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OPTIMAL WAGE RE-NEGOTIATION

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ABSTRACT

This paper investigates an economy in which there are short-term wage contracts that are re-negotiated under certain conditions. This paper determines the optimal frequency of wage re-negotiation and shows that it depends positively on measures of aggregate variability and Phillips curve slope. The role of optimal wage re-negotiation is to mitigate the output effects of various shocks. In the context of an open economy, it is shown that the desirable exchange rate regime in an economy with optimal wage re-negotiation depends on the stochastic structure of the economy.

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I. Introduction

Recent analyses, such as those by Fisher (1977) and Gray (1976), have focused attention on the role of wage contracts in explaining short-term dynamics. A wage contract builds a short-term rigidity into the system, fixing the money wage in the short run. To analyze the influence exerted by the limited flexibility of such contracts some authors have investigated the role of partial indexation. [1] In these studies, the analysis has been shifted to more normative aspects, and attention has been given to the "optimal" flexibility of wage contracts, i.e., to the optimal degree of wage indexation. One criterion used in these analyses has been to consider as a benchmark the output in a fully flexible economy, and to derive as optimal the indexation scheme that would bring actual output "closest" to the fully flexible economy output. Such a procedure implicitly assumes the existence of costs that prevent the instantaneous adjustment of the labor market in order to regain its equilibrium. However the analysis does not treat the effects of those costs on the optimal contracting scheme. This paper attempts to model the role of adjustment costs in the wage scheme by focusing attention on the possibility of contract re-negotiation. We expect to observe re-contracting if its benefit exceeds its costs. The analysis will consider the optimal degree of wage re-contracting, and will contrast it with the optimal degree of wage indexation.

In a recent contribution, Flood and Marion demonstrated that in an open economy under optimal wage indexation, in a world of one good, floating rates are preferred to fixed rates, regardless of the stochastic structure of the economy. This paper will consider how this conclusion is modified if the limited wage flexibility is due to optimal wage re-negotiation instead of optimal wage indexaion. We find that the two wage adjustment schemes differ considerably, in the closed as well as in the open economy.

Section II determines optimal wage re-negotiation in a closed economy. Section III extends the discussion to an open economy, under both fixed and floating rates, and investigates the desirable exchange rate regime under optimal wage re-negotiation. Section IV closes the paper by discussing the implications of the findings.

II. Optimal Re-contracting in a Closed Economy

Consider a closed economy characterized by the existence of short-term labor contracts that pre-set the wage. Such contracts occur because the transaction costs of wage negotiation make them beneficial. This argument implies, however, that in some circumstances we expect the benefit from re-contracting to exceed the costs, making re-negotiation desirable. Thus, there is a cost benefit element in assessing the desirability of wage re-negotiation. The purpose of this section is to model this case in order to arrive at an optimal re-contracting scheme.

Consider an economy in which nominal wage contracts for period t are negotiated in period t-1, before current prices are known, so as to equate expected labor demand to expected labor supply. Such a contract contains two parts. First, it pre-sets the wage. Second, it specifies the conditions under which re-contracting will occur. These conditions exist when the real wage resulting from the contract deviates "too much" from the market clearing wage in a flexible economy.

More formally, consider an economy where the labor supply (l^s) is given by [2] :

$$(1) \qquad l_t^s = \delta(w_t - p_t)$$

where w_t and p_t are the money wage and money prices, expressed in logarithms.

The production function is given by:

(2) $$y_t = h \cdot l_t + \nu_t; \; 0 < h < 1$$

where ν_t is a white noise technology shock. In a fully flexible economy, the labor market clears at a real wage $\hat{\tau}_t$:

(3) $$\hat{\tau}_t = (\log h + \nu_t)/[1 + (1-h)\delta] \quad .$$

Let us denote actual wage, prices, and output by (w_t, p_t, y_t). For each period, there are two subcases. Let us consider first the case in which the contract wage is binding. We denote wages, prices and output in this case by (w_t', p_t', y_t') . Next, let us consider the case in which re-contracting occurs. In such a case we denote wages, prices and output by $(\tilde{w}_t, \tilde{p}_t, \tilde{y}_t)$.

Suppose that the contract money wage is set such as to equate the expected real wage resulting from the contract to the expected real wage in a flexible economy $(\hat{\tau}_t)$, i.e.

(4) $$w_t' = E_{t-1}(\hat{\tau}_t) + E_{t-1}(p_t | p_t = p_t') \; .$$

$E_{t-1}(X_t|Y)$ is the expected value of X_t at period t-1, conditional on information Y. It is assumed that the information set includes all contemporaneous shocks, as well as knowledge of the model.

The analysis assumes also that in case of re-contracting the real wage is set at its market clearing level, $\hat{\tau}_t$. A possible measure describing the pressure in the labor market working towards re-contracting is the discrepancy between the real wages in the two situations, i.e.

$$(5) \qquad \psi_t = (w_t' - p_t') - \hat{\tau}_t = \tau_t' - \hat{\tau}_t$$

where τ_t' denotes real wage if the contract binds. ψ_t describes the discrepancy in the real wage between the case where the contract binds (τ_t') and the case of a fully flexible economy $(\hat{\tau}_t)$. Assume that the contract agreement allows for re-negotiation if the real wage pressure ψ_t exceeds a threshold value k.

Thus:

$$(6) \qquad (p_t, w_t, y_t) = \begin{cases} (p_t', w_t', y_t') & \text{if } |\psi_t|<k \\ (\tilde{p}_t, \tilde{w}_t, \tilde{y}_t) & \text{if } |\psi_t|>k \end{cases} .$$

The policy question addressed in this section is the optimal value of k. Another possible version of such a model allows for partial wage indexation as part of the contract agreement. This possibility has been analyzed by previous authors; the purpose of the current analysis is to consider the difference between optimal indexation and optimal re-negotiation schemes. Thus, the analysis will assume the absence of wage indexation and will contrast the different natures of the two schemes at a later point. We assume that contracts are made because there are real output costs associated with re-negotiation, making a continuous market clearing a second best possibility. If those costs are C, the output in case of re-negotiation is given by $\hat{y}_t - C$ (where $\hat{y}_t$ is the output in a fully flexible economy).[3] Thus, actual output (y_t) is given by:

$$(7) \qquad y_t = \begin{cases} \hat{y}_t - C & \text{if } |\psi_t|>k \\ y'_t & \text{if } |\psi_t|<k \end{cases} .$$

The notion here is that the cost of pre-setting the wage ahead of time (a wage contract) is negligible relative to the costs of last-minute wage revision (given by C).[4]

Next, following Gray, it is also assumed that there are costs associated with the divergence from the flexible equilibrium output. A possible loss function to describe these costs is: [5]

$$(8) \qquad L = E(y_t - \hat{y}_t)^2 .$$

The money market equilibrium is given in a log-linear form:

$$(9) \qquad m_t - p_t = y_t - \alpha \cdot i_t$$

where m_t is the logarithm of the money supply in period t. i_t is the nominal interest rate, given by

$$(9') \qquad i_t = r + E_t p_{t+1} - p_t$$

where r is the real interest rate, assumed to be exogenously given. Assuming that in the short run, employment is demand determined when the contract binds

($|\psi_t| < k$) we find that the contract output is:

$$(10) \qquad y'_t = d_o + d_1 \nu_t + d_2 (p'_t - E_{t-1}(p_t \big| |\psi_t| < k))$$

where $d_o = (\delta \cdot h \cdot \log h) / ((1-h) \cdot \delta + 1)$, $d_1 = 1/(1-h)$, $d_2 = h/(1-h)$

The existence of wage contracts implies that unexpected price increases reduce real wages, increasing employment and output. In such a case, the price level is given by:

$$(11) \qquad p'_t = \frac{m_t + \alpha(r + E_t P_{t+1}) - d_0 - d_1 \nu_t + d_2 E_{t-1}(p_t \big| |\psi_t| < k)}{1 + \alpha + d_2}$$

If the wage pressure is strong enough ($|\psi_t| > k$), re-contracting will occur. Realized output in such a case is given by

$$(12) \qquad \tilde{y}_t = [\nu_t(1+\delta) + h \cdot \delta \cdot \log h] / [1 + (1-h)\delta] - C.$$

Notice that in case of re-contracting the Phillips curve effect is nil, and realized output is equal to frictionless output (the first term in eq. 12) minus the cost of re-contracting. Price level is given in such a case by:

$$(13) \qquad \tilde{p}_t = \frac{m_t + \alpha(r + E_t P_{t+1}) - \tilde{y}_t}{1 + \alpha}.$$

A comparison of eq. 11 and 13 reveals that if the contract binds (eq. 11), the effect of the Phillips curve is to mitigate the price effect of a given monetary shock because of the induced output effect.

To simplify notation, let us assume a simple stochastic framework, neglecting trends in the variables and assuming zero correlation between the random shocks:

$$(14) \qquad m_t = \bar{m} + u_t; \; u_t \sim N(0,\sigma_u^2); \; \nu_t \sim N(0,\sigma_\nu^2)$$

u_t is the monetary shock, and ν_t is the real one. With the help of eq.10-13 we find that

$$(15) \qquad y_t - \hat{y}_t = \begin{cases} -C & \text{if } |\psi_t|>k \\ \theta_t & \text{if } |\psi_t|<k \end{cases}$$

where: $\theta_t = d_2(p_t' - E_{t-1}(p_t \mid |\psi_t|<k) + \frac{\nu_t}{1+(1-h)\delta})$.

If re-negotiation occurs ($|\psi_t|>k$) , output will deviate from the flexible equilibrium output by the real cost of re-negotiation (C). If the contract is binding, output will deviate by θ_t from the flexible equilibrium.

Using eq.3,4 and 5 we find that

$$(16) \qquad \psi_t = -(p_t' - E_{t-1}(p_t \mid |\psi_t|<k)+\nu_t \cdot \frac{1}{1+(1-h)\delta}) \; .$$

Notice that

$$(17) \qquad \theta_t = - d_2 \cdot \psi_t \; .$$

If the contract binds, actual output (y_t') deviates from the frictionless equilibrium level ($\hat{y}_t$) in proportion to the labor market pressure (ψ_t). The factor of proportionality is the Phillips curve slope (d_2). Thus, we can rewrite eq. 15 as

$$(15') \qquad y_t - \hat{y}_t = \begin{cases} -C & \text{if } |\theta_t| > d_2 \cdot k \\ \theta_t & \text{if } |\theta_t| < d_2 \cdot k \end{cases} .$$

Define z to be the normalized value of $d_2 \cdot k$, i.e. $z = d_2 \cdot k/\sigma_\theta$. Notice that ψ_t and θ_t are normally distributed. It can be shown that:

$$(18) \qquad V_\theta = (V_u + d_3^2 \cdot V_\nu) \cdot \left(\frac{d_2}{1+\alpha+d_2} \right)^2$$

for $d_3 = (\alpha-\delta)/[1+(1-h)\delta]$.

Let us denote by $\Phi(z)$ and $\phi(z)$ the standard normal cumulative distribution and density function. Using the properties of a normal distribution we find that

$$(19) \qquad L = V_\theta \cdot H(z) + C^2 \cdot 2\Phi(-z)$$

where [6] $H(z) = 1-2\Phi(-z)-2 \cdot z \cdot \phi(z)$.

We can use L to derive the optimal value of k, which minimizes L. It is given by

$$(20) \qquad k^* = \frac{C}{d_2} .$$

Inspecting eq. 20 reveals that a higher cost of re-negotiation will reduce the use of re-contracting (a higher k*). A larger slope of the

Phillips curve will magnify deviations from the output target, encouraging re-negotiation (a lower k*). Notice that if the transaction costs associated with re-contracting are zero, $k^* = 0$, implying that the labor market clears continuously, nullifying the role of wage contracts. For the optimal k, the frequency of wage re-negotiation is measured by

$2\,\Phi(-z^*)$, where $z^* = k^* \cdot d_2/\sigma_\theta$.

Suppose that we increase uniformly the volatility of all the shocks affecting the economy, without affecting the relative importance of the underlying shocks (i.e. holding V_ν/V_u given). In such a case we find from eq.20 that

$$(21) \qquad \left.\frac{dz^*}{dV_\theta}\right|_{V_\nu/V_u \text{ given}} < 0$$

$$(22) \qquad 0 < \left.\frac{dL}{dV_\theta}\right|_{V_\nu/V_u \text{ given}} < 1 .$$

Higher volatility of the shocks will increase the desirability of re-contracting, because more frequently the labor market pressure is enough to justify it. The effect of this adjustment is to increase output volatility (relative to $\tilde{y}_t$, i.e. L) by less than the increase in the volatility of the underlying shocks. In this sense, optimal re-contracting mitigates the effects of higher aggregate volatility on output variability.

Comparing an optimal re-contracting policy to an optimal indexation[7] reveals that the optimal frequency of re-contracting depends on aggregate volatility (V_θ) whereas optimal indexation depends only on the relative importance of the real and monetary shocks (i.e. on V_ν/V_u). As a result, optimal indexation is homogenous of degree zero and output volatility under optimal indexation is homogenous of degree one with respect to aggregate volatility. In contrast we have just demonstrated that a given increase in aggregate volatility will increase output volatility at a lower rate under the re-contracting scheme.

The Appendix considers the case in which we allow for optimal wage indexation as well as optimal wage re-contracting. It turns out that the characteristics of possible wage schemes described above stay intact in a system that allows for both adjustment possibilities. Adding optimal wage indexation has the effect of reducing aggregate volatility, reducing in turn the use of re-contracting ($dz^* > 0$). Optimal indexation, however, proves to be independent of optimal re-contracting.

III. Optimal Re-contracting in an Open Economy

The purpose of this section is to analyze how optimal re-contracting works in an open economy. This will enable us to evaluate the desirability of different exchange rate regimes. A recent contribution by Flood and Marion has demonstrated that under optimal wage indexation, in a world of one good, floating rates are preferred over fixed rates, regardless of the stochastic structure of the shocks affecting the economy.[8] As Section II concluded, optimal wage indexation differs considerably from optimal wage re-contracting. This section shows that this difference manifests itself also in the choice of optimal exchange rate regimes. It turns out that under optimal wage re-contracting regimes, the ranking of exchange rate regimes depends on the stochastic structure of the shocks. Thus, unlike thé case under optimal wage indexation, we cannot rank exchange rate regimes under optimal wage re-contracting without further information regarding the relative magnitude of the shocks affecting the economy. This circumstance also suggests that the ranking of exchange rate regimes might depend on the labor market structure.

Consider the case of a small, open economy under perfect capital mobility, in a world of one traded good. The labor market has the structure described in Section II (eq.1-7).

The small country is linked to the world by interest rate parity and the law of one price. Thus, eq. 9' is replaced by

$$(9'') \qquad i_t = i_t^* + E_t \; e_{t+1} - e_t$$

where i_t^* is the foreign interest rate, and e_t is the exchange rate, expressed in logarithm. The money market equilibrium becomes

$$(23) \qquad m_t - p_t = y_t - \alpha(i_t^* + E_t \; e_{t+1} - e_t) \; .$$

Goods prices are assumed to be linked by the law of one price:

$$(24) \qquad p_t = p_t^* + e_t \; .$$

III.a. The floating exchange rate regime

Under the floating exchange rate regime the money supply is exogenously given, and the exchange rate is free to adjust to money market pressure. Let us assume zero correlation between the random shocks, which are normally distributed:[9]

$$(25) \qquad m_t = \bar{m} + u_t; \; u_t \sim N\,(0,\sigma_u^2); p_t^* \sim N\,(0,\sigma_{p^*}^2); i_t^* \sim N\,(0,\sigma_{i^*}^2) \; .$$

using eq.1-7 and the money market equilibrium condition, we find that prices are given by:

$$p_t' = \frac{m_t + \alpha(p_t^* + i_t^* + E_t e_{t+1}) - d_0 - d_1 \nu_t + d_2 E_{t-1}(p_t \big| |\psi_t| < k)}{1 + \alpha + d_2}$$

(26)

$$\tilde{p}_t = \frac{m_t + \alpha(p_t^* + i_t^* + E_t e_{t+1}) - ([\nu_t(1+\delta) + h \cdot \delta \cdot \log h]/[1+(1-h)\delta] - C)}{1 + \alpha}$$

where, as in Section II, p_t' represents prices if the labor contract is binding, and $\tilde{p}_t$ represents prices if there is re-contracting. Comparing eq. 26 to eq. 11-12 reveals that the only difference between the closed and open economies is that $\alpha(E_t\ p_{t+1} + r)$ is replaced by $\alpha\ (p_t^* + E_t e_{t+1} + i_t^*)$. Thus, all the conclusions of Section II hold for an open economy under floating rates, where now $\theta_t = \theta_t^L$:

(27) $$\theta_t^L = d_2(p_t' - E_{t-1}(p_t \big| |\psi_t| < k) + \frac{\nu_t}{1 + (1-h)\delta})$$

where p_t' is given in eq. 26.

III.b. <u>The fixed exchange rate regime</u>

Under a fixed exchange rate regime, eq. 23 and 24 hold for the given, pre-set exchange rate. To simplify notation, assume that $e_t = 0$. Equilibrium in the money market is achieved via the balance of payments mechanism; thus, the money supply is now endogenous, and $p_t = p_t^*$. As a result, we find that

(28) $$p_t' = \tilde{p}_t = p_t^*$$

(29) $$\theta_t^x = d_2(\ p_t^* + \frac{\nu_t}{1 + (1-h)\delta}\ ) .$$

All the results of Section II hold for this case, where now $\theta_t = \theta_t^x$.

Our loss function is monotonic, increasing with respect to V_θ (see eq.19). Thus, the exchange rate regime with a lower V_θ has a more stable output relative to $\hat{y}_t$. The fixed exchange rate regime is preferred over floating rates, therefore, if

(30) $$V_{\theta^x} < V_{\theta^L} ,$$ or if

(31) $$(1+d_2)(1+2\alpha+d_2) \cdot V_{p_t^*} + \frac{(1+2\alpha+d_2-\delta)(1+d_2+\delta)}{(1+(1-h)\delta)^2} \cdot V_\nu <$$

$$< V_u + \alpha^2 V_i^* .$$

Floating rates become more desirable as the volatility of foreign prices and real shocks increases because under floating rates the exchange rate adjustment mitigates the effect of those shocks. The relative desirability of a fixed exchange rate goes up with the volatility of the domestic money supply and of foreign interest rates because fixed exchange rates isolate domestic output from the volatility of foreign interest rates and the domestic money supply.[10]

IV. Implications

The existence of wage contracts introduces wage rigidity into the economy because it limits the capacity of wages to adjust to contemporaneous shocks. Two possible channels that allow limited wage flexibility are partial wage indexation and the possibility of wage re-contracting. This paper has focused on the properties of optimal wage re-contracting, contrasting wage re-contracting with wage indexation. The main difference between the two is that the optimal frequency of wage re-contracting depends on measures of aggregate volatility and not on the relative importance of various shocks. In contrast, optimal wage indexation depends on the relative importance of various shocks, and not on measures of absolute volatility. The paper shows that the optimal frequency of wage re-contracting depends positively on aggregate volatility and the Phillips curve slope. The role of optimal re-contracting is to mitigate the output effects of various shocks. In the context of an open economy the difference between optimal wage indexation and optimal wage re-contracting is manifested in the fact that the desirability of various exchange rate regimes under optimal wage re-contracting depends on the stochastic structure of the economy, whereas under optimal wage indexation Flood and Marion(1982) have shown that in a world of one good floating rates are preferred, regardless of the stochastic structure. The paper shows that under optimal wage re-contracting floating rates become more desirable when the volatility of foreign prices and real supply shocks increases and when the volatility of the domestic money supply and of foreign interest rates slackens.

Appendix

The purpose of this Appendix is to consider how the analysis in the paper is affected if we allow also for wage indexation.[11] It turns out that adding the possibility of optimal wage indexation to a system with optimal wage re-contracting has the effect of reducing the frequency of re-contracting. The value of optimal indexation, however, is independent of optimal re-contracting (k^*), and it is equal to optimal indexation in an economy without re-contracting. This is a result of the fact that optimal indexation depends on relative variances in the underlying shocks and not on measures of aggregate volatility, whereas optimal use of re-contracting depends on aggregate volatility. Because allowing optimal re-contracting does not affect the relative importance of the underlying shocks, it does not affect the value of optimal indexation.

Allowing for a partial indexation in a framework with wage re-contracting implies that the wage equation (eq. 4) is modified to:

$$w_t' = E_{t-1}(\hat{\tau}_t) + E_{t-1}(p_t | p_t = p_t') + b(p_t' - E_{t-1}(p_t | p_t = p_t'))$$

where b is the degree of wage indexation. This in turn implies that the Phillip's curve slope is now $\bar{d}_2$:

$$\text{(A2)} \qquad \bar{d}_2 = d_2 (1-b) = \frac{h}{1-h} (1-b) .$$

The analysis in eq. 1-3, 5-14 stays intact, where now $\bar{d}_2$ replaces d_2. Notice that the Phillips curve slope is proportional to the degree to which price changes are not indexed (1-b) . The new values of θ_t and ψ_t (denoted by

$\bar{\theta}_t$, $\bar{\psi}_t$) are:

$$\text{(A3)} \qquad \bar{\theta}_t = d_2[(1-b)\ (p_t' - E_{t-1}\ (p_t|\bar{\psi}_t|<k)) + \frac{\nu_t}{1+(1-h)\delta}]$$

$$\text{(A4)} \qquad \bar{\psi}_t = - \bar{\theta}_t/d_2$$

The loss function is now given by:

$$\text{(A5)} \qquad \bar{L} = V_{\bar{\theta}}\ .\ H(\bar{z}) + C^2\ .\ 2\ \Phi(-\bar{z})$$

where $\bar{z} = d_2\ .\ k/\sigma_{\bar{\theta}}$, and

$$\text{(A6)} \qquad V_{\bar{\theta}} = (\frac{\bar{d}_2}{1 + \alpha + \bar{d}_2})^2\ [V_u + V_\nu\ .(\bar{d}_3)^2]\ ,$$

where $\bar{d}_3 = \frac{1+\alpha-(1-b)\cdot(1+\delta)}{(1+(1-h)\delta)\cdot(1-b)}$.

From the loss function we derive that optimal re-contracting ($\bar{k}^*$) and optimal wage indexation ($\bar{b}$) are:

$$\text{(A7)} \qquad \bar{k}^* = \frac{C}{d_2}$$

$$\text{(A8)} \qquad \bar{b} = 1 - \frac{1+\alpha}{(1+(1-h)\delta)\ (1-h)V_u/V_\nu+1+\delta}\ .$$

Notice that optimal wage re-contracting (A7) is equal to eq. 20 in the paper. Notice also that optimal wage indexation depends on relative volatility (V_u/V_ν) and not on aggregate volatility. It turns out that under optimal wage re-contracting deriving $\bar{b}$ is equivalent to minimizing $V_{\bar{\theta}}$. Thus, the value of optimal indexation is equal to the same value derived in a system without re-contracting ($k = \infty$). The effect of allowing optimal wage indexation is to reduce $V_{\bar{\theta}}$. This works to increase z* ($\bar{z}^* > z^*$), which is equivalent to a reduction in the use of re-contracting.

Comments

1. See, for example, Flood and Marion(1982) and Gray(1976).

2. This model modifies the framework used by Gray(1976) and Fischer(1977).

3. The fixed cost of re-negotiation is assumed not to affect the marginal product of labor. Thus, $y_t - C$ is a logarithmic approximation of the output around the non-stochastic equilibrium.

4. The assumption of an asymmetric cost of negotiation structure is crucial for the explanation of the wage contract advanced in this paper. It states that negotiation for setting the current wage (w_t) within the period is costly relative to a negotiation which sets the current wage ahead of time (at the end of t-1). Notice that because of the stochastic structure used in the paper the contract wage is time-independent, therefore the above assumption of cost-asymmetry is natural. In general, the wage contract might be time-dependent, and the above asymmetry can be the result of the costs of collecting and processing current information (cost of survey, etc.) needed for re-contracting. In contrast, pre-setting the wage ahead of time requires only well-known, costless information. If all negotiations were equallly expensive, then we would observe no wage stickiness. The modeling of the nature of the cost asymmetry is left for future research. I am indebted to an anonymous referee for raising this issue.

5 This loss function is also used by Gray(1976) and Flood and Marion(1982). An alternative loss function is L':

$$L' = E[a_1(\hat{y}_t - y_t')^2 \cdot \chi + a_2 \cdot C \cdot (1-\chi)]$$

where a_1, a_2 are positive constants, and χ is zero if $|\psi_t| > k$, and one if $|\psi_t| < k$. L' distinguishes between the deadweight loss in the labor market and the transaction cost. It can be shown that the main results of the paper remain intacat if we adapt L' instead of L.

6. To derive eq.19 we use the fact that

$$(\sqrt{2\Pi})^{-1}\int_{-z}^{z} x \cdot^2 \exp(-x^2/2)dx = (\sqrt{2\Pi})^{-1}\int_{-z}^{z}[\exp(-x^2/2)-(x\exp(-x^2/2))']dx$$

$$= 1-2\Phi(-z)-2\phi(z)z.$$

7. Optimal wage indexation is derived in Gray(1976) and Flood and Marion(1982).

8. This result was a special case in Flood and Marion's paper. So as to demonstrate the difference between the various wage adjustment schemes, this section contrasts their result with the case of an economy under optimal wage indexation. For an analysis of wage indexation in an open economy, see also Marston (1982).

9. To simplify notation the analysis takes the case of zero correlation between the various shocks. The case of non-zero correlation can be treated in a similar way (see Flood and Marion).

10. For studies that emphasize the dependence of the optimal exchange rate regime on the stochastic structure see, for example Boyer(1978), Flood(1979), Turnovsky(1976). For a good survey, see Tower and Willett. The contribution of this section lies in its analysis of optimal exchange rate regimes under optimal wage re-negotiation.

11. It is assumed that the transaction costs of implementing a known partial wage-price indexation scheme are nil

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