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**Optimal Wage Indexation in a
Reputational Model of Monetary Policy
Credibility**

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Abstract

Price versus productivity indexing is considered in a model of monetary policy with wage bargaining. In a perfectly price-indexed economy, the government has no temptation to create unexpected inflation and the inflationary bias associated to the credibility problem is completely eliminated. On the other hand, productivity-indexing is more appropriate to dampen macroeconomic fluctuations when real disturbances are the causes. We show that productivity-indexing alone guarantees both price and employment stability, provided the government's reputation is good enough and/or the union's bargaining power is not too high.

1. Introduction

Since the early 1970s both academic researchers and policymakers devoted considerable attention to the macroeconomic effects of wage indexation to price changes and, in particular, to the issue of the optimal degree of such indexation. Problems of double digits inflation, following the first and second oil shocks, were in fact common to many industrialized countries, including United Kingdom, Italy and, later, United States. However, these two groups focused on different effects. The standard optimal indexation literature (Gray (1976); Fisher (1977)) emphasized the role of price indexation in stabilizing or destabilizing output in an economy randomly disturbed by both real and monetary shocks. The inadequacy of such indexation as a response to real disturbances led them to conclude that the optimal degree of price indexation is less than one and, in general, depending on the underlying stochastic structure of the economy. In contrast, informal policy discussions focused on the allegation that indexation is inflationary. Until recently economists lacked models of the sources of inflation so that it was difficult to formalize the effects of indexation on inflation. Starting with the late 1980's, formal models applied the Barro and Gordon (1983) insight that, with discretionary policy, the employment gains from surprise inflation tempt the monetary authority to create positive trend inflation. Fischer and Summers (1989) stressed that policies which reduce the cost of inflation, such as indexation, cause Barro-Gordon policymakers to choose higher inflation. On the other hand, as Ball and Cecchetti (1991) pointed out, wage indexation reduces the employment effects of surprise inflation and therefore weakens the temptation of the government to inflate. Since indexation has one inflationary effect (lower costs of inflation) and one anti-inflationary effect (a steeper Phillips curve), the net effect appears ambiguous.

At the beginning of the '90s the macroeconomic scenario changed and one pressing problem for all industrialized countries was the resurgence of unemployment as a consequence of the slowdown in the economic activity. The issue of price indexation was much less at debate, given the low level of inflation shared by the main industrialized economies. Even in Italy, where the unions considered for a long time price indexation as a central point of their wage

request, any direct mechanism tied to the price level was abolished in 1992. In many countries a growing emphasis started to be given to labor and wage flexibility in order to limit the loss of employment; the decentralization of industrial relations and the increasing tendency to allow negotiations at the plant level may be seen partly as a device to keep more in line wages with productivity changes.

In this paper we analyze the problem of optimal wage contract by modeling the effects of different wage negotiation schemes on inflation and output in a context of incomplete information with respect to the government's preferences, in presence of stochastic productivity shocks and wages resulting from a bargaining process between unions and firms. Hence, our work departs from the previous literature in many respects. In contrast to the standard optimal indexation literature (Gray (1976); Fisher (1977)), here the equilibrium level of employment is too low and monetary policy is explicitly considered. As in the papers by Fischer and Summers (1989), Ball and Cecchetti (1991) and others, we characterize monetary policy as a repeated game between the government and the private sector. Unlike them, we assume that the private sector is incompletely informed about the government's type: whether it is inflationary or anti-inflationary. The uncertainty related to monetary policy is therefore somehow endogenized, since shocks to money supply emerge as a consequence of some equilibrium outcomes. No shock to the demand for money is considered, though. In addition, we assume that there is an exogenous stochastic productivity shock, whose distribution is known to the economy. Furthermore, here the private sector is represented by a wage formation mechanism which incorporates the behavior of two agents: a union and a firm. They bargain over the nominal wage taking into account their expectations about the inflationary policy implemented by the government and the realization of the productivity shock. This setup enables us to model the negotiating behavior of the two parties and, consequently, the effects of different wage negotiation schemes on the equilibrium wage. The government decides the level of inflation after the wage bargaining process has taken place and after having observed the realization of the real shock.

We consider four types of wage contracts: with no indexation at all, with complete indexation to inflation, with indexation to real shocks, with double indexation. In fact, many existing types of

decentralized contracts in which wages are determined or revised according to the productivity observed at the single firm level may be considered, at least partially, as tools to reach wage flexibility in response to real shocks.

The model admits two types of equilibria in pure strategies: a "pooling" equilibrium, where no inflation results except in the last period of the game, and a "separating" equilibrium, where the "weak" government prefers to inflate since the beginning of the game.

The optimal wage negotiation scheme (i.e. the wage negotiation scheme which minimizes the loss function of the government) turns out to depend on several parameters, such as the reputation of the government, the relative bargaining power of the parties, the size of the shock and the degree of risk aversion of the workers. The mechanism with price indexation alone tends to be inferior to the one with double indexation, since the latter exhibits both the advantages of flexibility of the real wage in response to real shocks and the lack of incentives for the government to implement inflationary policies. The price indexation scheme may be superior or inferior to the no indexation case since the time-consistency constraint on the government's behavior induced by price-indexed wages may be compensated by the gain from surprise inflation which, in case of strong adverse shocks, might be considerable; the higher the reputation of the government the less efficient is the price indexation scheme. Productivity-indexed wages may or may not be superior to no-indexed wages, even though in general it attains higher utility, since with productivity indexation more pooling equilibria may be sustained. However, with strongly risk-averse unions and highly volatile real shocks, the level of the equilibrium wage with productivity adjustment may be so high that the advantages of such indexation scheme may be offset by the resulting higher mean unemployment rate.

Section 2 of this paper presents the macroeconomic model.

Section 3 analyzes the bargaining game and computes the equilibria under the four wage negotiation schemes.

Section 4 examines the optimal monetary policy, given that the behavior of the private sector is described by the wage formation process analyzed in the previous section. Section 4.1 computes the equilibrium of the "one-shot" game. Section 4.2 characterizes the reputational equilibrium of the repeated game, under the hypothesis that

the private sector is incompletely informed about the government's preferences about the trade-off between inflation and output.

Section 5 presents some numerical examples.

Section 6 concludes.

2. The Model

The macroeconomy is described by two simple equations; an aggregate demand function:

$$M_t/p_t = y_t, \quad (1)$$

where M_t is the money supply, p_t is the price level and y_t is real output; and an aggregate supply function:

$$y_t = F(L_t), \quad (2)$$

where $F(L_t)$ is the production function relating employment to output. The technology is described by a standard Cobb-Douglas:

$$F(L_t) = A_t (1/\alpha)L_t^\alpha, \quad \alpha < 1 \quad (3)$$

where, to represent the effect of a productivity shock we multiply the production function by a time dependent parameter A_t . We assume that A_t moves exogenously according to the process:

$$A_t = 1 + e_t,$$

where $e_t = \begin{cases} e & \text{with prob. } 1/2 \\ -e & \text{with prob. } 1/2 \end{cases}$, $e \in (0,1)$.

Given our specification of the production function, the demand for labor, $L_t = (F')^{-1}(w_t)$, is determined by the following equation:

$$L_t = (w_t/A_t)^{1/(\alpha-1)} \quad (4)$$

where $w_t = W_t/p_t$ is the nominal wage deflated by the general price index.

The government sets M_t to maximize:

$$u_t^g = \sum_{s=t}^T \delta_g^{s-t} E_s \left\{ -\Pi_s^2 - \lambda(L_s - \bar{L})^2 \mid \Omega_s^g \right\}, \quad \lambda > 0, \quad 0 < \delta_g < 1 \quad (5)$$

where $\Pi_s = p_s - p_{s-1}$ is the rate of inflation in period s and E_s is the expectation operator conditional on the information set available to the government at time s , Ω_s^g . Equation (5) says that the government wants to keep inflation and employment close to some desired levels, which are assumed to be zero and \bar{L} , respectively. The parameter λ indicates the relative weight assigned by the government to the employment objective.

The firm and the union negotiate each period over the nominal wage. Each party bargains so as to maximize its own payoff which is given by

$$u_t^f = E_t \left\{ [F(L_t) - w_t L_t] \mid \Omega_t^p \right\}, \quad (6)$$

and

$$u_t^u = E_t \left\{ [u(w_t) - \bar{u}] L_t \mid \Omega_t^p \right\}, \quad (7)$$

respectively for the firm and the union. Ω_t^p denotes the information set available to the public at the beginning of the contract period t , while bargaining is taking place. Equation (6) says that the firm is a profit maximizer. The union has N members, all alike. L of them are employed and achieve a level of utility $u(w)$. If not employed by the firm, the worker achieves a level of utility \bar{u} which can be thought of as the utility from receiving an unemployment compensation benefit. $u(w)$ is the standard sort of concave utility function; we assume

$$u(w) = w^\beta, \quad \beta < 1. \quad (8)$$

The union wishes to maximize $u(w)L + (N-L)\bar{u}$, which can be written as $[u(w) - \bar{u}]L + N\bar{u}$. Since N and \bar{u} are treated as data for the purpose of the union wage setting the problem can be summarized by saying that the union wishes to maximize the membership aggregate gain from employment, over and above the utility \bar{u} that every member starts with (equation

(7)).

The game proceeds as follows. At the beginning of each period union and firm bargain over the nominal wage, taking into account their expectations about both the inflationary policy implemented by the government and the realization of the productivity shock in that period. Then the shock realizes, and the government chooses its inflationary strategy conditional on the observation of the nominal wage set during the negotiation process and the realization of the productivity shock. Finally, the firm takes nominal wages as given by the bargaining outcome and sets employment and output according to equations (4) and (3), once the price level has become observable. Therefore, both current and past values of the relevant variables are known by the government while choosing its optimal inflationary strategy, $\{W_{t-1}, e_{t-1}\} \in \Omega_t^g$ ($i=0,1,\dots$); whereas only lagged inflation and past realizations of the productivity shock are included in the information set available to the parties during the wage negotiation process, $\{\Pi_{t-1}, e_{t-1}\} \in \Omega_t^p$ (only for $i=1,2,\dots$).

The conflict between government and private sector is generated by the hypothesis that the level of employment determined by the negotiated wage, because of the relative bargaining power of the parties, is below the level desired by the government. Hence, it has an incentive to inflate so as to lower the real wage and increase employment. But if the parties realizes this, they will agree upon a higher nominal wage during the bargaining process.

The strategic interaction between government's behavior and private sector's behavior is analyzed throughout the paper under different hypotheses about the information available to the players.

3. Wage Bargaining

The bargaining situation we model is the following. At the beginning of each period the firm and the union have to reach an agreement on the nominal wage that is going to prevail until the end of that period. Once the wage is set, the firm chooses the volume of employment unilaterally.

The payoff of the firm for the agreement is its profit $F(L)-(W/p)L$ while that of the union is the total utility $[u(W/p)-\bar{u}]L+N\bar{u}$

received by its N members, where $F(L)$ and $u(w)$ are as specified in equations (3) and (8), and L is obtained by solving $F'(L)=W/p$ (equation (4)). We restrict agreements to be nominal wages W in which the profit of the firm is nonnegative, $F(L) \geq (W/p)L$ ($W/p \leq \infty$)¹, and which are at least equal to the wage which makes union's members indifferent between being employed and unemployed, $u(W/p) \geq \bar{u}$ ($W/p \geq \bar{u}^{(1/\beta)}$). Thus each pair of utilities that can result from agreement takes the form $(F(L)-(W/p)L, [u(W/p)-\bar{u}]L+N\bar{u})$, where $\bar{u}^{(1/\beta)} \leq W/p \leq \infty$, $L=(F')^{-1}(W/p)$ and $0 \leq L \leq N$. If the two parties fail to agree, then the firm obtains a profit of zero (since $F(0)=0$) and the union receives $N\bar{u}$, so that the disagreement utility pair is $d = (d^f, d^u) = (0, N\bar{u})$. Then the set of utility pairs that can be attained in an agreement is

$$U = \{(u^f, u^u) \in \mathbb{R}^2 : (u^f, u^u) = (F(L)-(W/p)L, [u(W/p)-\bar{u}]L+N\bar{u}), d^f \geq 0, d^u \geq N\bar{u}\}.$$

This is a compact convex set, which contains the disagreement point $d=(0, N\bar{u})$ in its interior. Thus the pair (U, d) defines our bargaining problem². The equilibrium concept we focus on is the Nash asymmetric bargaining solution, which is uniquely given by

$$\operatorname{argmax}_{(d^f, d^u) \leq (u^f, u^u) \in U} (u^f - d^f)^\gamma (u^u - d^u)^{1-\gamma}, \quad \gamma \in (0, 1).$$

Wage bargaining takes place at the beginning of each period, when neither the shock to productivity nor the government inflationary policy are observable by the parties. They therefore have to form expectations about the real wage and the employment level that the negotiated nominal wage will actually yield in that contract period,

¹ The upper unboundedness of the negotiable nominal wage depends essentially on the absence of fixed cost in the profit function of the firm. It would not be hard to eliminate it, by introducing sunk costs which the firm sustains only when agreement, and consequently production, takes place. Under this specification, the maximum wage that the firm is willing to agree upon would be finite and the corresponding payoff would coincide with the disagreement payoff of zero.

² Formally, a bargaining problem is a pair (S, d) , where $S \subset \mathbb{R}^2$ is compact and convex, $d \in S$, and there exists $s \in S$ such that $s_i > d_i$ for $i=1, 2$.

once the shock has realized and the inflation has been chosen by the government. The predicted nominal wage for our problem is then

$$W = \underset{E(W/p) \geq \bar{u}^{-(1/\beta)}}{\operatorname{argmax}} \{E[u^f | \Omega^p]\}^\gamma \{E[u^u | \Omega^p]\}^{1-\gamma}$$

$$\underset{E(W/p) \geq \bar{u}^{-(1/\beta)}}{\operatorname{argmax}} \{E[F(L) - (W/p)L | \Omega^p]\}^\gamma \{E[(u(W/p) - \bar{u})L | \Omega^p]\}^{1-\gamma}, \quad (9)$$

where $F(L)$, L and $u(W/p)$ are given by equations (3), (4) and (8), respectively. The parameter γ can be interpreted as the bargaining power of the firm, and $1-\gamma$ as the bargaining power of the union.

In the analysis which follows, we will assume that a positive productivity shock has the same chances to realize as a negative one (1/2), and that the parties have common beliefs that $\Pi=0$ occurs with probability q and $\Pi \neq 0$ with probability $(1-q)$. In this last case, we will further assume that the government sets $\Pi_+ \neq 0$ if it observes a positive productivity shock ($e_t = e$) and $\Pi_- \neq 0$ if the productivity shock is negative ($e_t = -e$).

We consider four different wage negotiation setups, each leading to a different bargaining equilibrium. We first analyze a negotiation structure in which neither price indexation nor productivity adjustment is allowed. The second setup we consider is one in which wages adjust to productivity shocks but are not price-indexed: here, shocks to productivity are totally absorbed by changes in wages but uncertainty about the price level induces uncertainty about the real wage and consequently about employment. In our third negotiation scheme wages are indexed to prices but cannot adjust to productivity shocks. Under such circumstance, parties bargain in fact over the real wage while they are uncertain about the employment level that will be chosen by the firm once the productivity shock is observed. Uncertainty over employment is completely resolved under our third negotiation scheme in which wages adjust to both price and productivity disturbances: wages are totally protected against monetary shocks but move according to the realization of the productivity shock.

To make the distinction between the alternative negotiation schemes more clear, it is convenient to rewrite our labor demand function as defined in equation (4) (time subscripts will be omitted when superfluous):

$$L = \{ W / [(1+\Pi) A] \}^{1/(\alpha-1)}, \quad (10)$$

where the price index at the beginning of the period is assumed to be one, for notational convenience. Thus, prices in the relevant period are expected to be $1+\Pi$.

The four bargaining situations can be summarized as follows.

1. Neither price-indexation nor productivity adjustment is allowed (NPINPA): the parties bargain over W , the nominal wage.
2. Productivity adjustment is allowed but price-indexation is not (PA): the parties bargain over $W^a \equiv W/A$, the nominal wage adjusted to productivity changes.
3. Price indexation is allowed but productivity adjustment is not (PI): the parties bargain over $w \equiv W/(1+\Pi)$, the real wage.
4. Both price-indexation and productivity adjustment are allowed (PI&PA): the parties bargain over $w^a \equiv W/[(1+\Pi)A]$, the real wage adjusted to productivity changes.

3.1 Equilibrium with no price-indexation and no productivity adjustment

Whenever the bargaining rules are such that negotiated wages are permitted to adjust neither to price nor to productivity disturbances, the parties have to form expectations about both the government inflationary policy and the realization of the productivity shock. Therefore

$$E[u^f | \Omega^P] = [(1-\alpha)/\alpha] W^{\alpha/(\alpha-1)} C_1^f,$$

$$E[u^u | \Omega^P] = W^{\beta+1/(\alpha-1)} C_{11}^u - \bar{u} W^{1/(\alpha-1)} C_{12}^u,$$

where

$$C_1^f = q/2[(1+e)^{1/(1-\alpha)} + (1-e)^{1/(1-\alpha)}] + (1/2)(1-q) [(1+e)^{1/(1-\alpha)} (1+\Pi_+)^{\alpha/(1-\alpha)} + (1-e)^{1/(1-\alpha)} (1+\Pi_-)^{\alpha/(1-\alpha)}],$$

$$C_{11}^u = q/2[(1+e)^{1/(1-\alpha)} + (1-e)^{1/(1-\alpha)}] + (1/2)(1-q) [(1+e)^{1/(1-\alpha)} (1+\Pi_+)^{1/(1-\alpha)-\beta} + (1-e)^{1/(1-\alpha)} (1+\Pi_-)^{1/(1-\alpha)-\beta}],$$

$$C_{12}^u = q/2[(1+e)^{1/(1-\alpha)} + (1-e)^{1/(1-\alpha)}] + (1/2)(1-q) [(1+e)^{1/(1-\alpha)} (1+\Pi_+)^{1/(1-\alpha)} + (1-e)^{1/(1-\alpha)} (1+\Pi_-)^{1/(1-\alpha)}].$$

The Nash equilibrium of this bargaining game gives the nominal wage

$$\hat{W} = \left[\frac{C_{12}^u \bar{u}(\alpha\gamma+1-\gamma)}{C_{11}^u [\alpha\gamma+1-\gamma-\beta(1-\alpha)(1-\gamma)]} \right]^{1/\beta} \quad (11)$$

3.2 Equilibrium with productivity adjustment but no price-indexation

The bargaining situation now is such that uncertainty over the productivity shock affects the utilities of the parties only to the extent that wages are not price-indexed and the government is going to choose its inflationary policy after having observed the realization of the shock and according to it. Consequently, the expected payoffs to the parties are

$$E[u^f | \Omega^P] = [(1-\alpha)/\alpha] (W^a)^{\alpha/(\alpha-1)} C_2^f,$$

$$E[u^u | \Omega^P] = (W^a)^{\beta+1/(\alpha-1)} C_{21}^u - \bar{u} (W^a)^{1/(\alpha-1)} C_{22}^u,$$

where $C_2^f = q+(1-q)(1+\Pi)^{\alpha/(1-\alpha)}$,
 $C_{21}^u = q/2[(1+e)^\beta + (1-e)^\beta] +$
 $(1/2)(1-q)(1+\Pi)^{1/(1-\alpha)-\beta} [(1+e)^\beta + (1-e)^\beta],$
 $C_{22}^u = q+(1-q)(1+\Pi)^{1/(1-\alpha)}.$

The Nash asymmetric solution is

$$\hat{W}^a = \left[\frac{C_{22}^u \bar{u}(\alpha\gamma+1-\gamma)}{C_{21}^u [\alpha\gamma+1-\gamma-\beta(1-\alpha)(1-\gamma)]} \right]^{1/\beta}, \quad (12)$$

and the nominal wage resulting after having observed the realization of the productivity shock is $W = \hat{W}^a A$.

3.3 Equilibrium with price-indexation but no productivity adjustment

The expected utilities from the agreement of the firm and the union are respectively

$$E[u^f | \Omega^P] = [(1-\alpha)/\alpha] w^{\alpha/(\alpha-1)} C_3,$$

$$E[u^u | \Omega^P] = [w^{\beta+1/(\alpha-1)} - \bar{u}w^{1/(\alpha-1)}] C_3,$$

where the constant $C_3 = 1/2[(1+e)^{1/(1-\alpha)} + (1-e)^{1/(1-\alpha)}]$ shows that, under this wage negotiation setup, the parties face uncertainty only with regard to the realization of the productivity shock. The Nash asymmetric equilibrium outcome of the bargaining game is obtained simply by solving equations (9), with $E[u^f | \Omega^P]$ and $E[u^u | \Omega^P]$ replaced by the expressions above. It gives

$$\hat{w} = \left[\frac{\bar{u}(\alpha\gamma+1-\gamma)}{\alpha\gamma+1-\gamma-\beta(1-\alpha)(1-\gamma)} \right]^{1/\beta}. \quad (13)$$

The nominal wage that will finally result, once inflation has been observed, is therefore $W = \hat{w}(1+\Pi)$.

3.4 Equilibrium with price-indexation and productivity adjustment

The expected utilities of the parties from an agreement under a wage negotiation scheme where both price-indexation and productivity adjustment are allowed are given by

$$E[u^f | \Omega^P] = [(1-\alpha)/\alpha] (w^a)^{\alpha/(\alpha-1)},$$

$$E[u^u | \Omega^P] = (w^a)^{\beta+1/(\alpha-1)} C_4 - \bar{u}(w^a)^{1/(\alpha-1)},$$

where the parameter $C_4 = 1/2[(1+e)^\beta + (1-e)^\beta]$ catches the fact that, while bargaining, the union is uncertain about the real wage that workers will

actually end up with, since it depends on the realization of the productivity shock. The equilibrium real wage is

$$\hat{w}^a = \left[\frac{\bar{u}(\alpha\gamma+1-\gamma)}{C_4[\alpha\gamma+1-\gamma-\beta(1-\alpha)(1-\gamma)]} \right]^{1/\beta}, \quad (14)$$

and the corresponding nominal wage is $W = \hat{w}^a(1+\Pi)A$.

4. Monetary Policy

We characterize monetary policy as a repeated game between the government and the private sector. Because of the wage negotiation structure, which makes the real wage dependent on the relative bargaining power of the parties, employment is below the level desired by the government. As a consequence, the government has an incentive to reduce real wages by creating unexpected inflation. The private sector realizes this and, while bargaining over the nominal wage, takes into account the expected inflationary policy of the government. The outcome of the wage negotiation process is thus affected by the government's behavior and in turn affects the government's payoff by determining, via wage rates, the level of employment in each period. The game is repeated T times, that is the number of periods that the government survives in power. To simplify the exposition, we will restrict the analysis to the case in which $T=2$; the results can then be easily generalized to any arbitrary choice of T . The game consists of the government choosing Π_t and the public choosing W_t , with payoffs given by equations (5), (6) and (7) for the government, the firm and the union, respectively³.

³ Notice that while the government faces an intertemporal optimization problem, since the action it takes in each period affects its payoffs in subsequent periods, the private sector solves its bargaining problem period by period, separately. The total payoffs to the firm and the union from the repeated game are simply obtained by adding up their one-period utilities, equations (7) and (8).

4.1 The "one-shot" game

This section computes the equilibrium of the "one-shot" noncooperative game in which the government cannot precommit to a monetary policy rule before nominal wages are set. Although timing in this game is such that the government moves after the bargaining process has taken place, we assume that wage negotiation occurs at each firm level so that, while solving their maximization problem and choosing the optimal nominal wage, the parties have to take inflation as given. The possibility of coordination among wage negotiation outcomes in different firms is not considered here. Consequently, the private sector, taken as a whole, behaves like a Nash player: it cannot choose its control variable strategically, by incorporating the government reaction function into its decision process. The "one-shot" Nash equilibrium can be computed as follows. The government chooses Π to maximize

$$u^g = -\Pi^2 - \lambda(L - \bar{L})^2, \quad (15)$$

subject to (10). Since it moves after the private sector, the government is forced to take nominal wages as given. In the benchmark case (NPINPA), its first-order condition yields

$$\Pi = \underset{\Pi}{\operatorname{argmax}} \left[-\Pi^2 - \lambda \{ [W/(1+\Pi)A]^{1/(\alpha-1)} - \bar{L} \}^2 \right] \quad (16)$$

The firm and the union bargain over W . They maximize the product of their expected utilities

$$u^f = E \left[A(1/\alpha)L^\alpha - [W/(1+\Pi)]L \right],$$

and

$$u^u = E \left[\{ [W/(1+\Pi)]^\beta - \bar{u} \} L \right],$$

subject to (10), taking Π as given. The private sector reaction

function is the equilibrium outcome of the bargaining process, equation (11). The Nash equilibrium is obtained by combining (11) and (16). In particular, equation (16) expresses optimal inflation as a function of the productivity parameter. Let Π_+ denote the optimal inflation when the government observes a positive productivity shock, and Π_- the optimal inflation associated to a negative realization of the shock. Then the Nash equilibrium pairs $[\hat{W}^{\circ}, \Pi_+^{\circ}]$ and $[\hat{W}^{\circ}, \Pi_-^{\circ}]$ under NPINPA are obtained by combining (14) and (16), respectively with $A=1+e$ and $A=1-e$.

Obviously, the Nash equilibrium wage-inflation pair varies if a different wage negotiation scheme is assumed. If the bargaining rules do not admit price-indexation then the optimal policy of the government is still to inflate. Under PA, the parties bargain over $W^a=W/A$. Hence, the first-order condition of the government gives

$$\Pi = \underset{\Pi}{\operatorname{argmax}} \left[-\Pi^2 - \lambda \{ [W^a / (1+\Pi)]^{1/(\alpha-1)} \bar{L} \}^2 \right]. \quad (17)$$

The Nash equilibrium under PA is given by the pair $(\hat{W}^{a^*} A, \Pi^{a^*})$, where \hat{W}^{a^*} and Π^{a^*} are obtained by combining (12) and (17)⁴. On the contrary, whenever perfect price-indexation is allowed (cases PI and PI&PA), employment is independent of the monetary policy and the best that the government can do is to set inflation always equal to zero. The Nash equilibrium under PI is therefore given by the pair $(\hat{w}, 0)$; under PI&PA it is $(\hat{w}^a A, 0)$.

4.2 The repeated game

The subgame perfect equilibrium of the noncooperative repeated

⁴ Notice that, in the "one-shot" case we assume that the private sector is perfectly informed about the preferences of the government (in particular, we assume that the constant $\lambda > 0$ in the utility function of the government is known to the parties). Therefore, the parameter q (i.e. the probability that the parties assign to the event of observing zero inflation), which appears in the expressions (12) and (14), has to be taken equal to zero. Under the assumption of incomplete information and when the game is repeated, q becomes a function of the reputation of the government.

game can be derived working backwards from the last period. Since there is no dynamic state variable, the "one-shot" Nash equilibrium is the unique subgame perfect equilibrium of the repeated game if we assume finite horizon and complete information⁵. Hence, no announcement will ever be believed unless it coincides with the solution to the government problem given by equation (16) above. If either of the two assumptions is dropped, however, announcements may become an effective policy instrument.

Here the game is solved for a finite horizon ($T=2$) and under the hypothesis that the public has incomplete information about the parameter λ in the government objective function. For simplicity, it is assumed that λ can take one of two values: it may be $\lambda=0$, that is the government behaves as it is committed irrevocably to pursuing a zero-inflation policy (a "tough" government); or $\lambda=\bar{\lambda}>0$, that is the government behaves as if it is rationally attempting to maximize the utility function (5) (a "weak" government). If the government is actually tough, its optimal strategy is simply to set M_t so as to have $\Pi_t=0$ in any period. If the government is weak, its optimal behavior is more sophisticated. As we saw in section 3, the equilibrium nominal wage of the bargaining process depends on the private sector beliefs about the government preferences⁶. Consequently, even a weak government may choose not to inflate. By resisting inflation it develops a reputation for being tough which it hopes will discourage expectation of inflation in the future. In this section we examine such a reputational equilibrium. The setting is as in Kreps and Wilson (1982b), Backus and Driffill (1985) and Barro (1986). The solution concept is Kreps and Wilson's (1982a) sequential equilibrium, which enable us to find the solution recursively, starting with the final period.

⁵ The functional forms we have adopted guarantee that the equilibrium of the "one-shot" game is unique. Therefore, under the assumption of finite horizon and perfect information, no cooperative outcome can be sustained in the repeated game as subgame perfect equilibrium.

⁶ The parameter q in the expected utilities of the firm and the union is in fact the probability that the parties assign to the event of observing zero inflation. As it will become clear from the following analysis, such beliefs are a function of the reputation of the government, i.e. the probability that the government is "tough".

The game proceeds as follows: when the game is started the players, government and private sector, choose their actions given the strategy of the other player; besides, the government takes into account the impact of its current behavior on its next period's reputation. In particular, at the beginning of each period the union and the firm negotiate over the nominal wage so as to maximize their expected utilities, on the basis of their prior beliefs about the nature of their opponent. Then the government choice becomes observable and the parties revise their beliefs according to Bayes rule. This new probability will be taken into account by the parties during the wage negotiation in the following contract period.

The central feature of the model is the government's ability to manipulate its reputation. When the game starts, the public assigns a prior probability \bar{x} to the event that $\lambda=0$, and a probability $(1-\bar{x})$ to the event that $\lambda=\bar{\lambda}>0$. \bar{x} is common knowledge. Let $x_t = \text{prob}(\lambda=0)$ be the public's beliefs at time t ; let $q_t = \text{prob}(\Pi_t=0)$ and $x_t^* = \text{prob}(\Pi_t=0 | \lambda=\bar{\lambda})$. Therefore, q_t is the unconditional probability that there will be no inflation at time t , and x_t^* is the conditional probability of zero inflation, given that the government is weak. We will characterize the strategy of the weak government as a probability of playing tough in both pure and mixed strategies. From these definitions it follows that

$$q_t = x_t + (1-x_t)x_t^* \quad (18)$$

The hypothesis that x_t is revised according to Bayes rule implies that

$$\begin{aligned} x_{t+1} &= 0 && \text{if } \Pi_t \neq 0, \\ x_{t+1} &= x_t / [x_t + (1-x_t)x_t^*] = x_t / q_t && \text{if } \Pi_t = 0 \end{aligned} \quad (19)$$

Consider first the solution of the game when the wage negotiation scheme is of the type assumed in our benchmark case (NPINPA). In the final period T the weak government will always inflate, since destroying its reputation can have no future consequences. Its optimal inflationary strategy is still given by the solution to the system of equations (11) and (16). However, now the private sector is not perfectly informed about the government's type. Consequently, the Nash equilibrium of the "one-shot" game depends on the

reputation of the government. Let $W^*(q_t)$ and $\Pi^*(q_t)$ denote the Nash equilibrium values of the "one-shot" game, given that the reputation of the government in period t (x_t) is such that the private sector expects $\Pi_t=0$ with probability q_t and $\Pi_t \neq 0$ with probability $1-q_t$. After some straightforward substitutions, using (10) and (15), the expected utility of a weak government in period T can be written as

$$u_T^g = -\bar{\Pi}(q_T) - \bar{\lambda}\{E_{22}(q_T)[W^*(q_T)]^{2/(\alpha-1)} - 2\bar{L}E_2(q_T)[W^*(q_T)]^{1/(\alpha-1)}\} - \lambda\bar{L}^2, \quad (20)$$

where, according to Bayes' rule, $q_T = \bar{x}/q_{T-1}$ if in period $T-1$ the government has pursued a noninflationary strategy ($\Pi_{T-1}=0$), and $q_T=0$ if instead in period $T-1$ the government has inflated ($\Pi_{T-1} \neq 0$). The variables $\bar{\Pi}$, E_{22} and E_2 in equation (20) reflects the fact that the government expects the realization of the productivity shock in period T to be positive or negative evenly with probability $1/2$. More precisely:

$$\begin{aligned} \bar{\Pi}(q_T) &= 1/2[(\Pi_+^*(q_T))^2 + (\Pi_-^*(q_T))^2], \\ E_2(q_T) &= 1/2\{[(1+e)(1+\Pi_+^*(q_T))]^{1/(1-\alpha)} + [(1-e)(1+\Pi_-^*(q_T))]^{1/(1-\alpha)}\}, \\ E_{22}(q_T) &= 1/2\{[(1+e)(1+\Pi_+^*(q_T))]^{2/(1-\alpha)} + [(1-e)(1+\Pi_-^*(q_T))]^{2/(1-\alpha)}\}. \end{aligned}$$

In period $T-1$, the government must consider the impact of its behavior on its reputation in the final period. With probability x_{T-1}^* the government sets $\Pi_{T-1} = 0$; if $\Pi_{T-1} = 0$ is realized, its utility in period $T-1$ is

$$u_{T-1}^g = -\bar{\lambda}\{E_0^2[W^*(q_{T-1})]^{2/(\alpha-1)} - 2\bar{L}E_0[W^*(q_{T-1})]^{1/(\alpha-1)}\} - \lambda\bar{L}^2, \quad (21)$$

where $E_0 = (1+e_{T-1})^{1/(1-\alpha)}$ is observed by the government at $T-1$. With probability $(1-x_{T-1}^*)$ the government plays the optimal inflationary strategy, $\Pi_{T-1} = \Pi^*(q_{T-1})$; in this case, its utility is given by

$$u_{T-1}^g = -\Pi^{*2}(q_{T-1}) - \bar{\lambda}\{E_1^2(q_{T-1})[W^*(q_{T-1})]^{2/(\alpha-1)} - 2\bar{L}E_1(q_{T-1})[W^*(q_{T-1})]^{1/(\alpha-1)}\} - \lambda\bar{L}^2, \quad (22)$$

where $E_1(q_{T-1}) = (1+e_{T-1})^{1/(1-\alpha)}(1+\Pi^*(q_{T-1}))^{1/(1-\alpha)}$.

Denoting by $V_{T-1}(x_{T-1}^*)$ the government expected utility from period T-1 up to the end of the game we then have

$$\begin{aligned}
V_{T-1}(x_{T-1}^*) = & x_{T-1}^* \left\{ -\bar{\lambda} \{E_0^2 [W^*(q_{T-1})]^{2/(\alpha-1)} - 2\bar{L}E_0 [W^*(q_{T-1})]^{1/(\alpha-1)}\} - \lambda \bar{L}^2 + \right. \\
& \delta_g \left[-\bar{\Pi}(q_T) - \bar{\lambda} \{E_{22}(q_T) [W^*(q_T)]^{2/(\alpha-1)} - 2\bar{L}E_2(q_T) [W^*(q_T)]^{1/(\alpha-1)}\} - \lambda \bar{L}^2 \right] \left. \right\} + \\
& (1-x_{T-1}^*) \left\{ -\Pi^{*2}(q_{T-1}) - \bar{\lambda} \{E_1^2(q_{T-1}) [W^*(q_{T-1})]^{2/(\alpha-1)} \right. \\
& \quad \left. - 2\bar{L}E_1(q_{T-1}) [W^*(q_{T-1})]^{1/(\alpha-1)}\} - \lambda \bar{L}^2 + \right. \\
& \left. \delta_g \left[-\bar{\Pi}(0) - \bar{\lambda} \{E_{22}(0) [W^*(0)]^{2/(\alpha-1)} - 2\bar{L}E_2(0) [W^*(0)]^{1/(\alpha-1)}\} - \lambda \bar{L}^2 \right] \right\}. \quad (23)
\end{aligned}$$

The last term in (23) reflects the fact that if the government inflates in period T-1, which it does with probability $(1-x_{T-1}^*)$, then its reputation is blown and the public will expect inflation in the final period ($q_T=0$). The first term expresses the probability of playing zero actual inflation in T-1, and then collecting a payoff in T associated with a reputation x_T , where x_T is given by equation (19). For a given nominal wage in period T-1, $V_{T-1}(x_{T-1}^*)$ is linear in x_{T-1}^* . But W_{T-1} has to be taken as given, since the public does not observe the government's action when it chooses the wage rate in period T-1. Moreover, $0 \leq x_{T-1}^* \leq 1$. Hence, there are three cases to consider:

- (i) $\partial V_{T-1}(x_{T-1}^*) / \partial x_{T-1}^* > 0$, which implies $x_{T-1}^* = 1$. That is, the optimal government strategy in period T-1 is the pure strategy of no inflation. Hereafter, an equilibrium in which the government plays such a strategy will be called *pooling*.
- (ii) $\partial V_{T-1}(x_{T-1}^*) / \partial x_{T-1}^* < 0$, implying $x_{T-1}^* = 0$. Here the optimal strategy is the pure inflationary strategy: $\Pi_{T-1} = \bar{\Pi}$. In this case, the equilibrium will be called *separating*.
- (iii) $\partial V_{T-1}(x_{T-1}^*) / \partial x_{T-1}^* = 0$, in which case the government chooses a mixed strategy (it plays $\Pi_{T-1} = 0$ with probability $x_{T-1}^* > 0$, and $\Pi_{T-1} = \bar{\Pi}$ with probability $(1-x_{T-1}^*) > 0$).

Differentiating the right-hand side of (24) with respect to x_{T-1}^* and simplifying, we obtain that $\partial V_{T-1}(x_{T-1}^*) / \partial x_{T-1}^* \stackrel{\geq}{\leq} 0$ as:

$$\begin{aligned}
& \bar{\lambda} \left[\left[E_1^2(q_{T-1}) - E_0^2 \right] [W^*(q_{T-1})]^{2/(\alpha-1)} - 2\bar{L} \left[E_1(q_{T-1}) - E_0 \right] [W^*(q_{T-1})]^{1/(\alpha-1)} \right] - \\
& \quad - \Pi^{*2}(q_{T-1}) \stackrel{\leq}{\geq} \\
& \delta_g \left\{ \bar{\lambda} \left[\left[E_{22}(q_T) [W^*(q_T)]^{2/(\alpha-1)} - 2\bar{L}E_2(q_T) [W^*(q_T)]^{1/(\alpha-1)} \right] - \right. \right.
\end{aligned}$$

$$\{E_{22}(0)[W^*(0)]^{2/(\alpha-1)} - 2\bar{E}_2(0)[W^*(0)]^{1/(\alpha-1)}\} - [\bar{\Pi}(0) - \bar{\Pi}(q_T)] \}. \quad (24)$$

The left-hand side of (24) is the net gain for the government from creating unexpected inflation today, i.e., it is the "temptation to cheat". The right-hand side of (24) is the net cost for the government from creating unexpected inflation today rather than tomorrow or, in other words, it is the gain, in terms of next period output, from maintaining a reputation. When the two sides of (24) are equal, the government chooses a mixed strategy (i.e., $0 \leq x_{T-1}^* \leq 1$), since it is indifferent between creating unexpected inflation today rather than tomorrow. If (24) holds with a $>$ sign, then the net gain of inflating today exceeds the corresponding net cost, and the government chooses a pure inflationary strategy right away (i.e., $x_{T-1}^* = 0$). Conversely, if (24) holds with a $<$ sign, the net gain from creating unexpected inflation is smaller than the cost of losing its reputation, and the government resists the temptation to inflate (i.e., $x_{T-1}^* = 1$).

The characterization of the equilibrium of the repeated game under different wage negotiation schemes is equivalent to what we have just described. Under PA, the government expected utility from period T-1 up to the end of the game is still expressed by equation (23), with E_0 , $E_1(q_{T-1})$, $E_2(q_T)$, $E_{22}(q_T)$ and $\bar{\Pi}(q_T)$ given instead by

$$\begin{aligned} E_0 &= 1 \\ E_1(q_{T-1}) &= (1 + \Pi^*(q_{T-1}))^{1/(1-\alpha)} \\ E_2(q_T) &= (1 + \Pi^*(q_T))^{1/(1-\alpha)} \\ E_{22}(q_T) &= (1 + \Pi^*(q_T))^{2/(1-\alpha)} \\ \bar{\Pi}(q_T) &= \Pi^{*2}(q_T), \end{aligned}$$

since under this wage negotiation scheme employment is automatically stabilized and, therefore, it is independent of the realization of the productivity shock. Equation (24), with E_0 , $E_1(q_{T-1})$, $E_2(q_T)$, $E_{22}(q_T)$ and $\bar{\Pi}(q_T)$ replaced by the values obtained above, again summarizes the conditions which have to hold in a pooling, separating or mixed strategy equilibrium, when the bargaining rules are such that only productivity adjustments are allowed. Finally, under both PI and PI&PA, it is straightforward to see that the unique equilibrium of the repeated game coincides with the one computed for the "one-shot" case: the government always chooses not to inflate and the private sector sets wages accordingly.

In the following section we will present the results for a selected set of numerical examples. We will focus on three equilibria in pure strategies: the "pooling" equilibrium, which we define as an equilibrium where the government chooses not to inflate with probability one always, independently of the realization of the productivity shock; the "separating" equilibrium, where the optimal probability for the government to inflate is one, independently of the realization of the productivity shock; finally, we analyze the conditions for an equilibrium in which the government implements a zero-inflation policy if a positive shock is observed and inflates whenever the productivity shock is negative, a "mixed" equilibrium. The range of parameter values for which each equilibrium occurs is considered under different wage negotiation schemes as well as under different macroeconomic scenarios.

5. Some Numerical Results

The macroeconomic scenario that we postulate is the following. Full employment is taken to be the level of employment which realizes in a competitive labor market, in absence of shocks. In other words, it is the level of employment associated to the real wage which would occur if the union had no power. In our notation this means $\bar{L} = (\bar{u}^{-1/\beta})^{1/(\alpha-1)}$, where $\bar{u}^{-1/\beta}$ is the wage which makes union's members indifferent between being employed and unemployed. It corresponds to the equilibrium wage of the bargaining under $\gamma=1$. We let α , the labor's share, be 0.7 and \bar{u} , the utility from being unemployed, be 0.9. Hence, \bar{L} is approximately 1.5. The parameter λ is such that the relative weight assigned by the government to the employment objective is one (the same as the weight assigned to the inflation target)⁷. Finally, the government discount factor, δ_g , is assumed to be 0.9. Given these parameter values, we

⁷ In order to make the two weights comparable, we choose $\lambda=1/\bar{L}^2=0.45$. Doing so, we actually assign a weight equal to one to the unemployment rate objective, $[(L-\bar{L})/\bar{L}]^2$, which seems more appropriate since the other objective, Π , is also expressed in terms of rates and not of levels.

simulate the model under different realizations of the productivity shock, relative bargaining powers of the parties and degrees of the union's risk aversion. Here, we present the result obtained with $e=\pm 0.03$, $\beta=0.9$ and two different measures of the bargaining power of the firm, $\gamma=0.9$ and $\gamma=0.6$. The main conclusions, in terms of welfare, drawn from these cases will be compared to the results obtained when a strong and highly risk averse union is introduced ($\beta=0.3$ and $\gamma=0.3$). The possibility of having productivity shocks with higher variability ($e=\pm 0.08$) is also considered at the end of this section.

In Figures 1, 2 and 3 we present the range of values of the initial reputation of the government (\bar{x} , the probability that the parties assign at the beginning of the game to the event that the government is "tough") for which a pooling, a separating or a mixed equilibrium occurs. Figures 1 and 2 refers to our benchmark case, in which neither price-indexation nor productivity adjustment is considered (NPINPA). Figure 3 presents the results for the case where the wage negotiation mechanism allows for productivity adjustment (PA). More precisely, in Figures 1(a) and 2(a) we plot the differences in the government's expected utilities from playing the pooling strategy at T-1 and from deviating from it, against the reputation of the government at the beginning of the game ($\bar{x}\in[0,1]$). If such differences are greater than zero then a pooling equilibrium is attainable. The two curves refer to the cases where a positive or a negative productivity shock occurs at T-1. Of course, with a positive productivity shock a pooling equilibrium is more likely to occur so that a lower value of \bar{x} is required for a pooling equilibrium to be attained. Therefore, the curve associated to a positive shock is on the left of the one associated to a negative shock. For a pooling equilibrium to be sustainable independently of the realization of the shock, we obviously need both curves lying in the positive quadrant. When the bargaining power of the firm is high, $\gamma=0.9$, the pooling equilibrium is attained for values of \bar{x} greater than 0.15 (Fig. 1(a)). When $\gamma=0.6$, \bar{x} must be at least 0.45 for a pooling equilibrium to occur. Figures 1(b) and 2(b) present the ranges of \bar{x} for which a separating equilibrium occurs, respectively when the bargaining power of the firm is 0.9 and 0.6. In the first case a separating equilibrium realizes for $\bar{x}<0.25$; with a stronger union, never. Finally, Figures 1(c) and 2(c) show the mixed equilibrium. The increasing (decreasing) curve represents the excess gain of the

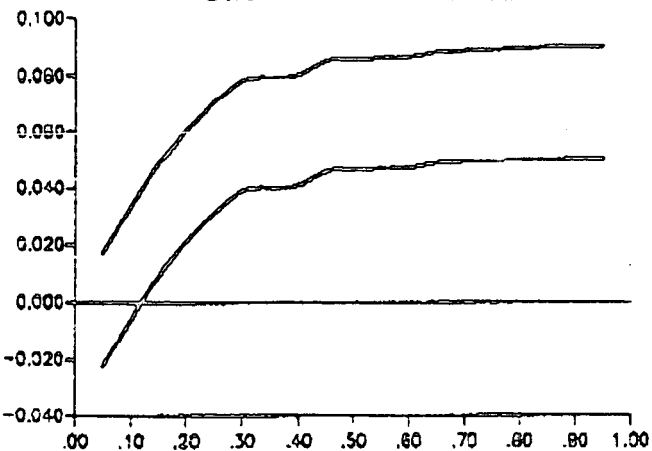
government from playing the "mixed" strategy over the payoff it will get if it deviates from it, when a positive (negative) shock is realized. A "mixed" equilibrium occurs when both curves lie in the positive quadrant. For $\gamma=0.9$, a very small range of values of \bar{x} (around 0.10) sustains such equilibrium. A "mixed" equilibrium never occurs for $\gamma=0.6$. The results for the PA case are shown in Figure 3. Here, only pooling and separating equilibria are considered, since the optimal strategy of the government is independent on the realization of the shock. As in the previous case, there is a range of \bar{x} in which both pooling and separating equilibria are sustainable. However, the range of parameter values for which a pooling equilibrium occurs results highly enlarged. With a weak union ($\gamma=0.9$), even a government with a bad initial reputation ($\bar{x}=0.05$) acts optimally by choosing the pooling strategy. A stronger union ($\gamma=0.6$) makes the minimum value of \bar{x} required for a pooling equilibrium to increase to 0.35. A separating equilibrium occurs for $\bar{x} \leq 0.35$, if $\gamma=0.9$; never, when $\gamma=0.6$.

We now briefly compare the welfare implications of the four wage negotiation schemes we have been describing so far. Welfare is measured by the expected two-periods utility of the government associated to each wage negotiation scheme. Table 1 shows the results for the case of a weaker union ($\gamma=0.9$); table 2 the case of a stronger union ($\gamma=0.6$). Table 3 refers to the case with a strong and very risk-averse union ($\gamma=0.3$, $\beta=0.3$); within this setup, we also address the possibility of having a highly volatile productivity shock.

The level of welfare associated to wage negotiation schemes which allow for price-indexation (PI&PA and PI) is independent on \bar{x} , since the optimal strategy of the government under this setup is always to set inflation equal to zero, regardless on its initial reputation. Having both price and productivity indexation yields, with the exception of the case of a strong and very risk averse union, a higher level of welfare (lower disutility for the government) than having just price-indexation, because of the additional employment stabilization effect involved in it. Price-indexing is optimal whenever the reputation of the government is bad ($\bar{x}=0.2$), since the credibility enforcement implied by such negotiation structure prevents the parties to agree on high nominal wages and, consequently, the government to pursue high inflationary policies. For higher values of \bar{x} , price-indexed wage formation mechanisms are dominated by both schemes

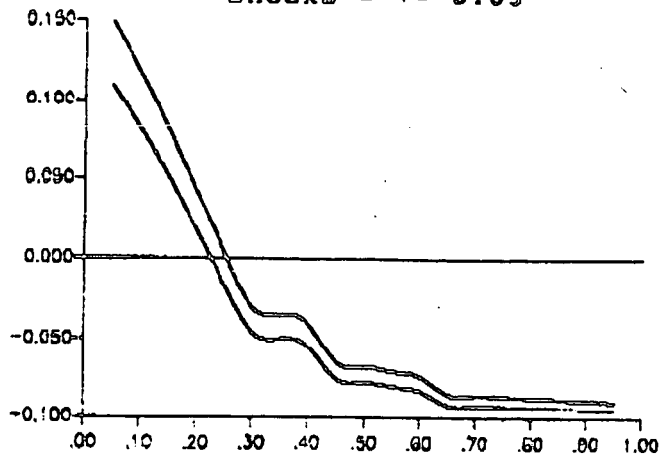
with no indexation at all and those which allow for productivity adjustments only. The case of a weaker union exhibits a stronger superiority of the productivity adjustment scheme over all the others. When $\gamma=0.6$, productivity-indexing delivers the lowest disutility to the government for values of $\bar{x} \geq 0.6$; when $\gamma=0.9$, it is enough to have a government with initial reputation of 0.4 to make the productivity-adjustment wage negotiation scheme the optimal one. Finally, the higher the variance of the real shock, the higher the benefit (cost) of productivity-indexing (price-indexing) relatively to the no-indexation case.

1
Pooling equilibrium
 bargaining power of firms = 0.9
 shocks = ± 0.03



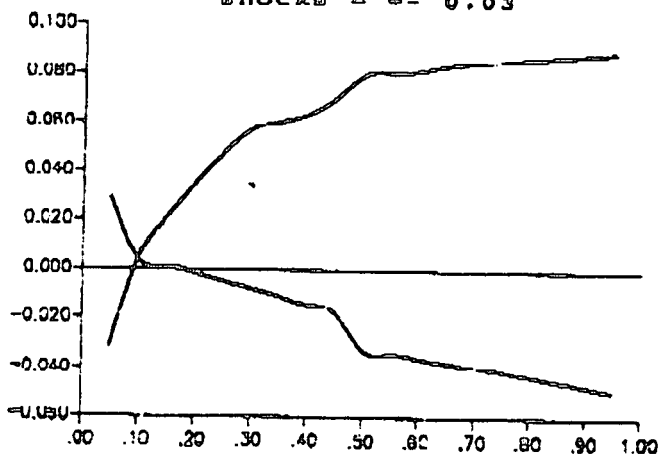
1(a)

Separating equilibrium:
 bargaining power of firms = 0.9
 shocks = ± 0.03



1(b)

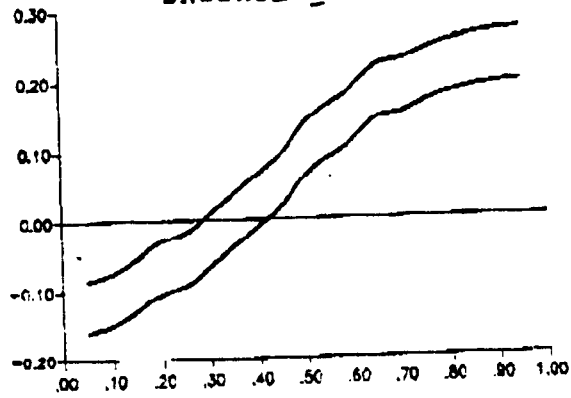
Mixed equilibrium:
 bargaining power of firms = 0.9
 shocks = ± 0.03



1(c)

Fig. 1

Pooling equilibrium:
 bargaining power of firms = 0.6
 shocks = ± 0.03



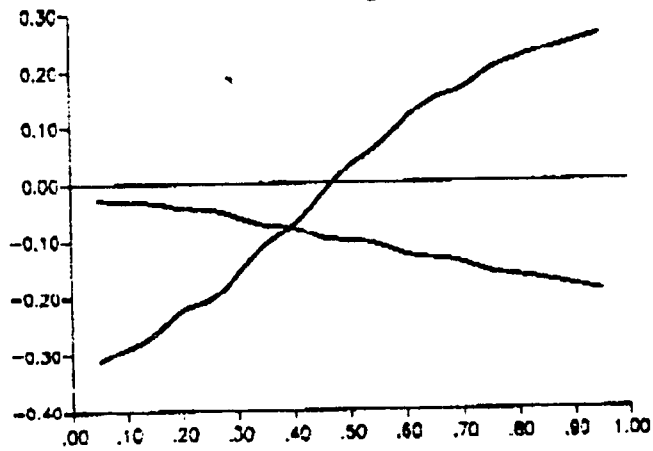
2(a)

Separating equilibrium:
 bargaining power of firms = 0.6
 shocks = ± 0.03



2(b)

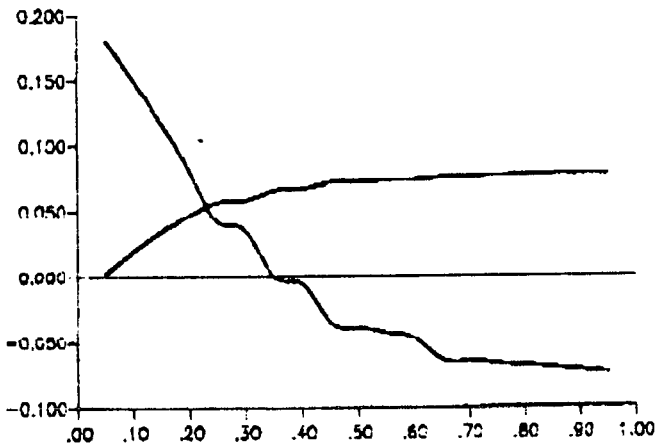
Mixed equilibrium:
 bargaining power of firms = 0.6
 shocks = ± 0.03



2(c)

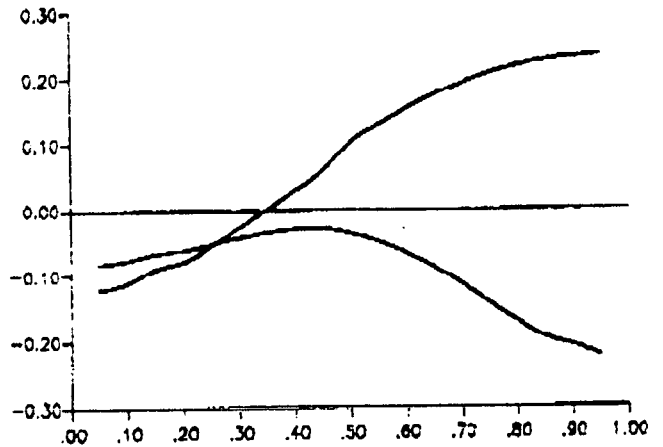
Fig. 2

Pooling and separating equilibria:
 bargaining power of firms = 0.9
 shocks = ± 0.03



3(b)

Pooling and separating equilibria:
 bargaining power of firms = 0.6
 shocks = ± 0.03



3(b)

Fig. 3

Table 1

($e=0.03$, $\gamma=0.9$) *

	NPINPA	PA	PI&PA	PI
$\bar{x}=0.2$	-.056 (p) -.130 (s)	-.048 (p) -.127 (s)	-.032	-.045
$\bar{x}=0.4$	-.036 (p)	-.028 (p)	-.032	-.045
$\bar{x}=0.6$	-.030 (p)	-.022 (p)	-.032	-.045
$\bar{x}=0.8$	-.027 (p)	-.019 (p)	-.032	-.045

(*) In parentheses are the equilibrium types: p=pooling, s=separating.

Table 2

($e=0.03$, $\gamma=0.6$) *

	NPINPA	PA	PI&PA	PI
$\bar{x}=0.2$	-	-	-.315	-.319
$\bar{x}=0.4$	-	-.399 (p)	-.315	-.319
$\bar{x}=0.6$	-.279 (p)	-.276 (p)	-.315	-.319
$\bar{x}=0.8$	-.213 (p)	-.210 (p)	-.315	-.319

(*) In parentheses is the equilibrium type: p=pooling.

Table 3

($\beta=0.3, \gamma=0.3$)

	NPINPA	PA	PI&PA	PI
$e=0.03$ ($\bar{x}=0.7$)*	-0.5280	-0.5281	-0.5745	-0.5740
$e=0.08$ ($\bar{x}=0.75$)*	-0.4805	-0.4931	-0.5805	-0.5779

(*) With $e=0.03$, the unique equilibrium is pooling for $\bar{x} \in [0.7, 1]$, under NPINPA, and for $\bar{x} \in [0.65, 1]$, under PA. With $e=0.08$, the unique equilibrium is pooling for $\bar{x} \in [0.75, 1]$, under NPINPA, and for $\bar{x} \in [0.65, 1]$, under PA.

6. Concluding Remarks

In this paper we have considered a reputational model where monetary policy is characterized as a repeated game between the government and the private sector. The government wishes to stabilize prices and employment around some desired levels. The private sector is represented by a wage formation mechanism which incorporates the behavior of two agents: a union and a firm. They bargain over the nominal wage taking into account their expectations about the inflationary policy implemented by the government and the realization of a stochastic productivity shock.

This setup enables us to focus on the welfare implications of different wage negotiation schemes. In particular, price versus productivity indexing is compared. In a perfectly price-indexed economy, the government has no temptation to create unexpected inflation and the inflationary bias associated to the credibility problem is completely eliminated. On the other hand, negotiation mechanisms which allow wages to respond to productivity shocks seem to be more appropriate to dampen macroeconomic fluctuations when real disturbances are the causes.

We show that, for some set of parameter values, a wage negotiation scheme which allows only for productivity adjustments is enough to guarantee both price and employment stability, since the employment stabilization effect incorporated in this kind of wage determination structure sufficiently reduces the government incentives to create unexpected inflation. The analysis suggests that, provided the reputation of the government is good enough (i.e. the probability that the private sector attaches to the event that the government dislikes inflation is high enough) and/or the relative bargaining power of the union is not too high, the optimal degree of price-indexation is indeed zero.

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