticks to zero inflation under *both* interpretations. But in the first case it is because he is concerned only about price stability, whereas in the second case it is because he is able to precommit to a zero rate of inflation. The work of Backus and Driffill (1985a, b) implies that, as long as the strong policymaker sticks to zero inflation, it does not matter whether he does that because of the first or the second reason.¹

This paper can be viewed as a generalization of the second interpretation of the ‘strong’ policymaker type in which he is always committed to keep his promises but he can *choose ex ante* whether or not to commit himself to a zero rate or to another rate of inflation. This rather modest generalization alters the basic conclusions of previous work in several important ways. First, when the strong (in the second sense) policymaker is free to choose the rate to which he commits, he often chooses a positive rate under incomplete information. Second, whether the strong policymaker overshoots (downward) his perfect information strategy in order to separate himself from his weak

¹Although very similar in structure to Barro’s (1986) paper, those papers are somewhat less explicit about the source of the difference between strong and weak policymakers. They conceive of a ‘hard-nosed’ or strong policymaker as one that never inflates. Obviously, this may be due to his being concerned *only* about price stability *or* to his being irrevocably committed to zero inflation. All these papers, including Barro (1986), draw on analogous problems in industrial organization and in particular on the work of Kreps and Wilson (1982) and Milgrom and Roberts (1982) which is also the source of the terminology ‘weak’ and ‘strong’ to designate the policymaker’s type.

counterpart or compromises on it, critically depends on whether policymakers differ in their relative aversion to inflation and unemployment or in their ability to precommit. Vickers (1986) shows that in the first case it is optimal for the less inflationary policymaker to signal his type by setting an excessively low inflation so as to make it incompatible with the behavior of the more inflationary type. This paper demonstrates that in the second case a 'strong' policymaker does exactly the opposite. He compromises on his full-information inflation target by partially accommodating inflationary expectations. This difference in results leads to quite different interpretations of frequent failures to stabilize inflation in some Latin American countries. In the first case failure implies that a 'weak' policymaker is in office. In the second case failure is consistent with the view that a policymaker who is able to precommit is in office. But due to his initial low reputation he compromises by announcing and delivering more modest counterinflationary objectives.

The paper also introduces a novel methodological device that makes it possible to model situations in which the policymaker is able to precommit without necessarily binding him to precommit to a zero rate of inflation. This is done by letting him make an announcement about the rate of inflation he will choose after nominal contracts or expectations have been determined *prior* to the formation of those expectations. Since the public attributes a positive (but smaller than one) probability that the announcement will be respected, the announcement has a partial effect on expectations and nominal contracts. The announcement is crucial in that it enables the 'strong' policymaker to partially signal his intentions *before* expectations are formed. And this occurs in spite of the incentive of the weak policymaker to mimic his announcement.

Section 2 lays down the basic structure and illustrates the tendency of strong policymakers to accommodate in a one-period model. Section 3 extends the analysis to a two period's framework and characterizes separating and pooling equilibria. Section 4 characterizes mixed strategies equilibrium in the two period's framework and relates equilibrium types to initial reputation and the rate of time preference. A summary of results for the T -periods horizon appears in section 5. Concluding comments follow.

2. Different abilities to precommit in a one-period game and accommodation

The framework used is similar in several respects to the one presented in Barro (1986). There are two policymakers' types with the same objective function that is positively related to surprise inflation and negatively related to actual inflation. This common objective function is given by

$$v(\pi, \pi^e) = -\frac{a}{2}\pi^2 + b(\pi - \pi^e), \quad a, b > 0, \quad (1)$$

where π and π^e are the actual and the expected rates of inflation. Actual inflation is assumed to be directly controlled by the policymaker in office. The benefits from surprises arise because of their stimulatory impact on employment combined with the presumption that the natural level of employment is too low.²

The only difference between the policymakers is in their ability to precommit. The first policymaker, to which we refer as dependable, always lives up to his declarations. The other policymaker, to whom we refer as weak, fulfills previously announced plans only if such a course of action is ex post efficient. In the absence of a policy preannouncement, *either* type of policymaker maximizes $v(\cdot)$ taking π^e as given. This leads to the well-known discretionary equilibrium $\pi = b/a \equiv c$. With rational expectation, $\pi^e = c$, so that there are no surprises in equilibrium and $v(\cdot) = -b^2/2a$. If a preannouncement of policy is made, the dependable policymaker always adheres to it, whereas the weak policymaker is not bound by the announcement.

The issue of why dependability differs across policymakers and is private information can be approached in two ways. First the distribution of policymakers by their level of dependability may reflect the general norms of society. The adherence to the norm of dependability varies across individuals in a community and is, at least *a priori*, the private information of each individual. Since policymakers are drawn from the society in which they live there are similar individual variations in dependability across policymakers. The general public is, at least initially, not fully informed about the dependability of the policymaker in office for the same reason that the dependability of a randomly drawn individual is not known with certainty. Given existing norms each individual is informed *a priori* about the distribution of the population by dependability but not about the dependability of particular other individuals. This approach alone is already sufficient to provide rigorous foundations for our model of private information about dependability.

But it is also possible to motivate those assumptions through a political economy approach that views policymakers as politicians that seek reelection. As stressed in the political science literature [see Enelow and Hinich (1984, p. 174), for example], voters view dependability as a desirable attribute. Hence, dependability is one of the 'electoral assets' that improve the likelihood of reelection. But a candidate for office generally offers an entire package of positions on the issues and various personal characteristics, of which dependability is only one component. Under these circumstances, one may assume that the attitude of each voter towards dependability is private information. This forces each policymaker to estimate the effect of dependability on his electoral prospects. This estimate is the private information of

²By conventional wisdom, this is due to the existence of distortionary taxes. A criticism of this view and alternative foundations for the effects of surprise inflation on output appear in Cukierman (1990, ch. 2, sects. 5 and 6). π^e is a proxy for nominal wage contracts, which are concluded prior to the choice of π by the policymaker.

the policymaker.³ In this context a dependable policymaker can be viewed as a policymaker who estimates that the electoral cost of reneging on announcements is larger than the benefits of surprise inflation (an illustration using Bush's famous 'read my lips' statement appears in the Conclusion). The converse holds for a weak policymaker.⁴

The public knows that the policymaker may be dependable (type D) or weak (type W), but does not know which type is in office. At the beginning of the period the incumbent policymaker may announce, if he so chooses, his policy for the period. If he is of type D and the public is aware of this fact, his statement is fully believed. However, if he is of type W and this fact is common knowledge, the announcement has no effect on expectations. Under perfect information, where the public knows the policymaker type, it is easy to see that W's optimal policy is the discretionary solution, c . The optimal policy for D is to announce $\pi = 0$, and since he is bound by his announcement, he will adhere to it. Since the announcements of D are fully credible, the public will set $\pi^e = 0$. This enables D to achieve $v(\cdot) = 0$, which exceeds the discretionary level.

Consider now the imperfect information case. Let α be the prior probability assigned by the public to the event that the policymaker in office is of type D. The policymaker may or may not choose to make an announcement.

The timing of moves is as follows. First, if he chooses to, the policymaker in office makes an announcement, π^a . Then the public forms its expectation, π^e .⁵ Finally, the policymaker chooses actual inflation, π . Since the probability that π^a was announced by type D is α , the public's rational inflation expectation *after* being exposed to the announcement is⁶

$$\pi^e = \alpha\pi^a + (1 - \alpha)c. \quad (2)$$

We turn next to a characterization of the optimal announcement for a dependable policymaker under the (provisional) assumption that he makes an announcement. The optimal announcement can be obtained by maximizing the objective function in (1) subject to eq. (2) and the additional restriction

$$\pi = \pi^a. \quad (3)$$

³Moreover, even the election's outcome is not sufficient to enable the policymaker to evaluate the contribution of this component to the outcome with full precision.

⁴The suggestion of private information about whether a player is precommitted or not also appears in the industrial organization literature [Milgrom and Roberts (1982, p. 303)].

⁵This expectation can be viewed as a proxy for nominal wage contracts.

⁶By choosing π^a , the dependable policymaker signals to the public which equilibrium within the set of potential equilibria he aims at. A precise game-theoretic characterization of this set appears in part 1 of the appendix.

Substituting (2) and (3) into (1) and maximizing with respect to π^a ,

$$\pi^a = \pi = (1 - \alpha)c \equiv \pi^* \tag{4}$$

The level of welfare associated with π^* is

$$v(\pi^*, \alpha\pi^* + (1 - \alpha)c) = -(1 - \alpha^2) \frac{b^2}{2a} \tag{5}$$

If D does not make any preannouncement of policy, there is no commitment. Hence, the public correctly expects the discretionary rate, c , in this case. The corresponding value of welfare is $v(c, c) = -b^2/2a$, which is smaller than the level of welfare in (5) as long as $\alpha > 0$. Hence, provided he has some reputation ($\alpha > 0$), D is better off announcing π^* than remaining silent.

Consider now the behavior of W. Since he incurs no cost for renegeing on the announcement he always ends up inflating at the discretionary rate c . Given this fact, he has interest to keep himself indistinguishable, at the announcement stage, from D thereby maintaining inflationary expectations below c . The public knows that it is optimal for D, when he is in office, to announce π^* . Hence, if there is no announcement, or if $\pi^a \neq \pi^*$, the public concludes that W is in office and sets $\pi^e = c$. Since $\pi^e = c$ is worse for W than any lower expected rate of inflation he also announces π^* , thus maintaining the public's expectation at

$$\pi^e = \alpha\pi^* + (1 - \alpha)c = (1 - \alpha^2)c < c, \tag{6}$$

for all $\alpha > 0$. Hence, the announcement of π^* is an equilibrium strategy for both D and W. The subsequent equilibrium actions are π^* for D and c for W.⁷

The central point of this paper can be demonstrated already now by comparing the behavior of dependable or 'strong' policymakers⁸ under full and imperfect information. With full information a dependable policymaker is believed and he knows that he is believed. Consequently, he finds it optimal to choose a zero rate of inflation in each period and to preannounce it so as to maintain expectations at this level too. A dependable policymaker

⁷There could *a priori* be other self-fulfilling equilibria of this type. However, all of them except for the equilibrium described in the text can be eliminated by appealing to the Cho-Kreps (1987) intuitive criterion. Details appear in part 1 of the appendix.

⁸It should be stressed, at the risk of repetition, that in our framework a strong policymaker is one that is able to live up to his commitments. However, both policymakers have identical evaluations of the relative costs of inflation and unemployment. This notion of strength is identical to that of Barro (1986), but it differs from those of Hoshi (1988), Rogoff (1985), and Vickers (1986), all of which view the strong policymaker as one who is relatively more concerned about the costs of inflation in comparison to his weak counterpart.

that is known to be dependable thus behaves like the policymaker that is capable of commitments, as in Barro (1986) or Backus and Driffill (1985a).

In the presence of imperfect information the strong policymaker inflates at the rate $(1 - \alpha)c$ which is intermediate between zero and the discretionary rate c . The intuitive reason for this compromise is that the public does not give full credence to his announcement because of the possibility that he is weak. Hence, if the dependable policymaker announces (and sticks to) a zero rate, he creates unemployment. At a zero rate of inflation the combined costs of unemployment and inflation can be reduced by announcing and producing a positive rate of inflation. More precisely, surprise inflation when D is in office is

$$\pi - \pi^e = (1 - \alpha)(\pi - c),$$

where we made use of (2). If D sets $\pi = 0$, then surprise inflation will be $-(1 - \alpha)c$, which diminishes his utility (implying, say, a rise in real wages and an increase in unemployment). If, from $\pi = 0$, he raises π by one percentage point, then his utility loss is cut by $b(1 - \alpha)$ while his loss from the increase in inflation is negligible. As π increases, the latter loss becomes significant (i.e., $a\pi$) until an optimum is struck at $a\pi = b(1 - \alpha)$, which yields (4).

Essentially the 'shadow' of the weak policymaker induces the strong policymaker to adjust his behavior towards that of the weak one. As is clear from eq. (4), the adjustment is not full. It is stronger the lower α - that is, the lower the reputation of policymakers. Thus, if the public has a very pessimistic view about the fraction of dependable policymakers in the population ($\alpha \rightarrow 0$), a dependable policymaker behaves almost as a weak one. By contrast, in Barro (1986) a policymaker that is capable of binding commitments is *assumed* to always produce zero inflation even if such behavior is not compatible with the maximization of his objectives. When the strong policymaker is allowed to act optimally he always sticks to the behavior postulated in Barro when reputation is impeccable ($\alpha = 1$). But in all other cases he partially accommodates the public's expectation by producing positive inflation.

Before continuing, we pause for a methodological remark that highlights the crucial role of the announcement. One could have claimed that the announcement is not necessary by redefining a dependable policymaker as someone who never cheats on what the public expects *from him* and by letting him maximize (1) subject to (2) and (3) with π^a reinterpreted as this expectation rather than as an announcement. Since this problem is formally equivalent to the one we have solved, it obviously has the same solution, which is given by eq. (4). However, this reinterpretation is not possible since it implies that when he chooses *actual* inflation π , *after* expectations have been set, the policymaker can alter those expectations *retroactively*. This is obviously impossible since it contradicts the basic timing of moves in the

model. By contrast, the announcement (to which the strong policymaker always adheres) conveys information to the public *before* expectations and nominal contracts have been set. Thus, the announcement is crucial in that it conveys some information to the public about the subsequent action of the policymaker *before* the formation of expectations.

As stressed in the introduction, the tendency of strong policymakers to partially accommodate expectations under imperfect information about their ability to precommit contrasts with a result obtained by Vickers (1986). We are now in a position to amplify and identify the origin of this difference. Rather than accommodating the public's expectation, Vickers' strong policymaker inflates at a rate that is even lower than his perfect-information discretionary rate in order to *separate* himself from his weak counterpart. The reason is that in Vickers' framework strong and weak policymakers differ in their relative evaluations of the costs of inflation and of unemployment rather than in their precommitment ability. Hence, for appropriate configurations of parameters, the strong policymaker can separate himself from his weak counterpart by picking a sufficiently low inflation. But when, as is the case here, the public is uncertain about the precommitment ability of policymakers, the best strategy of a strong policymaker involves some accommodation of expectations. As demonstrated in the following sections, this result extends to cases in which the policymaking horizon is longer than one period.

3. Equilibrium when policymakers have a two-period horizon

This section extends the analysis to the case in which the policymaker in office has a two-period horizon. At the beginning of the first period one of the two types is in office for the duration of the game, but the public does not know the type with certainty. The novel element in comparison to the one-period model is that now the first period action of the policymaker may convey to the public information about his type. In choosing first-period inflation, the weak policymaker takes into consideration the effect of this action on his second-period reputation. This may lead to separating, pooling, or mixed-strategy equilibria. This section characterizes the separating and pooling equilibria. The mixed-strategy equilibrium is discussed in the following section.

The probability held by the public at the beginning of period t , $t = 1, 2$, that the incumbent is dependable is denoted by α_t . α_1 is the public's exogenously given prior while α_2 depends on the action taken by the policymaker in period 1. The common objective of both types of policymaker is to maximize the present value of welfare,

$$V \equiv v(\pi_1, \pi_1^e) + \delta v(\pi_2, \pi_2^e), \quad 0 \leq \delta \leq 1, \quad (7)$$

where δ is the rate of time preference of both types. The timing of moves within each period is the same as in the one-period model. First the policymaker may make an announcement, π_i^a . Then the public forms its expectation π_i^e . Finally, the policymaker picks inflation, π_i , for the period.

In the last period the weak policymaker always inflates at the discretionary rate, c . But he may not necessarily pick c in the first period if he feels it is disadvantageous to be revealed as weak by his choice of first-period inflation. Whether he feels that way or not depends on the relationship between the benefit in the first period of picking c rather than mimicking the dependable policymaker and the cost of being revealed as weak already at the start of the second period. If the benefit is larger than the cost, he picks c in the first period and gets revealed as weak, producing a separating equilibrium. If the benefit is smaller than the cost, he mimics the behavior of the dependable policymaker in the first period producing a pooling equilibrium.⁹ Each type of equilibrium may arise depending on the values of the discount factor, δ , and of the initial reputation parameter, α_1 .¹⁰

It is useful and economical to characterize the two types of equilibria above by first defining precisely the strategy options of the two policymakers and the concept of equilibrium. The strategy vectors of the two players or policymakers are

$$s^D = \{\pi_1^{Da}, \pi_1^D, \pi_2^{Da}, \pi_2^D\} \quad (8a)$$

and

$$s^W = \{\pi_1^{Wa}, \pi_1^W, \pi_2^{Wa}, \pi_2^W\}, \quad (8b)$$

where π_i^{ja} ($t = 1, 2, j = D, W$) is the rate of inflation announced by type j at the beginning of period t for that period and π_i^j is the actual rate he picks for that period.

An equilibrium in pure strategies is a pair of strategy vectors s^i ($i = D, W$) such that s^i maximizes V in eq. (7) given s^j ($j \neq i$) and the public's expectations formation mechanism.

For any period in which the type is not initially known with certainty and in which no announcement is made there is no commitment. For reasons elaborated in section 2 this leads to the self-fulfilling expectation, c , and to a welfare level for the period of $-b^2/2a$. This is true for either type of

⁹Vickers (1986) characterizes pooling and separating equilibria in a model of monetary policy in which the policymakers differ in their objectives rather than in their ability to precommit.

¹⁰This statement is substantiated below.

policymaker since in the absence of an announcement neither type is committed.¹¹

3.1. Separating equilibrium

Whether the equilibrium is separating or pooling depends on the parameters, α_1 and δ , in a way to be specified more precisely below. Suppose the configuration (α_1, δ) is such that a separating equilibrium obtains. Since the public knows the parameters α_1 and δ , it also knows that the policymaker will be revealed by the end of period 1. This implies that the weak policymaker will not mimic the dependable one in the first period. Given this fact, the best choice of actual inflation for W in period 1 is the discretionary rate, c , and this is common knowledge. However, the identity of the policymaker in power is not common knowledge prior to the realization of π_1 .

Consider now the following strategy for the dependable policymaker. At the beginning of period 1 he announces a rate of inflation π_1^* . Since he is dependable he also delivers this rate during the period and this is common knowledge. Hence, the rate of inflation expected by the public for period 1 following the announcement is a weighted average, with weights α_1 and $1 - \alpha_1$ of π_1^* and of c ,

$$\pi_1^e = \alpha_1 \pi_1^* + (1 - \alpha_1)c. \tag{9}$$

A necessary condition for maximization of V by D is the maximization of welfare in period 1. Substituting (9) into (1) and noting that the dependable policymaker always lives up to his promises, this necessary condition can be written as

$$\max_{\pi_1^*} \left\{ -\frac{a}{2} (\pi_1^*)^2 + b(1 - \alpha_1)(\pi_1^* - c) \right\}. \tag{10}$$

The solution for π_1^* is¹²

$$\pi_1^* = (1 - \alpha_1)c < c. \tag{11}$$

¹¹Recall that the commitment on the part of D works because he incurs a prohibitive cost when he reneges on his announcement. In the absence of an announcement there is nothing to renege on, nothing to trigger the cost, and therefore no commitment.

¹²This solution is essentially the same as that for D in the one-period model. In particular, since D prefers π_1^* to other potential equilibria, the expectation in (9) is rational. See section 2 and part 1 of the appendix.

The corresponding value of welfare is

$$v(\pi_1^*, \pi_1^e) = -(1 - \alpha_1^2) \frac{b^2}{2a}. \quad (12)$$

Since $v(\pi_1^*, \pi_1^e) > -b^2/2a = v(c, c)$, the dependable policymaker is better off making the optimal declaration than remaining silent.

We turn next to the behavior of the weak policymaker in the first period. Since equilibrium is separating, he knows that he will pick c already in the first period. But (given the off-equilibrium beliefs from section 2) he can improve welfare by mimicking the declaration, π_1^* , of the dependable policymaker at the beginning of period 1. The reason is that otherwise first-period welfare is $-b^2/2a$ since expectations adjust to c already at the beginning of that period. However, if π_1^* is announced, expectations are given by (9) and welfare in the first period is $v(c, \pi_1^e) = -b^2/2a + (b\alpha)^2/a$ which is greater than $-b^2/2a$.

In the second and last period type D is known to be himself with certainty when he is in office. Therefore, his second-period declaration is fully believed and $\pi_2^e = \pi_2^*$. Hence, when D is in office, the second-period objective function reduces to

$$\max_{\pi_2^*} -\frac{a}{2}(\pi_2^*)^2, \quad (13)$$

which is maximized for $\pi_2^* = 0$ provided D declares in advance that this is the rate of inflation to which he is committed.¹³

Having been revealed as weak, W picks the discretionary rate c in the second period since he no longer is able to affect expectations. For the same reason his second-period declaration has no effect on expectations and is therefore immaterial. We shall make the innocuous assumption that when indifferent between alternative announcements, a player chooses to announce the truth. Hence, in the second period W preannounces and produces inflation at rate c .

To sum up, the equilibrium strategies of the two types under separation are

$$s_s^D = \{(1 - \alpha_1)c, (1 - \alpha_1)c, 0, 0\} \quad (14a)$$

and

$$s_s^W = \{(1 - \alpha_1)c, c, c, c\}. \quad (14b)$$

¹³As in the first period, if D does not preannounce his intentions, there is no commitment so that the suboptimal inflation rate c emerges. Hence, D is better off declaring his intention of producing zero inflation than remaining silent.

A separating equilibrium emerges if and only if, given D's equilibrium strategy and expectation formation, W is better off picking c rather than mimicking D and inflating at rate $(1 - \alpha_1)c$ in the first period. If he does that, the public believes he is of type D. This enables him to credibly announce a zero rate of inflation for period 2 and then to surprise the public by inflating at rate c . The entire strategy of the weak policymaker for such a deviation from a separating strategy is

$$s_m^W \equiv s^W|_{\text{mimicking}} = \{(1 - \alpha_1)c, (1 - \alpha_1)c, 0, c\}. \quad (15)$$

The corresponding present value of the objective function in (7) is

$$\begin{aligned} V(s_m^W) &= -\frac{a}{2}(1 - \alpha_1)^2c^2 + b((1 - \alpha_1)c - \pi_1^e) \\ &\quad + \delta \left[\frac{a}{2}c^2 + b(c - 0) \right] \\ &= \frac{b^2}{2a}(\delta + \alpha_1^2 - 1). \end{aligned} \quad (16)$$

If, on the other hand, W sticks to the separating strategy in (14b), the present value of his objectives is

$$\begin{aligned} V(s_s^W) &= -\frac{a}{2}c^2 + b(c - \pi_1^e) + \delta \left[-\frac{a}{2}c^2 + b(c - c) \right] \\ &= \frac{b^2}{2a}(2\alpha_1^2 - \delta - 1). \end{aligned} \quad (17)$$

Consequently, a separating equilibrium emerges if and only if $V(s_s^W) > V(s_m^W)$. From (16) and (17) this is equivalent to the condition

$$\delta < \frac{\alpha_1^2}{2}. \quad (18)$$

Note that (given the stipulated off-equilibrium beliefs) the separating equilibrium in eqs. (14) is the only separating equilibrium. The reason being that in the second period, once their identities have been fully revealed, both policymakers always follow their most preferred strategies which are 0 and c for D and W, respectively. Since the equilibrium is separating, the best actual inflation for W in the first period is c . The arguments leading to the expression for π_1^* in eq. (11) imply that, given separation, π_1^* is the only

equilibrium strategy for D in the first period. Since W is always better off announcing π_1^* than doing anything else, both types always announce π_1^* at the beginning of the first period in a separating equilibrium. Hence, eqs. (14) constitute the only separating equilibrium.

3.2. Pooling equilibrium

In a pooling equilibrium there is no separation until the last move of the game which involves the choice of actual inflation in the second period. Hence, in all previous moves W must mimic D. That is

$$\pi_t^{Da} = \pi_t^{Wa}, \quad t = 1, 2, \quad (19a)$$

and

$$\pi_1^D = \pi_1^W \equiv \pi_1^{*P}. \quad (19b)$$

Since he is not able to commit himself, and since the second period is the last one, the weak policymaker always chooses the discretionary rate of inflation, c , in that period. Let π_1^{*P} be the rate of inflation chosen and announced by type D in the first period. The public knows the parameters of the model and therefore the fact that equilibrium is pooling too. Hence, expectations are

$$\pi_1^e = \pi_1^{*P} \quad (20a)$$

and

$$\pi_2^e = \alpha_1 \pi_2^{*P} + (1 - \alpha_1)c. \quad (20b)$$

Here, use has been made of the fact that $\alpha_2 = \alpha_1$ which, in turn, is a consequence of the fact that (excluding second-period inflation) the strategies of both policymakers are identical [see eqs. (19)]. In other words, the pooling equilibrium precludes any updating of probabilities. As a result there is no change in the probability distribution of policymakers' types held by the public between the beginning of the first and second periods.

The dependable policymaker knows that the public is aware of the fact that the weak policymaker will mimic him in the first period in words as well as in deeds. Hence, he knows that any announcement made by him will be fully believed as specified in (20a). Since both types live up to their declarations in the first period, there is no unexpected inflation and the rate of inflation that maximizes D's objectives in the first period is zero. Since W mimics D in the first period this implies

$$\pi_1^{Wa} = \pi_1^{Da} = \pi_1^W = \pi_1^D = 0. \quad (21)$$

In the second period, D's objective, under pooling, is [using (20b)]

$$\max \left\{ -\frac{a}{2}(\pi_2^{*P})^2 + b(\pi_2^{*P} - \alpha_1 \pi_2^{*P} - (1 - \alpha_1)c) \right\}. \tag{22}$$

Since this problem is formally identical to the one in eq. (10), it has the same solution that is given by eq. (11). Hence $\pi_2^{*P} = (1 - \alpha_1)c$. In summary the strategies of the two players when equilibrium is pooling are

$$s_p^D = \{0, 0, (1 - \alpha_1)c, (1 - \alpha_1)c\} \tag{23a}$$

and

$$s_p^W = \{0, 0, (1 - \alpha_1)c, c\}. \tag{23b}$$

A pooling equilibrium emerges if and only if, given D's equilibrium strategy and expectation formation, W is better off following the strategy s_p^W than deviating from it. If he follows the strategy s_p^W , the present value of the objective function is

$$V(s_p^W) = \delta \frac{b^2}{2a} (2\alpha_1^2 - 1). \tag{24}$$

If he decides to deviate from s_p^W , the weak policymaker picks c rather than 0 in the first period. However, since he is better off not being revealed prior to the formation of first-period expectations, he still announces a zero rate of inflation for the first period, thus maintaining first-period inflationary expectations at zero. Since he deviates from the pooling equilibrium strategy, the weak policymaker's type is common knowledge at the beginning of period 2. Hence, the public expects an inflation at rate c for period 2 if W deviates in period 1. To sum up, the entire strategy of the weak policymaker when he deviates from s_p^W is

$$s_{nm}^W \equiv s^W|_{\text{no mimicking}} = \{0, c, c, c\}, \tag{25a}$$

and the corresponding expectations are

$$\pi_1^e = 0, \quad \pi_2^e = c. \tag{25b}$$

Using eqs. (25) in (7), the corresponding present value of objectives is

$$V(s_{nm}^W) = \frac{b^2}{2a} (1 - \delta). \tag{26}$$

Hence, a pooling equilibrium obtains if and only if $V(s_p^W) > V(s_{nm}^W)$ which [using (24) and (26)] is equivalent to the condition

$$\delta > \frac{1}{2\alpha_1^2}. \quad (27)$$

By retracing the steps of the argument leading to the pooling equilibrium in (23), the reader can convince himself that (given the off equilibrium beliefs postulated in section 2) this is the only pooling equilibrium. The proof of uniqueness relies on the fact that any other pair of strategies either violates pooling or is not a Nash equilibrium.

3.3. *The relationship between the type of equilibrium and the policymaker's rate of time preference*

Conditions (18) and (27) define two nonintersecting ranges for the respective existence of separating and of pooling equilibria. Since

$$\frac{1}{2\alpha_1^2} > \frac{\alpha_1^2}{2} \quad \text{for } 0 < \alpha_1 < 1,$$

it follows that for sufficiently low values of δ equilibrium is separating and for sufficiently high values of δ equilibrium is pooling. The intuition is that weak policymakers with a high rate of time preference (low δ) prefer to obtain the employment benefits of surprise inflation as soon as possible. As a result, their weakness (or the trustworthiness of a type D policymaker) gets revealed early on, producing a separating equilibrium. On the other hand, weak policymakers with a low rate of time preference (high δ) find the current employment benefits smaller than the future costs caused by higher inflationary expectations. Hence, they mimic the behavior of type D early on and produce a pooling equilibrium.

Note that when

$$\frac{1}{2\alpha_1^2} > \delta > \frac{\alpha_1^2}{2}, \quad (28)$$

there are no equilibria in pure strategies. However, it is shown in section 4 below that in this range there are mixed-strategies equilibria.

3.4. *A remark on accommodation*

The separating and the pooling equilibria differ in the period in which the policymaker type gets revealed. In the first case revelation occurs at the end of the first period and in the second case it occurs at the end of the second period. In either case post-announcement expectations during the period of

type revelation are a weighted average of the announcement and of the discretionary rate. As a consequence during periods of type revelation the strong policymaker partially accommodates expectations as in the one-period model.

4. Mixed-strategies equilibrium and conditions for alternative types of equilibrium

Instead of choosing either π_1^* or c in the first period, the weak policymaker may randomize between them. Let P_1 and $1 - P_1$ be the probabilities assigned to π_1^* and c , respectively. Since this strategy (although not its realization) is common knowledge, the rate of inflation expected by the public for the first period is

$$\pi_1^e = \alpha_1 \pi_1^* + (1 - \alpha_1) [P_1 \pi_1^* + (1 - P_1) c]. \tag{29}$$

Whatever the outcome of the randomization, the weak policymaker always chooses the discretionary rate c in the second period. If the realization of his first-period randomization is also c , he is revealed as weak and he loses the ability to stimulate employment in the second period since the public, quite correctly, expects him to inflate at rate c . If the realization of the first-period randomization is π_1^* , the public remains unsure about the identity of the policymaker into the second period. It then pays the weak policymaker to declare the same rate of inflation at the beginning of the second period as a dependable policymaker would have done. The reason for this is that he thereby retains some ability to stimulate employment in the second period. Thus if π_1^* is the outcome of the randomization,

$$\pi_2^{Da} = \pi_2^{Wa} \equiv \pi_2^a. \tag{30}$$

Although it remains unsure about the policymaker's identity into the beginning of the second period, the public updates its probability of the event that the policymaker is dependable by means of Bayes' formula:¹⁴

$$\begin{aligned} \alpha_2 &\equiv \Pr[t = D | \pi_1^*, \pi_2^a] \\ &= \frac{\Pr[\pi_1^* | t = D] \Pr[t = D]}{\Pr[\pi_1^* | t = D] \Pr[t = D] + \Pr[\pi_1^* | t = W] \Pr[t = W]} \\ &= \frac{\alpha_1}{\alpha_1 + P_1(1 - \alpha_1)}. \end{aligned} \tag{31}$$

¹⁴As in Kreps and Wilson (1982), Backus and Driffill (1985a), and Barro (1986), randomization by the weak policymaker introduces gradual updating of probabilities. Note that after π_1^* has been observed, the announcement π_2^a does not provide additional information since the public knows that given $\pi_1 = \pi_1^*$ the declarations of both the weak and the dependable policymaker at the beginning of the second period are identical.

Here 't' stands for type and 'Pr' stands for probability. It is easy to see that for truly mixed strategies ($0 < P_1 < 1$), the occurrence of π_1^* (rather than of c) in the first period raises the public's prior that the policymaker is dependable. Given α_2 the rate of inflation expected by the public for the second period is

$$\pi_2^e = \alpha_2 \pi_2^* + (1 - \alpha_2)c, \quad (32)$$

where π_2^* is the rate of inflation picked by the dependable policymaker in the second period. Hence, when W types are known to randomize, dependable policymakers are under partial suspicion of not being dependable even in the second period. In view of eq. (32) the second-period problem of a dependable policymaker is

$$\max \left[-\frac{a}{2} (\pi_2^*)^2 + b(1 - \alpha_2)(\pi_2^* - c) \right]. \quad (33)$$

The solution to this problem is

$$\pi_2^* = (1 - \alpha_2)c. \quad (34)$$

In the first period a dependable policymaker picks π_1^* so as to maximize the present value of his objectives, taking into consideration the way first-period expectations are formed [eq. (29)]. Since the maximized value of second-period objectives does not depend on π_1^* , this problem reduces to¹⁵

$$\max_{\pi_1^*} \left[-\frac{a}{2} (\pi_1^*)^2 + b(1 - \alpha_1)(1 - P_1)(\pi_1^* - c) \right], \quad (35)$$

whose solution is

$$\pi_1^* = (1 - \alpha_1)(1 - P_1)c. \quad (36)$$

To summarize, when the weak player randomizes between π_1^* and c in the first period, the strategies of the two players in equilibrium are

$$s_m^D = \{(1 - \alpha_1)(1 - P_1)c, (1 - \alpha_1)(1 - P_1)c, (1 - \alpha_2)c, (1 - \alpha_2)c\} \quad (37a)$$

¹⁵The maximized value of his second-period objectives is $-\delta(1 - \alpha_2^2)b^2/2a$ and does not depend on π_1^* .

and

$$s_m^W = \{ \pi_1^* = (1 - \alpha_1)(1 - P_1)c, \pi_1^* \text{ with probability } P_1 \text{ and } c \text{ with probability } 1 - P_1, \\ (1 - \alpha_2)c \text{ if } \pi_1^W = \pi_1^* \text{ and } c \text{ if } \pi_1^W = c, c \}. \quad (37b)$$

The value of the mixing probability, P_1 , is determined by the condition that the weak policymaker is indifferent between mimicking the dependable one (choosing π_1^*) and between picking the one-shot discretionary inflation, c , and being revealed as not dependable already at the beginning of the second period. It is shown in part 2 of the appendix that this condition implies

$$f(P_1) \equiv (1 - \alpha_1)(1 - P_1) = 1 - \frac{\alpha_1 \sqrt{2\delta}}{\alpha_1 + (1 - \alpha_1)P_1} \equiv g(P_1). \quad (38)$$

Eq. (38) provides an implicit solution for P_1 in terms of δ and α_1 . The equilibrium strategy of the weak policymaker is truly mixed if and only if this solution occurs in the open range $(0, 1)$. The functions $f(P_1)$ and $g(P_1)$, which together determine P_1 , are plotted in fig. 1, together with the values of those functions for $P_1 = 0$ and $P_1 = 1$. It is easily seen that $f(P_1)$ is decreasing in P_1 and $g(P_1)$ is increasing in P_1 . W's strategy is truly mixed if and only if $g(\cdot)$ and $f(\cdot)$ intersect in the interior of the $[0, 1]$ range. Fig. 1 suggests that

$$\begin{aligned} P_1 > 0 & \text{ if and only if } \delta > \alpha_1^2/2, \\ P_1 = 0 & \text{ if } \delta = \alpha_1^2/2, \\ P_1 < 1 & \text{ if and only if } \delta < 1/2\alpha_1^2, \\ P_1 = 1 & \text{ if } \delta = 1/2\alpha_1^2. \end{aligned} \quad (39)$$

Eq. (39) in conjunction with the discussion leading to eqs. (18) and (27) in section 3 make it possible to completely characterize the conditions leading to alternative types of equilibria. This is summarized in the following proposition.

Proposition 1. Equilibrium is

(i) *separating if and only if*

$$\delta \leq \frac{\alpha_1^2}{2},$$

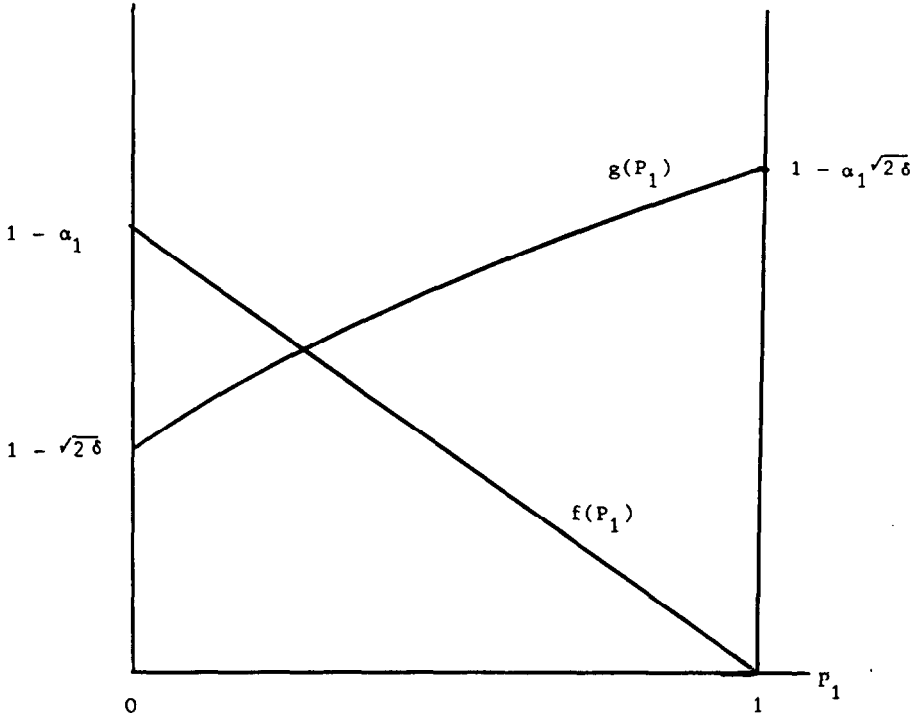


Fig. 1. Determination of the mixing probability P_1 .

(ii) *mixed if and only if*

$$\frac{\alpha_1^2}{2} < \delta < \frac{1}{2\alpha_1^2},$$

(iii) *pooling if and only if*

$$\frac{1}{2\alpha_1^2} \leq \delta.$$

When δ increases the function $g(\cdot)$ shifts down, but there is no change in the position of $f(\cdot)$. Hence, P_1 increases. Thus, P_1 is nondecreasing in δ . It is zero in the separating range and monotonically increasing in δ in the mixing range until δ reaches the value $1/2\alpha_1^2$ at which $P_1 = 1$. For higher

values of δ , P_1 remains at one, producing the pooling equilibrium discussed in section 3. Stated somewhat loosely, this means that the probability of separation is larger the larger the rate of time preference of the policymaker.

Another interesting feature of the equilibria is the way they depend on the initial reputation, α_1 , of policymakers. This is summarized in the following corollary of Proposition 1.

Proposition 2. (i) When reputation tends to zero ($\alpha_1 \rightarrow 0$), the ranges of δ for which there are either separating or pooling equilibria shrink towards the null set. Correspondingly the set of δ 's for which equilibrium is mixed tends towards the set $[0, 1]$.

(ii) When reputation becomes very high ($\alpha_1 \rightarrow 1$), the set of δ 's for which there are mixed strategies tends towards the null set. Correspondingly, the sets of δ 's for which there are either separating or pooling equilibria tend towards the sets $[0, \frac{1}{2}]$ and $[\frac{1}{2}, 1]$, respectively.

The message of Propositions 1 and 2 is summarized in fig. 2 which fully characterizes the type of equilibria that arise for alternative combinations of the initial reputation, α_1 , and of the discount factor, δ . The figure suggests that if we put a diffuse prior on the pairs of parameters α_1 and δ , the most likely equilibria are mixed followed by separating and then pooling equilibria. However, even the smallest set is dense implying that there is an infinite number of parameters configurations for which equilibrium is pooling.¹⁶

The intuition underlying the figure (and Proposition 2) is as follows: The smaller the reputation the larger the rate of inflation picked by D in the first period when separation is expected. However, the larger this rate the stronger the incentive of the weak policymaker to postpone separation to the last period. Hence, the range of δ 's for which equilibrium is separating shrinks. In addition, as can be seen from eq. (24), the benefit to the weak policymaker of fully mimicking the dependable one shrinks as reputation declines. As a consequence, the range of δ 's for which there is pooling also shrinks.

Note finally that with mixed strategies on the part of W, there is a positive probability that the dependable policymaker accommodates expectations in *both* periods by inflating at positive rates in both. The reason is that under mixing there may be no complete separation even in the last period. In such cases the time profile of inflation chosen by a strong policymaker can be

¹⁶This contrasts with Vickers (1986) who finds that separating equilibria are substantially more likely than pooling equilibria.

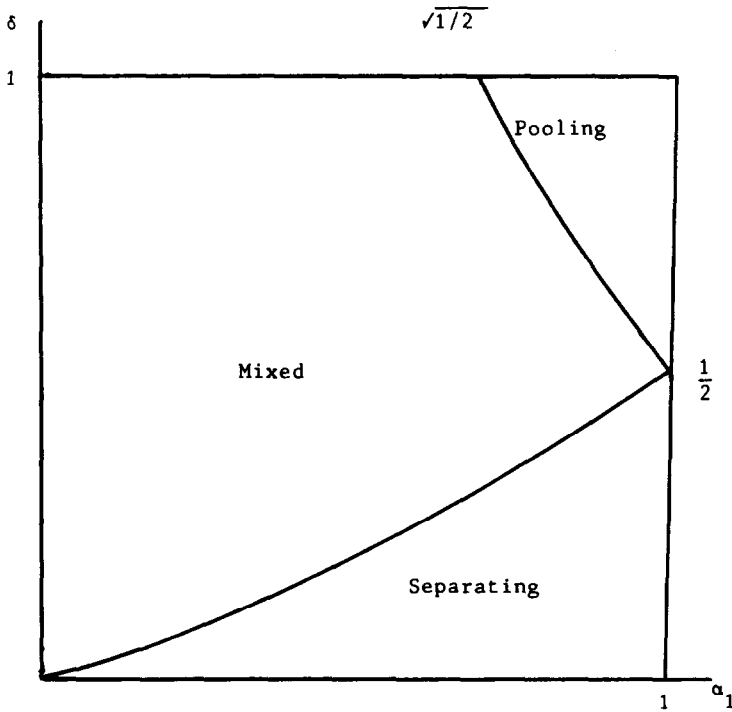


Fig. 2. Types of equilibria corresponding to alternative configurations of α_1 and δ .

derived by noting [from (34) and (36)] that

$$\frac{\pi_2^*}{\pi_1^*} = \frac{(1 - \alpha_2)c}{(1 - \alpha_1)(1 - P_1)c} = \frac{1 - \alpha_2}{1 - \alpha_2\sqrt{2\delta}} \tag{40}$$

Hence, π_2^* is larger than, equal to, or smaller than π_1^* , depending on whether δ is larger than, equal to, or smaller than $\frac{1}{2}$.

5. Mixed equilibrium when policymakers have a T -period horizon

This section reports results about equilibrium behavior when policymakers have a T -period rather than a two-period horizon.¹⁷ Following Barro (1986) we focus on equilibria that are characterized by (possibly) an initial period of

¹⁷The derivation of the results appears in Cukierman and Liviatan (1989).

pooling followed by a period of randomization, by the weak policymaker, that terminates only in the last period of the game. The main difference in results is that (unlike in Barro) the dependable policymaker inflates at positive and varying rates starting from the period in which the weak policymaker would have started to randomize had he been in office. In contrast to Barro, expected inflation during the period of randomization by the weak policymaker varies over time. Although positive, the rates of inflation chosen by the strong policymaker during this period are, on average, lower than those chosen by the weak policymaker on a period-by-period basis. Before randomization by the weak policymaker starts, there may be a period of pooling, during which both policymakers announce and maintain a zero rate of inflation. During this period the public, quite correctly, expects a zero rate of inflation.

Whether randomization is preceded by a period of pooling or not depends on the initial reputation, α_1 , and on the discount factor, δ . In particular, randomization is preceded by pooling only if $\delta > \frac{1}{2}$. The intuition is that a period of pooling at zero (announced and actual) inflation is possible only if policymakers are sufficiently patient. When randomization is preceded by one or more periods of pooling, the period in which pooling is replaced by randomization by the weak policymaker (denoted τ) depends on the initial reputation, α_1 , and on the policymaker's rate of time preference, δ .¹⁸ Since the public knows these parameters, it can calculate τ and use this information in forming its expectation.

We first report results for the case $\tau > 1$ in which there is a stage of pooling before randomization. Let α_t and π_t^* be, respectively, the reputation of policymakers at the beginning of period t and the equilibrium strategy of the strong policymaker. Let P_t ($t \geq \tau$) be the probability assigned to π_t^* by the weak policymaker during period t . When he is in office the dependable policymaker inflates at a positive and *increasing* rate at all $t > \tau$. During those periods expected inflation is *increasing* too and larger than π_t^* . The intuition underlying these results is as follows: As long as either policymaker sticks to the rate of inflation, π_t^* , his reputation increases. This effect, taken separately, would have produced a decreasing path of π_t^* over time. But as his reputation improves, the weak policymaker takes larger chances of being revealed by gradually increasing the probability assigned to the discretionary rate, c . This effect, taken alone, tends to raise both actual and expected inflation over time. Since $2\delta > 1$, this effect dominates the first one and both actual and expected inflation increase over time during the tenure of the strong policymaker. The same phenomenon occurs during the tenure of the

¹⁸As in Barro (1986), τ is an increasing function of the initial reputation α_1 and of the discount factor δ . In other words, the period of randomization, $T - \tau$, becomes shorter as α_1 and δ increase.

weak policymaker as long as the randomization does not reveal his identity to the public.

Thus, when it is believed that a weak policymaker, if in power, would randomize, even the dependable policymaker is led to produce a rising inflationary path over time. He finds this course of action advantageous because the public's inflationary expectations are increasing over time. From D's point of view this increase is at least partially out of control. He obviously can counteract the increase by making more conservative announcements. But since he also has to fulfill them, he finds it optimal to partially accommodate the rising trend of inflationary expectations by raising the rate of inflation as well.

The difference between inflationary expectations and the inflation produced by D, $(\pi_t^e - \pi_t^*)$, is a useful measure of the extent to which he accommodates expectations. This difference is always positive for $t \geq \tau$, implying that the strong policymaker never fully accommodates expectations.¹⁹ The degree of accommodation may be increasing or decreasing over time but is more likely to be increasing during the final stages of the office period. Since $\pi_t^e - \pi_t^*$ is positive, unexpected inflation, $\pi_t^* - \pi_t^e$, is negative throughout the randomization period when D is in office. Thus, as in Barro (1986), the dependable policymaker is subject to a 'peso problem'.²⁰ In spite of the fact that their inflationary expectations are constantly biased upward, individuals continue to err in the same direction.

In the case $\tau = 1$, i.e., when randomization starts already in the first period, δ is not constrained to be larger than $\frac{1}{2}$. Hence, π_t^* may be increasing or decreasing over time depending on whether δ is larger or smaller than $\frac{1}{2}$. In the special case $\delta = \frac{1}{2}$, π_t^* is constant, which implies that the effect of an increasing α_t and a decreasing P_t just offset each other. As a consequence, expected and unexpected inflation are also time-invariant when $\delta = \frac{1}{2}$.

6. Concluding remarks

The main message of this paper is simple. A policymaker who is able to commit will produce zero inflation if the public knows this fact with certainty. However, when the public is not totally certain about his commitment ability, even a dependable policymaker partially, but optimally, accommodates inflationary expectations. This behavior is particularly in evidence immediately following stabilization programs. During such periods the reputation of the policymaker for commitment ability is often not very high. Many stabilization programs, such as the recent ones in Israel, Argentina, and Brazil, followed

¹⁹When there is full accommodation, $\pi_t^e - \pi_t^* = 0$.

²⁰Such a problem has been identified in the context of forward exchange markets by Krasker (1980).

on the ashes of previous unsuccessful stabilization attempts and broken promises. In such situations even policymakers that are capable of precommitment find it optimal to partially accommodate inflation. However, unlike policymakers who are not capable of precommitment, they do that not by breaking their promises. Instead they announce and achieve more modest targets with respect to the reduction of inflation, as a result of which inflation is not fully conquered.²¹

A related, more general message is that in the presence of private information about dependability (or about the cost to the policymaker of renegeing on preannouncements) 'cheap talk' is informative. This message transcends the model of monetary policy presented here. An example from a different area is candidate Bush's statement on television that if he is elected there will be no new taxes – the famous 'read my lips' statement. The reason this statement was informative is that the public knew that if Bush would renege on the statement he would incur a cost. Hence, the fact that he made that statement conveyed some new information about the likelihood of new taxes to the public. But in the absence of precise knowledge about the cost of renegeing to Bush, the 'read my lips' statement, although informative, still left a margin of uncertainty.

Stein (1989) has recently presented a theory of imprecise policy announcements within a framework in which the policymaker's exchange-rate target is private information. Our model shares with his model the feature that announcements convey noisy but meaningful information to the public, thereby changing the tradeoffs facing the policymaker. However, unlike in Stein's model our strong policymaker has no incentive to cheat. He, therefore, makes a fully truthful announcement. But the potential presence of another policymaker who has an incentive to cheat renders this announcement imprecise from the public's point of view. In addition, the policymaker's objective function postulated by Stein differs from ours.

Finally, the paper implies that whether the uncertainty about policymakers' types is due to different precommitment abilities or to different relative concerns about inflation and unemployment has important implications for the policy chosen by the strong policymaker.²² In the first case, as shown here, he partially compromises on his price stability objective. In the second case, as shown by Vickers (1986), he inflates at a rate that is even lower than his discretionary rate under perfect information in order to separate himself from his weak counterpart.

²¹As a byproduct, the paper provides a theory of endogenous preannouncements, which complements the discussion of mandatory preannouncements of monetary targets in Cukierman and Meltzer (1986).

²²Earlier papers, like Backus and Driffill (1985a, b), can be interpreted in either way because they implicitly assume, as does Barro (1986), that the strong (in our sense) policymaker behaves in the same manner whether his type is common knowledge or not. See also footnote 1.

Appendix

A.1. Demonstration of the uniqueness of the strategy $\pi^ \equiv (1 - \alpha)c$ for the dependable policymaker*

There may, in general, exist many self-fulfilling equilibria in which the public's beliefs are

$$\pi^e = \begin{cases} c & \text{for } \pi^a \neq \pi', \\ \alpha\pi^a + (1 - \alpha)c & \text{for } \pi^a = \pi', \end{cases} \quad (\text{A.1})$$

for some $\pi' \neq \pi^*$. To establish this, it is sufficient to show that [provided both policymakers are aware of the fact that expectations are formed according to (A.1)] it is individually rational for both W and D to announce π' . This is obviously the case for W as long as $\pi' < c$ and $\alpha > 0$. To find conditions under which π' is an individually rational policy for D too, we compare the value of D's objectives when he announces and delivers π' with their value under alternative policies. For any $\pi^a = \pi \neq \pi'$, $\pi^e = c$. Hence, the best strategy for D subject to the constraint that $\pi^a \neq \pi'$ can be found by solving

$$\max_{\pi^a} -\frac{a}{2}(\pi^a)^2 + b(\pi^a - c). \quad (\text{A.2})$$

The solution to this problem is the discretionary rate, c , and the associated value of the objective function is

$$-\frac{a}{2}c^2. \quad (\text{A.3})$$

If, alternatively, D announces π' , the value of his objectives is, in view of (A.1)

$$-\frac{a}{2}(\pi')^2 + b(1 - \alpha)(\pi' - c). \quad (\text{A.4})$$

D is better off announcing (and delivering) π' rather than any other rate if and only if the value of objectives in (A.4) is larger than the value of objectives in (A.3). Provided $\pi' < c$, this is equivalent to

$$\pi' > (1 - 2\alpha)c.$$

Hence,

$$E^* \equiv \{\pi' | c > \pi' > (1 - 2\alpha)c\} \quad (\text{A.5})$$

is the entire set of possible self-fulfilling equilibrium announcements. Note that in particular π^* and values of π' , in a sufficiently small neighborhood of π^* , are contained in E^* .

Which of these equilibria is best for D? The answer to this question [maximizing (A.4) with respect to π' subject to $\pi' \in E^*$] is π^* . Thus, D strictly prefers π^* over all other equilibria. Note that all equilibria in the set E^* (π^* excepted) can be eliminated by using the Cho–Kreps intuitive criterion. To produce the structure of beliefs in (A.1), for any arbitrary $\pi' \in E^*$, the policymaker in office may address the public, at the beginning of the game in the following manner: ‘Your beliefs should be formed as in (A.1) since, if they are, those beliefs are self-fulfilling.’ But, as we saw, D prefers the equilibrium π^* over all other equilibria in E^* and the public knows that. Hence, he can, by using the above argument for $\pi' = \pi^*$, induce the structure of beliefs

$$\pi^e = \begin{cases} c & \text{for } \pi^a \neq \pi^*, \\ \alpha\pi^a + (1 - \alpha)c & \text{for } \pi^a = \pi^*. \end{cases} \tag{A.6}$$

D’s argument to the public in this case could be: ‘Since I prefer π^* to all other $\pi' \in E^*$, you should have beliefs as in (A.6) since i) this structure of beliefs is best for me, ii) if you believe in it, it is the *unique* self-fulfilling equilibrium independent of the policymaker’s type in office.’

Finally, note that since the public knows that it is in D’s best interest to make such a statement, W is, indeed, compelled to make it too in order not to be revealed at the outset. It follows that the equilibrium described in the text is unique.

A.2. Derivation of eq. (38)

The present values of W’s objectives when he mimics D and when he does not are, respectively,

$$V(s^W|\pi_1^*) = -\frac{a}{2}(\pi_1^*)^2 + b(\pi_1^* - \pi_1^e) + \delta \left[-\frac{a}{2}c^2 + b(c - \pi_2^e) \right] \tag{A.7a}$$

and

$$V(s^W|c) = -\frac{a}{2}c^2 + b(c - \pi_1^e) - \delta \frac{a}{2}c^2, \tag{A.7b}$$

where

$$s^W|\pi_1^* \equiv \{\pi_1^*, \pi_1^*, \pi_2^*, c\} \tag{A.8a}$$

$$s^W|c \equiv \{\pi_1^*, c, c, c\}. \tag{A.8b}$$

The probability, P_1 , is determined by the indifference condition

$$V(s^W | \pi_1^*) = V(s^W | c). \quad (\text{A.9})$$

Using (29), (32), and (34) in eqs. (A.7), substituting the resulting expressions in (A.9), and rearranging, we obtain

$$x^2 - 2x + 1 - 2\delta\alpha_2^2 = 0, \quad (\text{A.10a})$$

where

$$x \equiv (1 - \alpha_1)(1 - P_1). \quad (\text{A.10b})$$

The solution to the quadratic in (A.10a) is

$$(1 - \alpha_1)(1 - P_1) = 1 - \sqrt{2\delta\alpha_2^2}. \quad (\text{A.11})$$

Since α_1 and P_1 are bounded between zero and one, $0 \leq x \leq 1$. Hence, the positive root is irrelevant. Eq. (38) is obtained by substituting the updating equation, eq. (31), into (A.11). Q.E.D.

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