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# Unemployment persistence, wage indexing and central bank independence

Tilemahos Efthimiadis
*Researcher*

## Abstract

This paper examines the effect of wage indexation on the optimal degree of central bank conservativeness in a dynamic economy. In particular, we find that when unemployment persists, wage indexation is inflationary as it lowers the will of the central banker to fight inflation. Furthermore, we show that there is a positive relationship between the degree of the monetary authorities" discount factor and inflation. We conclude that it is optimal to delegate monetary policy to an independent and conservative central banker.

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## 1. Introduction

In a seminal paper Rogoff (1985) showed that it is optimal to delegate monetary policy to an independent and conservative central banker, that is, a central banker that is not influenced by politicians and places a greater weight on inflation vis-à-vis the government. This delegation reduces the inflationary bias of monetary policy that arises in the Barro-Gordon (1983) framework. Rogoff's proposal is supported by a series of empirical studies that often find a negative relationship between central bank conservativeness and inflation across countries; see Cukierman *et al.*, (1993), Alesina, (1988), Grilli *et al.*, (1991), among others.[1]

However, the model that Rogoff develops is a static one while it is shown in the relevant literature that output and unemployment are persistent; see Nelson and Plosser (1982) and Alogoskoufis and Manning (1988). Taking into account this stylized fact many authors examine central bank independence when there is persistence in the economy. With persistence, Rogoff's result may be invalid. In particular, Lockwood *et. al.* (1998) show that with unemployment persistence, delegating monetary policy to an independent central banker is not always desirable.

Extending the Rogoff framework, a series of authors have embedded wage indexing into the relevant literature of time inconsistency in monetary policy. Mourmouras (1997b) shows that wage indexation is inflationary in the sense that it weakens the will of government to fight inflation and delegates monetary policy to a central banker that is less inflation-averse than in the original Rogoff model. Hutchison and Walsh (1998) find similar results and show that, in a closed economy, a greater degree of central bank conservativeness will increase nominal rigidity resulting in a flatter short run output-inflation trade-off.

In this paper we examine the effect of wage indexation on central bank conservativeness in a dynamic setting. In particular, we examine the case where unemployment is characterized by persistence. To the best of our knowledge this has not been previously examined in the literature.

The rest of the paper is organized as follows. In Section 2 we introduce the theoretical model. In Section 3 we solve the model and provide the main results. Section 4 concludes.

## 2. The Model

The model is built around Lockwood *et. al.* (1998) and extended to allow for indexed wage contracts as in Gray (1976) and Fischer (1983).

Labour demand is given by:[2]

$$l_t = p_t - w_t - \varepsilon_t \tag{1}$$

where $l_t$ is labour, $p_T$ is the price level and $\varepsilon_t$ is a random *iid* labour shock.

The trade union's loss function is as follows:

$$Q_t^u = E_{t-1}[(1-\theta)(w_t - p_t - \Omega)^2 + \theta(l_t^u - l_t)^2] \tag{2}$$

where $\Omega > 0$ is the real wage target and $l_t^u$ is a moving employment target.

[1] However, Franzese (1999) argues that these linear-additive models are misspecified and concludes that the anti-inflation effect of central bank independence is nonlinear.

[2] All variables are in logs.

The assumed trade union employment target follows that of Linbeck and Snower (1986), Blanchard and Summers (1986) and Alogoskoufis and Manning (1998). In particular, the employment target of the union ($Q_t^u$) is the weighted geometric mean of those insiders who have been recently employed ($L_{t-1}$) and the total labour force ($N$). Thus, $L_t^u = L_{t-1}^a N^{1-a}$ where $0 \leq a \leq 1$. Taking logarithms we have:

$$l_t^u = a l_{t-1} + (1-a)n \tag{3}$$

where $a$ in effect measures the trade union's power, that is, how much it influences employment vis-à-vis outsiders. The union minimizes its loss function $Q_t^u$ (2) subject to its employment target $l_t^u$ (3) and labour demand $l_t$ (1). This yields the optimal expected real wage ($\tilde{l}_t^u$):

$$w_t - E_{t-1}p_t = (1-\theta)\Omega - \theta l_t^u = -\tilde{l}_t^u \tag{4}$$

We assume that wage contracts are indexed and therefore, the actual nominal wage is determined by:

$$\tilde{w}_t = E_{t-1}w_t + \zeta(\pi_t - \pi_t^e) \tag{5}$$

where $\pi_t$ is the actual rate of inflation, $E_{t-1} = \pi_t^e$ are inflation expectations and $\zeta$ is the wage indexing parameter which is exogenous ($\zeta \in [0,1]$).[3]

Combining (4) and (5) we have:

$$w_t - p_t^e = (1-\theta)\Omega - \theta l^u - \zeta(\pi_t - \pi_t^e) = E_t w_t \tag{6}$$

Combining (4) and (1) gives us the deviation of employment from its target:

$$l_t - \tilde{l}_t^u = p_t - E_{t-1}p_t - \varepsilon_t = \pi_t - E_{t-1}\pi_t - \varepsilon_t \tag{7}$$

where $\tilde{l}_t^u$ is the union's effective employment target. Using (7) and (6) gives us the rate of unemployemt:

$$\begin{aligned} u_t &= n - l_t \\ &= (n - \tilde{l}_t^u) + (\tilde{l}_t^u - l_t) \\ &= (1-\rho)u_n + \rho u_{t-1} - (1+\zeta)(\pi_t - \pi_t^e) + \varepsilon_t \end{aligned} \tag{8}$$

where $u_t$ is the level of unemployment, $\rho = \theta a$ which is the degree of unemployment persisitence ($\rho \in [0,1]$) and $u_n = (1-\theta)(n+\Omega)/(1-\rho)$.

The government's (static) loss function is as follows:

$$L_t^g = u_t^2 + \lambda \pi_t^2 \tag{9}$$

The central banker's (static) loss function is as follows:

$$L_t^{cb} = u_t^2 + \lambda_{cb} \pi_t^2 \tag{10}$$

As in Rogoff (1985) the government and the central banker have different weights on inflation ($\lambda \neq \lambda_{cb}$) but they share the same inflation and unemployment targets which are assumed to be zero. The dynamic loss functions are given as:

[3]The wage indexing rule used here is very common in the literature (e.g. Gray, 1976; Fischer, 1977; Mourmouras, 1997a) and seems to be motivated by the actual form that labour contracts take in the real world.

$$L^g = E_0 \sum_{t=1}^{\infty} \delta^{t-1} L_t^g \tag{11}$$

and

$$L^{cb} = E_0 \sum_{t=1}^{\infty} \delta_{cb}^{t-1} L_t^{cb} \tag{12}$$

where $\delta < \delta_{cb}$. [4]

The timing of events is as follows:

1. The government appoints an independent central banker and optimally sets her degree of conservativeness ($\lambda_{cb}$).
2. Wage setters set the nominal wage ($w_t$).
3. The stochastic labour shock is realized ($\varepsilon_t$).
4. The central banker optimally chooses the rate of inflation ($\pi_t$).
5. Equilibrium employment is determined ($l_t$).

## 3. Solving the Model

### 3.1 Discretion

At first we examine the case where the government does not delegate monetary policy to an independent and conservative central banker and sets itself the level of inflation. The model presented here is a dynamic game where the state variable is lagged unemployment.[5] This type of game has been previously studied by Lockwood and Philippopoulos (1994).[6]

We focus only on the perfect equilibrium where the current actions of the players at time $t$, namely ($p_t$, $w_t$), depend on the game history only through the state variable $u_t$, often known as Markov-perfect equilibrium (Fudenberg and Tirole, 1991) in the game theory literature. This restriction rules out punishment strategies which could be used to sustain a reputation for low inflation as in Barro and Gordon (1983).

Wage setter's form rational expectations for the level of inflation:

$$\pi_t^e = E_{t-1}\pi_t \tag{13}$$

The government's expected present discounted value of losses from $t+1$ onward can be characterized by:

$$V(u_t) = \beta_0 + \beta_1 u_t + \beta_2 \frac{u_t^2}{2} \tag{14}$$

Therefore, in accordance with its loss function (9) the government aims at minimizing the following:

$$u_t^2 + \lambda \pi_t^2 + \delta V(u_t) \tag{15}$$

subject to (13) and (8). Solving this minimization problem yields:

[4] It has been argued that central banker's tend to serve longer terms than government (Lockwood *et. al.*, 1998) and therefore will have relatively higher discount factors.

[5] Whether the game is dynamic when $a > 0$ and repeated when $a = 0$.

[6] One minor difference is that the state variable in Lockwood and Philippopoulos (1994) is labour $l_t$ while in this setting it is unemployment $u_t$.

$$-2(1+\zeta)u_t + 2\lambda\pi_t - \delta(1+\zeta)\beta_1 - \delta(1+\zeta)\beta_2 u_t = 0 \tag{16}$$

Rearranging the above equation we can derive the government's feedback rule:

$$\pi_t = \phi_0 + \phi_1 u_t \tag{17}$$

where

$$\phi_o = \frac{\delta(1+\zeta)\beta_1}{2\lambda} \tag{18}$$

and

$$\phi_1 = \frac{(2+\delta\beta_2)(1+\zeta)}{2\lambda} \tag{19}$$

Combining (13) with (19) we have:

$$\hat{\pi}_t = \phi_0 + \phi[(1-\rho)u_n + \rho u_{t-1}] + s\varepsilon_t \tag{20}$$

where $s = \frac{\phi}{1+\phi}$. Combining the above equation with (8) gives us:

$$\hat{u}_t = (1-\rho)u_n + \rho u_{t-1} + (1 - s(1+\zeta))\varepsilon_t \tag{21}$$

The coefficients in the central banker's function are determined by the below equation:

$$V(u_{t-1}) = E_{t-1}[\hat{u}_t^2 + \lambda\hat{\pi}_t^2 + \delta V(\hat{u}_t)] \tag{22}$$

Equationg terms in $u_{t-1}$ and $u_{t-1}^2$ on both sides of the above equation gives us two Ricatti equations:

$$b_2^2\delta^2(1+\zeta)^2 + 2b_2\delta(2+\lambda+2\zeta) + 4(1+\lambda) = 0 \tag{23}$$

$$b_1 = \frac{(-1+\rho)\rho u_n(4(1+\lambda) + b_2\delta(b_2\delta(1+\zeta)^2 + 2(2+\lambda+2\zeta)))}{2\lambda(-1+\delta\rho) + \delta\rho(1+\zeta)(2+b_2\delta(1+\zeta))} \tag{24}$$

Equation (23) has real roots only if:
$\lambda > 4\zeta(1+\zeta)$
in which case it has two real roots. Lockwood and Phillipopoulos (1994) argue that the equilibrium associated with the smaller root to (23) has some nice properties, whereas the other equilibrium is badly behaved. In what follows, we take the smaller root to (23). We can summarize as follows:

**Proposition 1.** *With discretion, inflation is given by a rule ($\phi_0$, $\phi$, $s$) whose components must satisfy (18), (19), (20), (23), (24).*

### 3.2 Delegation

We examine the case where monetary policy is delegated from the government to an independent and conservative central banker with preference parameter $\lambda_{cb}$. One again the outcome for inflation, which is a Markov-perfect equilibrium, where inflation is characterized by (18), (19), (20), (23), (24) where $\lambda$ is replaced by $\lambda_{cb}$ and $\delta$ is replaced by $\delta_{cb}$ ($\delta < \delta_{cb}$).

To see the effect of wage indexation on inflation we substitute $\phi_o$ (18), $\phi_1$ (19),and $s$ into $\hat{\pi}_t$ (20), take the FOC for $\zeta$:

$$\frac{\partial\pi}{\partial\zeta} = \frac{\delta_{cb}}{2\lambda_{cb}}(b_1 + b_2[r(u_{t-1}-u_n) + u_n + \frac{4e\lambda_{cb}^2}{[2(1+\lambda_{cb}) + b_2\delta_{cb}(1+\zeta)]^2}]) \tag{25}$$

**Proposition 2.** *Wage indexation is inflationary ($\partial\pi/\partial zeta > 0$).*

Proof: Equation (25) is always positive if $\rho(u_{t-1} - u_n) + u_n > 0$. We can rewrite this as $u_{t-1} + (1-\rho)u_n$ and as $0 < r < 1$ and $u_n > 0$ this is always positive and therefore $\partial\pi/\partial\zeta > 0$.[7]

**Proposition 3.** *A higher discount factor ($\delta$) leads to less inflation ($\partial\pi/\partial\delta < 0$).*

Proof: We substitute $\phi_o$ (18), $\phi_1$ (19),and $s$ into $\hat{\pi}_t$ (20), take the FOC for $\delta$:

$$\frac{\partial\pi}{\partial\delta} = \frac{(1+\zeta)}{2\lambda_{cb}}(b_1 + b_2[\rho(u_{t-1} - u_n) + u_n + \frac{4e\lambda_{cb}^2}{[2(1+\lambda_{cb}) + b_2\delta_{cb}(1+\zeta)]^2}]) < 0 \tag{26}$$

Therefore inflation is reduced when monetary policy is delegated to an independent central banker. The central banker (on average) serves a longer term than the government and therefore will have a higher discount factor ($\delta < \delta_{cb}$).

**Proposition 4.** *The more conservative is the monetary authority, that is, the higher parameter $\lambda$ is, the lower inflation is.*

Proof: We substitute $\phi_o$ (18), $\phi_1$ (19),and $s$ into $\hat{\pi}_t$ (20), take the FOC for $\lambda$:

$$\begin{aligned}\frac{\partial\pi}{\partial\lambda} = -\frac{(1+\zeta)[b_1\delta(1+\zeta) + (2 + b_2\delta(1+\zeta))]}{2\lambda_{cb}}[\rho(u_{t-1} - u_n) + u_n + \\ + \frac{4e\lambda_{cb}^2}{[2(1+\lambda_{cb}) + b_2\delta_{cb}(1+\zeta)]^2}] > 0\end{aligned} \tag{27}$$

Therefore, as $\partial\pi/\partial\lambda < 0$ by delegating monetary policy to a conservative central banker ($\lambda_{cb} > \lambda$) inflation is reduced.

## 4. Conclusions

In this paper we examined the effect of wage indexation on the degree of central bank independence when unemployment persists. We conclude that wage indexation is inflationary. This is consistent with the relevant literature which mainly focuses on static one-period models. Furthermore, we find that a higher discount factor leads to less inflation and therefore it is optimal to delegate monetary policy to an independent and conservative central banker. Finally, we find a negative relationship between the conservativeness of the central banker and the level of inflation.

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[7] All other parameters are strictly positive. An implicit restriction is that the wage indexing parameter ($\zeta$) must lesser than one (partial indexation). Otherwise, the Phillips curve becomes flat and the model collapses.

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