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Monetary Policy, Reputation and Hysteresis*

By Hans Peter Grüner**

1. Introduction

If decision makers in a central bank are interested in a high employment level, they have, following Barro and Gordon (1983), an incentive to create surprise-inflation. If nominal wages are fixed for a certain period of time, surprise inflation lowers the real wage and, in a situation of classical unemployment, output and employment increase. In their well-known analysis, Barro and Gordon show that such attempts to stimulate employment are defeated if the public rationally anticipates such a policy. In this case the public raises inflation expectations up to the point where the marginal loss arising from inflation equals the marginal gain from employment stimulation. The emerging situation is therefore one of inflation and unemployment. If inflation and unemployment are costly for society, then society will prefer the second-best outcome without inflation and with the given unemployment level. This outcome, however, is only achievable if the central bank can credibly precommit not to inflate after nominal contracts are made, i.e. if inflation is made more costly for the central bank or if the incentives to create surprise inflation are removed. From this point of departure a vast array of literature has developed in the last ten years, dealing with the ways such precommitment can be made possible. In one influential article, Backus and Driffill (1985) argue that it can arise naturally from a repeated game: if there is a positive initial probability that the central banker is "conservative", i.e. that he is only interested in inflation, not employment, and if the public learns about the central banker's type over time, then there is an incentive for "weak" policymakers (policymakers who are interested in the employment target) to mimic the conservative type for a number of periods and to gain counterinflation-reputation.

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This positive result can be seen as a theoretical justification for the choice of any central bank constitution which leaves monetary policy to an independent and – potentially – conservative central banker. Such central bank constitutions include the German *Bundesbankgesetz*, the modified regulations for the *Banque de France* and also the current plans for the European Central Bank (ECB). Their common feature is that they rely exclusively on the central banker's own interest to build up an anti-inflation reputation and that they do not include any additional regulatory devices. In this paper, I want to argue, that the results obtained by Backus and Driffill are overly optimistic and that it is thus dangerous to rely on central bank independence alone. Backus and Driffill obtain their strong result by directly applying the technical analysis of the repeated prisoner's dilemma situation (see Kreps and Wilson, 1982) to the repeated monetary-policy game. This, however, requires that there is no direct link between state variables at different points of time in the game. Backus and Driffill especially assume that the incentives to create surprise inflation do not change over time. However, as we know from the work on hysteresis in unemployment (e.g. Blanchard and Summers, 1986, Burda, 1990) this is not true for at least some European countries. Changes of the rate of unemployment – a major incentive to create surprise – are highly persistent within Europe. This implies that if surprise inflation has short-run employment effects, it will also have long run employment effects. In the present paper, I drop the restrictive assumption of unchanged state variables. The "natural" solution to the time-inconsistency problem, proposed by Backus and Driffill, is re-examined under the assumption that there is hysteresis in unemployment.

I will examine a simplified two-period version of the Backus and Driffill model in Section 2. We will see that under the assumption of hysteresis the type of the policymaker is revealed when he chooses policy in the first period. Thus, there is little hope for countries with hysteresis that the possibility of gaining reputation has a disciplinary effect on a weak central banker. Alternative concepts for central bank credibility which rely on contracts rather than on central bank independence alone are discussed in the section 3.

2. A model of reputation and hysteresis

A natural solution to the time inconsistency problem is that a weak policymaker is interested in gaining a reputation for being tough. In their repeated monetary policy-game, Backus and Driffill (1985) assume that there are two potential monetary policy makers, one weak (here indexed by W) and one conservative or "hard nosed" (indexed by HN). In their signaling game the weak policymaker chooses a mixed strategy which, with a positive probability, will not reveal his type. Their result, however, is based on the assumption that incentives to create surprise inflation do not change over time. The repeated game in this section re-examines reputation formation under the assumption that hysteresis on the labor market links incentives to create surprise inflation over time. We thereby maintain Backus and Driffill's assumption that a hard-nosed policymaker always chooses zero inflation. Under hysteresis changes in unemployment have a tendency to persist over several periods. In the extreme case (c.f. Blanchard and Summers, 1986), unemployment follows a random walk when there is no unexpected policy intervention. With hysteresis, the unemployment rate becomes a state variable in the repeated monetary policy game. An unanticipated policy intervention which reduces current unemployment through surprise inflation will reduce unemployment in later periods. The introduction of hysteresis into the repeated game is an important extension since hysteresis is a common problem of the European countries (see e.g. Burda, 1990, Blanchard and Summers, 1986 and Grüner, 1993b, 1995). We will see that it changes results substantially: under hysteresis, weak policymakers no longer have sufficiently strong incentives to mimic the behavior of a conservative central bank.

The game we use is a simple signaling game where time is divided into two periods, $t = 1,2$.[1] In each period, the uninformed player (the public) chooses inflation expectations, π_t^e before the informed agent (the central bank) chooses actual inflation π_t. In the beginning of period 1 nature chooses the type of the central bank which is reflected in a parameter b. After this, the public chooses expectations π_1^e. Given π_1^e the central bank chooses the signal, π_1. In the second period, the type of the central bank remains unchanged.

It is assumed that in both periods the public chooses unbiased expectations whenever this is possible. I therefore assume that the public does not act strategically when it chooses expectations in period 1 in the sense that it does not choose biased expectations in order to make the central bank reveal its private information.[2] Formally the public is represented through two one-period players P1 and P2 which maximize the utility function $U^{P_t}(\pi_t, \pi_t^e) = -|E(\pi_t) - \pi_t^e|$ in periods 1 and 2 respectively. Utility of the central banker has the general form:

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[1] I restrict myself to the two period case because it delivers the whole intuition of the results and because the analysis of a game with more periods would be considerably harder.

[2] This assumption is appropriate whenever expectation-formation is not fully centralized. In the case where one single agent, e.g. one country-wide trade union, determines expectations, strategical behavior of this kind would become more likely. In this case the union might want to sacrifice correctness of expectations for more information about the central bank's type. However, when there is more than one trade union, unbiased expectations should be optimal for each of them.

$$z(\pi_1, \pi_2, \pi_1^e, \pi_2^e) = -\sum_{t=1}^{2} \delta^{t-1} \left[\frac{a}{2}\pi_t^2 + \frac{b}{2}(\pi_t - \pi_t^e - u_t^B)^2 \right] \tag{1}$$

where δ is a discount factor and π and π^e denote actual and expected inflation. The utility function is composed of two loss terms for each period. The first loss term $-\frac{a}{2}\pi_t^2$ represents increasing costs from positive (or negative) inflation rates. a is a given constant. The second term is the loss from current unemployment, u_t. Current unemployment is lower than the reference value u_t^B if there is surprise inflation in period t, i.e. $u_t = u_t^B + \pi_t^e - \pi_t$. One standard justification of this assumption is that expectations enter nominal wage contracts and that expectation errors change the real wage and thus the employment level (c.f. Barro and Gordon, 1983). At the stage where π_t^e and u_t^B are given, the central bank has two conflicting targets: (i) zero inflation and (ii) an inflation rate of $\pi_t^e + u_t^B$ which would reduce unemployment to zero. The parameter b is a measure of the central bank's commitment to a low inflation policy. Following Backus and Driffill we assume that the public does not know whether the policymaker in office is a weak ($b = \bar{b} > 0$) or a strong one ($b = 0$).

I will assume that, under hysteresis, a reduction of unemployment u_1 in period 1 through surprise inflation reduces the threshold level of unemployment u_2^B in period 2. Hysteresis of unemployment can be derived from different types of insider-outsider models. Their common feature is that the output stimulation in one period gives rise to an increase of either the "insider workforce" or the membership of the negotiating trade unions. This in turn reduces nominal wages. There is a large body of empirical evidence on hysteresis in Europe. Burda (1990) e.g. can not reject unit roots in sectoral employment for most European countries. He also has some evidence for the importance of trade-union membership in Germany.[3] I examine the game under two alternative assumptions on u_t^B:

Assumption 1

There is full hysteresis on the labor market, i.e. $u_2^B = u_1 = u_1^B + \pi_1^e - \pi_1$.[4]

[3] A survey of the empirical literature on hysteresis and insider power can be found in Grüner (1995).

[4] Assumption 1 considers an extreme case because both, positive and adverse employment shocks are fully persistent. I will later discuss the consequences of incomplete or asymmetric hysteresis. Assumption 1 neglects other than monetary shocks because they are not central to the argument here.

Assumption 2

There is no hysteresis and $u_2^B = u_1^B$.

u_1^B is exogenously given. The probability assigned to a hard-nosed policymaker at the beginning of period t is denoted by q_{t-1}. q_0 is given. A strategy of the central bank consists of two functions $\pi_1 = f_1(\pi_1^e, b)$ and $\pi_2 = f_2(\pi_1, \pi_1^e, \pi_2^e, b)$. A strategy for the public in period 1 (P1) consists of an action π_1^e, the strategy of the public in period 2 (P2) is a function $\pi_2^e = g(\pi_1, \pi_1^e)$.

Before we analyze the game under the alternative assumptions 1 or 2 we can derive some general properties of an equilibrium for both cases. We demand that the central bank's planned reaction to expected inflation in period 2, $f_2(\pi_1, \pi_1^e, \pi_2^e, b)$, must not represent an incredible threat to player P2. Hence, $f_2(\pi_1, \pi_1^e, \pi_2^e, b)$ can be obtained from the maximization of the central bank's second period utility for given expected inflation. This yields:

$$(2) \qquad \pi_2 = f_2^*(\pi_1, \pi_1^e, \pi_2^e, b) = \frac{b}{a+b}(\pi_2^e + u_2^B).$$

Moreover, it follows immediately from equation (1) that in any Nash equilibrium the action of the hard-nosed type (HN) must be zero inflation in both periods. This is so because his utility function is independent of expectations: $z^{HN}(\pi_1, \pi_2, \pi_1^e, \pi_2^e,) = -\sum_{t=1}^{2} \delta^{t-1} \frac{a}{2} \pi_t^2$. Consequently, for any given value of q_1, unbiasedness of expectations in period 2 always requires:

$$(3) \qquad \pi_2^e = q_1 \cdot 0 + (1-q_1)\frac{\bar{b}}{a+\bar{b}}(\pi_2^e + u_2^B) \Leftrightarrow \pi_2^e = g = \frac{(1-q_1)\bar{b}}{a+q_1\bar{b}} u_2^B.$$

Inflation of the weak type (type W) in period 2 is

$$(4) \qquad \pi_2^W = \frac{\pi_2^e}{1-q_1} = \frac{\bar{b}}{a+q_1\bar{b}} u_2^B$$

and the surprise W creates in the second period is:

$$(5) \qquad e_2 := \pi_2^W - \pi_2^e = \frac{q_1\bar{b}}{a+q_1\bar{b}} u_2^B.$$

If type W is in office, second period unemployment becomes:

$$(6) \qquad u_2 = \frac{a}{a+q_1\bar{b}} u_2^B$$

We choose sequential equilibrium as the equilibrium refinement (c.f. Kreps, 1990 and Fudenberg and Tirole, 1992). Thus we demand that for an equilibrium strategy profile

$$\left(f_1(\pi_1^e, b), f_2(\pi_1, \pi_1^e, \pi_2^e, b), \pi_1^e, g(\pi_1, \pi_1^e)\right),$$

there exist beliefs of player P2 that the policymaker is hard-nosed (HN), $q_1 = \mu(\pi_1, \pi_1^e)$, such that

(i) Beliefs $q_1 = \mu(\pi_1, \pi_1^e)$ are consistent with Bayes law whenever π_1 is chosen by at least one of the two types with a positive probability.

(ii) The reaction of the public in period 2, $\pi_2^e = g(\pi_1, \pi_1^e)$, is optimal given beliefs $q_1 = \mu(\pi_1, \pi_1^e)$ and f_1 and f_2.

(iii) The action of the central bank in period 1 is optimal, given the strategy of P2.

(iv) π_1^e is the optimal strategy of player P1, given $\pi_1 = f_1(\pi_1^e, b)$.

Pooling Equilibrium

Chances for a pooling equilibrium to prevail are best if utility is not discounted because gains from pooling accrue in period 2. For simplicity I therefore assume:

Assumption 3 $\delta = 1$.

We already know that in any equilibrium, type HN must choose zero inflation in both periods. Hence, the only candidate for a pooling equilibrium is $\pi_1^W = \pi_1^{HN} = 0$ where W and HN refers to the two types. We will see that the central bank's actions in both periods and hence its utility in a potential pooling equilibrium must be the same under the two different assumptions about the unemployment process. Type HN's utility in a pooling equilibrium is always zero. We now first calculate pooling utility of the weak type and then, in proposition 1 and 2, check whether it pays for him to deviate from the zero inflation rate in period 1.

In any pooling equilibrium, expectations in period 1 must be $\pi_1^e = 0$. Moreover, the central bank's strategy must satisfy $f_1(0, \bar{b}) = 0$. At the beginning of period 2 the public still has the initial beliefs about the central banker's type because there is pooling in period 1. Thus $q_1 = q_0$. Also, unemployment u_2^B remains at the old level u_1^B, both under assumption 1 and 2. Expected inflation in period 2 is given by (3), inflation by

(2) and second period unemployment by (6). Hence, utility of type W in the pooling equilibrium is:

$$(7) \quad z^{\text{pooling}} = -\frac{\bar{b}}{2}\left(u_1^B\right)^2 - \frac{a}{2}\pi_2^2 - \frac{\bar{b}}{2}u_2^2 = -\frac{a\bar{b}^2 + a^2\bar{b} + \bar{b}\left(a + q_0\bar{b}\right)^2}{2\left(a + q_0\bar{b}\right)}\left(u_1^B\right)^2.$$

We can now examine the existence of pooling equilibria under the different assumptions about the unemployment process. Under hysteresis, repeating the Barro-Gordon game has no disciplinary effect on the weak policymakers actions.

Proposition 1 Non-existence of pooling equilibria under hysteresis.

Under the assumptions 1 and 3, the game has no pooling equilibrium.

Proof 1

The best way to sustain a pooling equilibrium is to assume that out of equilibrium beliefs satisfy $\mu(\pi_1, 0) = 0$ for all inflation rates different from zero. To see this, consider any given deviation of type W from zero inflation in period 1 which leads to a level of unemployment u_2^B. For any given level of u_2^B, expected inflation in period 2 π_2^e increases when q_1 falls (equation 3). This increases the difference between the weak central bank's conflicting objectives of zero inflation and full employment in the second period. Hence lower values of q_1 reduce type W's second period utility for any given deviation from the period 1 equilibrium action. Consequently, if there is no pooling equilibrium for $\mu(\pi_1, 0) = 0 \; \forall \pi_1 \neq 0$, then there is no pooling equilibrium at all.

If W deviates from zero inflation in period 1 then unemployment becomes $u_1^B - \pi_1$ in both periods. Unemployment in period 2 equals unemployment in period 1 because, from $q_1 = 0$, there is no surprise inflation in period 2. Expected and actual inflation of W in period 2 are from (4): $\pi_2^W = \frac{\bar{b}}{a}(u_1^B - \pi_1)$. The utility of W becomes

$$(8) \qquad z^{\text{deviate}} = -\frac{a}{2}\pi_1^2 - \frac{a}{2}\left(\frac{\bar{b}}{a}\left(u_1^B - \pi_1\right)\right)^2 - \bar{b}\left(u_1^B - \pi_1\right)^2.$$

From (8) W's optimal choice of π_1 is given by:

$$(9) \qquad \begin{aligned} & -a\pi_1 + a\frac{\bar{b}}{a}\left(\frac{\bar{b}}{a}\left(u_1^B - \pi_1\right)\right) + 2\bar{b}\left(u_1^B - \pi_1\right) = 0 \\ \Leftrightarrow \; & \pi_1 = \frac{\bar{b}^2 + 2a\bar{b}}{a^2 + \bar{b}^2 + 2a\bar{b}}\,u_1^B \end{aligned}$$

From (9), unemployment in both periods is:

$$u_1 = u_2 = \frac{a^2}{a^2 + \bar{b}^2 + 2a\bar{b}}\, u_1^B \tag{10}$$

Substitution of (9) and (10) into (8) yields:

$$\begin{aligned} z^{\text{deviate}} &= \left[-\frac{a}{2}\left(\frac{\bar{b}^2 + 2a\bar{b}}{a^2 + \bar{b}^2 + 2a\bar{b}}\right)^2 - \frac{a}{2}\left(\frac{\bar{b}}{a}\left(\frac{a^2}{a^2 + \bar{b}^2 + 2a\bar{b}}\right)\right)^2 \right. \\ &\qquad \left. - \bar{b}\left(\frac{a^2}{a^2 + \bar{b}^2 + 2a\bar{b}}\right)^2 \right] \left(u_1^B\right)^2 = \\ &\qquad - \frac{a\bar{b}^4 + 4a^3\bar{b}^2 + 4a^2\bar{b}^3 + a^3\bar{b}^2 + 2\bar{b}a^4}{2(a + \bar{b})^4} \left(u_1^B\right)^2 \Leftrightarrow \\ z^{\text{deviate}} &= -\frac{a\bar{b}^2 + 2a^2\bar{b}}{2(a + \bar{b})^2} \left(u_1^B\right)^2 \end{aligned} \tag{11}$$

This is more than W's utility in the pooling case (7). Hence, no pooling equilibrium exists. Q.E.D.

With hysteresis the game has no pooling equilibrium. The opposite is true if we assume the absence of hysteresis.

Proposition 2 Existence of pooling equilibria without hysteresis

Under Assumption 2 and 3 there is a pooling equilibrium if q_0 exceeds a certain threshold q_0^*.

Proof 2 see appendix.

This second result is quite intuitive: if q_0 is large and if there is no hysteresis, then gains from inflating in period one or period two bring approximately the same employment gains for the weak policymaker. Cheating in period one is, however, costly if q_0 is high, because then expected inflation in period two is much higher than under pooling.

It remains to be verified whether there are separating equilibria in the game with hysteresis. I will show here that there are parameters a, b and q such that a unique separating equilibrium exists. In the separating equilibrium, there is a certain temptation for type W to choose zero inflation in period one because this makes the public believe that he is type HN in period two. However, the price he has to pay for mimicking is high, since in a separating equilibrium initial inflation expectations exceed zero. Hence, gaining reputation is very costly in terms of employment. We have:

Proposition 3 Existence of a separating equilibrium with hysteresis

Let $u_1^B > 0$. Under Assumptions 1 and 3 there are parameters a, b and q_0 in a neighbourhood of $(b = a = 1, q_0 = 1/2)$ such that the game has exactly one sequential equilibrium in pure strategies; this equilibrium is a separating equilibrium.

Proof 3 see appendix.

Propositions 1, 2 and 3 support – like the results of Vickers (1986) – the existence of separating rather than pooling equilibria in repeated monetary policy games. Vickers obtains this result because he allows the conservative central banker to choose a negative inflation rate. I maintain Backus and Driffill's assumption that the conservative central banker always chooses zero inflation. The reason why I do not obtain a pooling equilibrium is different: persistent gains through surprise inflation always create an incentive for a weak policymaker to surprise the public as soon as possible. It follows that in a country with full hysteresis, a weak central banker will never choose a low inflation rate to mimic a hard-nosed policymaker and that – in such a situation – different mechanisms are necessary to solve the time-inconsistency problem.[5]

The result has been derived under the somewhat extreme assumption of full hysteresis. I assumed that changes in employment which are created through surprise inflation are fully persistent. In the membership-hysteresis model this would correspond to the case where newly hired workers have the same influence on wage negotiations as old workers. If newly hired workers are excluded from the decision process inside the trade union then hysteresis is incomplete in the sense that adverse shocks are more persistent than beneficial shocks (c.f. Blanchard and Summers, 1986, for a discussion of this problem). One should expect from propositions 1 and 2 that, under the weaker assumption of incomplete hysteresis, there is a critical degree of persistence above which pooling ceases to exists.[6]

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5 Obviously, hysteresis should also alter the equilibrium inflation rate when there is no uncertainty about the policy maker's type because hysteresis raises the marginal utility of surprise inflation.

6 There are some more generalisation of the results which are possible. First the model might be extended to the case of more than two periods. Second, the existence of observational errors (e.g. money control errors) would be an interesting and realistic extension. Under control errors complete separation would no longer be possible. However, in this case hysteresis should increase incentives for a weak policy maker to "separate more", i.e. to choose a higher average inflation rate. This also would adversely affect (expected) beliefs that the policy maker is hard-nosed.

3. Policy Implications and Conclusion

The analysis of the time inconsistency problem of monetary policy by Barro and Gordon (1983) was followed by a voluminous literature on potential solution concepts. Among the most prominent solution concepts are

1) The natural solution via reputation formation (Backus and Driffill, 1985).

2) The conservative and independent central banker with no interest in unemployment at all (c.f. Rogoff, 1986).

3) A fixed exchange rate with a country that already has an anti inflation reputation (c.f. Giavazzi and Giovannini, 1989).

Our analysis shows that the positive results from Backus and Driffill (1985) on the disciplinary effects of reputation on weak policymakers are absent if there is hysteresis in unemployment. In this case, a weak policymaker always reveals himself when he chooses inflation. The reason for this is that persistent gains from playing tough in repeated prisoners' dilemma situations remove the disciplinary effects of reputation. Our result is of particular importance for European countries because hysteresis is a common feature in their labor markets. It implies that the delegation of monetary policy to an independent and potentially conservative central banker is at most a necessary but not a sufficient condition for low-inflation in those countries. Moreover, even a relatively conservative central banker should have higher incentives to create surprise inflation in the presence of hysteresis. This pessimistic view of reputation does of course not only apply to national European central banks but also to a common European Central Bank.

Alternatives to the *laissez-faire* solution of the time-inconsistency problem have recently been discussed in the game theoretical literature on mechanism design and monetary policy (Walsh, 1995, Lohmann, 1992, Persson and Tabellini, 1993 and Grüner, 1993a). These solutions implement the optimal policy through contracts for the central bank that link the central banker's remuneration to his performance. Therefore, they do neither need reputational effects nor any external exchange rate target in order to achieve monetary credibility. Walsh (1995) shows that a simple incentive mechanism can completely solve the credibility vs. flexibility trade-off which was first described by Rogoff (1985). Thus, incentive mechanisms can theoretically outperform the "more conservative than society" central bankers which have received so much attention in the recent literature.

Such a contract need not come in form of a strict monetary rule. Different forms of contracts are currently being discussed. Contracts which make the remuneration of the central banker dependent on deviations from a given inflation target (rule based contract) and contracts which punish deviations from auto-imposed monetary target announcements of the central bank (announcement based contracts). It has been shown that the major advantage of target announcements is that they can bind the central bank's actions effectively without endangering central bank independence. Although, theoretically, these mechanisms are able to generate second-best solutions, the problems of their practical implementation have so far received little attention in the literature[7]. One important problem is the practical determination of the optimal remuneration schedule for the central bank. Another open question is: who should be controlled by a mechanism in a bureaucracy like a central bank. The analysis of different manners in which to implement such incentive mechanisms is therefore on the agenda for future research.

Appendix

Proof 2

Utility of type W in a potential pooling equilibrium is again given by equation (7). I now consider the case where the central bank chooses a strategy with $f_1(0, \bar{b}) > 0$ instead of its equilibrium strategy. I want to show that there is a pooling equilibrium when out-of-equilibrium beliefs satisfy $q_1(\pi_1, 0) = 0 \, \forall \pi_1 \neq 0$. Suppose that type W is in office and that he chooses a positive inflation rate in period 1. In this case, the public believes that the central bank is weak at the beginning of period 2. From equation (3), expected and actual inflation in period 2 become $\bar{b}/a u_1^B$. Second period unemployment remains at u_1^B. Expected inflation in period 1 is zero and the optimal rate of inflation for W is $\frac{\bar{b}}{a+\bar{b}} u_1^B$ because there is no hysteresis. First period unemployment is $\frac{a}{a+\bar{b}} u_1^B$. W's utility is

$$(13) \qquad -\frac{a}{2}\left(\frac{\bar{b}}{a+\bar{b}} u_1^B\right)^2 - \frac{\bar{b}}{2}\left(\frac{a}{a+\bar{b}} u_1^B\right)^2 - \frac{a}{2}\left(\frac{\bar{b}}{a} u_1^B\right)^2 - \frac{\bar{b}}{2}\left(u_1^B\right)^2 =$$

$$(14) \qquad -\frac{a\bar{b}^2 + a^2\bar{b} + \left(\frac{\bar{b}^2}{a} + \bar{b}\right)(a+\bar{b})^2}{2(a+\bar{b})^2}\left(u_1^B\right)^2$$

For $q_0 = 1$ this is less than W's equilibrium utility (7). The proposition follows from continuity of (7) in q_0. Q.E.D.

[7] c.f. Grüner (1995b) for a discussion of advantages of different types of incentive mechanisms for central bankers and Walsh (1994) for an analysis of the central bank act of New Zealand. Grüner and Hefeker (1995) discuss political economy issues of contracts for central banks.

Proof 3

For analytical convenience, it is useful to compare utility of type W to his utility in a reference case where expected and actual inflation are zero in both periods. From equation (1) utility in the reference case is $-\bar{b}\,u_1^B$. This would be type W's utility if he could credibly commit not to inflate in both periods. Type W's utility gains with respect to this reference situation are denoted by Δz. In a separating equilibrium, type W creates surprise inflation e in period 1. I proceed in two steps. I first calculate the value for e in a separating equilibrium in order to determine equilibrium utility of type W (Step 1). Second, I examine whether W has an incentive to mimic HN in period 1 (Step 2).

Step 1) In a separating equilibrium only type HN chooses zero inflation in period 1, thus beliefs must satisfy $\mu(0) = 1$. Moreover, I assume that $\mu(\pi, \pi^e) = 0$ whenever $\pi \neq 0$. Take expected inflation in period one as given. The total gain realized by W by playing $\pi_1 = \pi_1^e + e$ in period 1 is the loss from inflation in both periods ($\pi_1 = \pi_1^e +$ and $\pi_2 = \frac{\bar{b}}{a}(u_1^B - e)$) plus twice the gain from reduced unemployment:

$$\Delta z^{\pi_1 = \pi^e + e} = -\frac{a}{2}(\pi_1^e + e)^2 + \frac{\bar{b}}{2}(2eu_1^B - e^2) - \frac{a}{2}\left(\frac{\bar{b}}{a}(u_1^B - e)\right)^2 + \frac{\bar{b}}{2}(2u_1^B e - e^2) \tag{15}$$

given that $\pi_1 = \pi_1^e + e \neq 0$. Maximization of (15) by choice of e necessitates:

$$\frac{\partial \Delta z^{\pi_1 = \pi^e + e}}{\partial e} = -a(e + \pi_1^e) - \frac{\bar{b}^2}{a}(e - u_1^B) + 2\bar{b}(u_1^B - e) = 0 \tag{16}$$

$$\Leftrightarrow \; e\left(2\bar{b} + \frac{\bar{b}^2}{a} + a\right) = \left(2\bar{b} + \frac{\bar{b}^2}{a}\right)u_1^B - a\pi_1^e. \tag{17}$$

(17) must be satisfied in a separating equilibrium with the above beliefs. Moreover, expectations must be unbiased. This necessitates that

$$e = \frac{q_0}{1 - q_0}\,\pi_1^e. \tag{18}$$

From (17) and (18) follows that the surprise in equilibrium must be:

$$e^* = \frac{\frac{\bar{b}}{a} + 2}{\frac{\bar{b}}{a} + 2 + \frac{a}{\bar{b}q_0}}\,u_1^B =: xu_1^B < u_1^B. \tag{19}$$

Substitution of e^* from (19) into (15) yields the gain $\Delta z^{\text{sep.eq.}}$ for type W in a separating equilibrium.

Step 2) Denote equilibrium expectations in period 1 with $\pi_1^{e^*}$. We now have to check whether there is another choice of $f_1(\pi_1^{e^*}, \bar{b})$ which makes type W better off than $f_1(\pi_1^{e^*}, \bar{b}) = \pi_1^{e^*} + e^*$. We already know that W does not prefer any other inflation rate which is different from zero. Thus it is sufficient to consider the case where W chooses zero inflation in period 1. Equilibrium expectations in period 1 are $(1 - q_0)/q_0 e^*$. Hence, type W creates a negative inflation surprise of $(1 - q_0)/q_0 e^*$ in period 1 when he chooses zero inflation. Unemployment rises to $u_2^B = [1 + (1 - q_0)/q_0 x] u_1^B$. In period 2, beliefs become $q_1 = \mu(0,0) = 1$, therefore $\pi_2^e = 0$. Inflation of type W in period 2 will be $\bar{b}/(a + \bar{b}) u_2^B$. The complete gain from mimicking HN is: $-\frac{a}{2}\pi_2^2 - \frac{\bar{b}}{2}(u_2^{B^2} - u_1^{B^2}) - \frac{\bar{b}}{2}((u_2^B - \pi_2)^2 - u_1^{B^2})$ or:

$$\begin{aligned}
\Delta z^{\pi_1 = 0} = \Bigg[& -\frac{a}{2}\left(\frac{\bar{b}}{a + \bar{b}}\left(1 + \frac{1 - q_0}{q_0}x\right)\right)^2 \\
& - \frac{\bar{b}}{2}\left(\left(\frac{1 - q_0}{q_0}x\right)^2 + 2\frac{1 - q_0}{q_0}x\right)\Bigg](u_1^B)^2 \qquad (20) \\
& + \frac{\bar{b}}{2}\left(u_1^{B^2} - (u_2^B - \pi_2)^2\right).
\end{aligned}$$

A separating equilibrium with the given beliefs exists iff (15) exceeds the gain from mimicking HN (20). I use:

$$\begin{aligned}
\frac{\bar{b}}{2}\left(u_1^{B^2} - (u_2^B - \pi_2)^2\right) &= \frac{\bar{b}}{2}\left(u_1^{B^2} - \left(\frac{a}{a + \bar{b}}u_2^B\right)^2\right) \\
&= \frac{\bar{b}}{2}\left(u_1^{B^2} - \left(\frac{a}{a + \bar{b}}[1 + (1 - q_0)/q_0 x]u_1^B\right)^2\right).
\end{aligned}$$

Substitution of e^* from (19) into (15) and division of (15) and (20) by $u_1^{B^2}$ gives us a sufficient condition for the existence of a separating equilibrium:

$$\begin{aligned}
& \Delta z^{\text{sep.eq.}} > \Delta z^{\pi_1 = 0} \Leftrightarrow -\frac{a}{2}\frac{1}{q^2}x^2 + \bar{b}(2x - x^2) - \frac{\bar{b}^2}{2a}(1 - 2x + x^2) > \\
& -\frac{a\bar{b}^2}{2(a + \bar{b})^2}\left(1 + \frac{1 - q_0}{q_0}x\right)^2 - \frac{\bar{b}}{2}\left(\frac{1 - q_0}{q_0}x\right)^2 \qquad (21) \\
& -\bar{b}\left(\frac{1 - q_0}{q_0}x\right) + \frac{\bar{b}}{2}\left(1 - \left(\frac{a}{a + \bar{b}}[1 + (1 - q_0)/q_0 x]\right)^2\right)
\end{aligned}$$

Division of the left hand side by $\bar{b}$ gives us $\left(-\frac{a}{2bq^2} - \frac{\bar{b}}{2a} + 1\right)x^2 + \left(2 + \frac{\bar{b}}{a}\right)x$. This term is always positive and exceeds $1/2$ for $\bar{b} = a = 1$ and $q = 1/2$. The only positive term on the right hand side is $\bar{b}/2 = 1/2$ for $\bar{b} = 1$. The proposition follows from the continuity of both sides in $a, \bar{b}$ and q. Q.E.D.

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Zusammenfassung

Backus und Driffill haben gezeigt, daß Reputation einen disziplinierenden Effekt auf das Verhalten schwacher Zentralbanken hat, wenn Output Schocks nicht persistent sind. In Europa beobachtet man jedoch Hysteresis auf den Arbeitsmärkten. In einem Signaling Spiel wird die Bedeutung von Hysteresis für das wiederholte Geldpolitikspiel untersucht. Die Anreize, anti-Inflations-Reputation zu gewinnen verschwinden unter Hysteresis. Zentralbankunabhängigkeit und Reputation alleine sind also keine hinreichenden Bedingungen für niedrige Inflation. Alternative Mechanismen werden vorgestellt.

Abstract

Backus and Driffill have shown that reputation has a disciplinary effect on weak monetary policy makers if output shocks are not persistent. In European countries, however, one observes hysteresis in output and employment. The present signaling game examines the effect of hysteresis on the labour market on the results of the repeated monetary policy game. Disciplinary effects of reputation disappear in the presence of hysteresis. Thus, reputation alone is not a sufficient device for establishing monetary discipline. We discuss alternative concepts for central bank credibility which rely on contracts rather than on central bank independence alone.

JEL-Klassifikation: D78, E50, E51, E58
Keywords: Signaling Games, Monetary Policy, Reputation, Hysteresis