NBER WORKING PAPER SERIES

WAGE FLEXIBILITY AND OPENNESS

Joshua Aizenman

Working Paper No. 1108

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

April 1983

The research reported here is part of the NBER's research program in International Studies. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

NBER Working Paper #1108
April 1983

Wage Flexibility and Openness

Abstract

This paper analyzes the degree of short-run, real wage flexibility in a two-sector economy under floating rates. This is done by deriving optimal wage indexation in a contracting framework. We find that the more closed the economy, the lower the degree of wage indexation. As a result, output will fluctuate less around its desired level in a more closed economy. These findings further imply that a given unexpected monetary shock will cause a smaller output shock in a more open economy, whereas a given real shock will induce a smaller output shock in a more closed economy.

Joshua Aizenman
Department of Economics
University of Pennsylvania
3718 Locust Walk CR
Philadelphia, PA 19104
(215) 898-7409

I. Introduction

Recent experience with flexible exchange rates suggests the existence of cross-country differences in the flexibility of real wages and in adjustment pattern to various shocks. For example, changes in the exchange rate appear to affect the price level in Europe, whereas they affect the level of exports and imports in the United States. The apparent sensitivity of wages to prices and exchange rates has led various authors to consider how wage indexation is related to the underlying economic structure.[1] Their findings suggest that different degrees of wage indexation generate different degrees of short-run real wage rigidity, which in turn implies different adjustment patterns to a given shock. Thus, understanding the determinants of optimal wage indexation might explain the existence of cross-country differences in adjustment patterns.

The purpose of this paper is to focus attention on the role of openness in explaining the degree of short-run real wage rigidity. The analysis investigates how optimal wage indexation is affected by the degree to which domestic output is exposed to the prices of internationally traded goods. A useful analytical simplification is to consider the case of a two-sector economy in which we dichotomize between traded and non-traded goods. In such a model, the country is taken as small in the traded sector (i.e. it is a price taker for traded goods) and large in the non-traded sector. Thus, there is one relative price determined endogenously--that of traded to non-traded goods. For a given relative price, the exchange rate sets the price level. A larger share of traded goods implies a larger exposure to international prices, diminishing the economic relevance of the endogenous determination of the relative price of traded to non-traded goods. This paper investigates how the endogenous determination of the above relative price affects wage indexation. This is done by applying the wage indexation approach formulated by Gray [1976]. This approach was used by Flood and Marion [1982] in the context of a one sector open economy, and the present paper extends their contribution to the case of a two-sector economy.

Section 2 describes the model. Section 3 derives the optimal wage indexation and conducts the comparative statics. Section 4 summarizes the findings, and provides concluding remarks. The Appendix summarizes the notation used in the paper.

2. The Model

Let us take a two-sector economy, producing traded and non-traded goods, under floating rates and perfect capital mobility. Consumers are assumed to have identical homothetic tastes, generating a price index given by

$$(1) \qquad P_t = (P_{n,t})^{\theta_n} \cdot (P_{z,t})^{\theta_z}$$

where $P_{n,t}$ and $P_{z,t}$ are money prices of traded and non-traded goods at time t, and θ_n and θ_z are the share of non-traded and traded goods. Real output, Y, is given by:

$$(2) \qquad Y_t = (N_t \cdot P_{n,t} + Z_t \cdot P_{z,t})/P_t$$

where N and Z represent the output of non-traded and traded goods. The demand for non-traded goods is given by

$$(3) \qquad (P_{z,t}/P_{n,t})^a \cdot Y_t \cdot \exp(\bar{c} - c(i_t - \pi_t)).$$

a is the compensated demand elasticity; i is the money interest rate, and π is the expected inflation:

$$(4) \qquad \pi_t = (E_t P_{t+1} - P_t)/P_t$$

where E_t is the conditional expectation operator which corresponds to the use of information available at period t. A higher real interest rate discourages current consumption, and c is the interest rate semi-elasticity of demand for non-traded goods. Throughout the paper it is assumed that the information set at time t contains the structure of the model and all variables dated t and earlier.

The demand for money balances is given by:

$$(5) \qquad Y_t \cdot P_t \cdot \exp(- k \cdot i_t).$$

The country operates under a floating rate regime, and the law of one price is assumed to hold for traded goods:

$$(6) \qquad P_{z,t} = S_t \cdot P^*_{z,t}$$

where S_t is the exchange rate at time t (domestic money price of one unit of foreign exchange) and P^*_z is the international price of traded goods. Under conditions of perfect capital mobility, and the absence of risk aversion, an arbitrage condition links the domestic and foreign interest rates:

$$(7) \qquad i_t - i^*_t = (E_t S_{t+1} - S_t)/S_t$$

To formulate short-run wage rigidity, the paper adapts the contracting approach to the Phillips curve. It should be noted that there exists a gap between a contracting approach to the Phillips curve and labor contracting theories. The contracting approach to the Phillips curve (as in Fischer and Gray) has not so far been derived from a strict micro foundation, (as Fischer (1977) has recognized). It is capable, however, of modeling the interaction between the money market and the Phillips curve. On the other hand, theories of labor contracting are derived from a micro foundation; but so far those theories have not been able to formulate in a satisfactory way the effects of money and financial assets on labor contracts. Because the focus of this paper is on the interaction of the money market and labor contracts, it applies to the Phillips curve the contracting specification (as used by Fischer and Gray), that has become a convention in the macro literature. These authors consider the case of an economy where nominal wage contracts are negotiated in period t-1, before current prices are known, so as to equate expected labor demand to expected labor supply. But actual employment in period t is demand-determined, and depends on the realized real wage. These models also allow for partial indexation, which may be set according to some optimizing criteria. For a recent application of the contracting approach in an open economy see Flood and Marion (1982) and Marston (1982).

Suppose that the labor supply is given by

$$(8) \qquad L_t^s = Q_s \cdot \left(\frac{W_t}{P_t}\right)^{\delta}$$

where W is money wage. Labor is the only mobile factor, and output is given by[2]

$$N_t = Q_n \cdot (L_{n,t})^{\alpha} \exp v_t$$

(9)

$$Z_t = Q_z \cdot (L_{z,t})^{\alpha} \cdot \exp v_t$$

where $L_{x,t}$ denotes the labor employed in sector x (x = n, z) in period t, and v_t is a multiplicative productivity shock. To close the model, let us specify the stochastic structure. Money and foreign prices are given by

$$(10) \qquad M_t = \bar{M} \cdot \exp m_t$$

$$(11) \qquad P^*_{z,t} = \exp p^*_t \, .$$

To simplify exposition, let us neglect trends in the variables, assuming that m, v, i^*, p^* are uncorrelated random variables, generated by white noise processes:

$$(12) \qquad x_t \sim N(0, \sigma^2_x) \text{ for } x = m, v, i^*, p^* \, .$$

As a reference point, let us start with the "non-stochastic equilibrium," i.e., the equilibrium in the economy if the value of all the random variables is zero $(m_t = v_t = i^*_t = p^*_t = 0)$. Suppose that prices in such an equilibrium are given by $P_n = P_z = S = 1$. Let us denote by lower-case variables the percentage deviation of the upper-case variable from its value in the non-stochastic equilibrium, i.e., for a variable X_t, $x_t = (X_t - X_o)/X_o$ where X_o is the value of X if all random shocks are zero. To simplify notation, we delete the time index. Thus (x_t, x_{t+k}) are replaced by (x, x_{+k}). To facilitate discussion, it is useful to take a log-linear approximation of the model around its non-stochastic equilibrium, writing the model in terms of percentage deviations. This is equivalent to the use of a first order approximation of a Taylor expansion around the equilibrium.[3]

From eq. 9 we get that output is given by

(13) $n = \bar{h}(p_n - w) + h\cdot v$

(14) $z = \bar{h}(p_z - w) + h\cdot v$

where $\bar{h} = \frac{\alpha}{1-\alpha}$; $h = \frac{1}{1-\alpha}$.

In a fully flexible economy, w corresponds to the wage that clears the labor market, i.e., $w = (\tilde{W}_t - W_o)/W_o$ where $\tilde{W}_t$ is the flexible equilibrium wage rate derived from eq. 8-9, and W_o is the equilibrium wage if $v = p^* = i^* = m = 0$. Under the labor contract, the wage contract for period t is pre-set at time t-1 at its expected money wage level in a fully flexible regime. Thus, the wage contract is $E_{t-1}\tilde{W}_t$. Under a partial indexation, actual wage is allowed to adjust in proportion to the cost of living increase:

(15) $\log W_t = \log E_{t-1}\tilde{W}_t + b[P_t - P_o]/P_o$

or, in terms of our shorter notation

(15') $w = b\cdot p$; $p = \theta_n\cdot p_n + \theta_z\cdot p_z$

where w is the unexpected wage adjustment, and p is the unexpected inflation. The case of b = 1 corresponds to full indexation, whereas b = 0 is where there is no indexation. In the first case we get short-run real wage rigidity, whereas in the second we get short-run nominal wage rigidity. In general, we expect $0 < b < 1$, providing limited flexibility in the contract scheme. Deriving the optimal degree of wage indexation is the topic of Section 3. Combining eq. 13-14 and 15'. We get:

$$(16) \qquad y = \bar{h}(1-b)\cdot p + h\cdot v.$$

Notice that $\bar{h}(1-b)$ in eq. 16 corresponds to the Phillips curve slope. A lower degree of wage indexation enhances the output effects of unexpected price changes.

Equilibrium in the non-traded sector implies that:

$$(17) \qquad n = -a(p_n - p_z) + y - c(i + p)$$

Equilibrium in the money market is given by:

$$(18) \qquad m = y - k\cdot i; \qquad i = i^* - s$$

Notice that an unexpected price level rise $(p > o)$ induces an expectation that prices will fall next period by p, implying that the real interest rate is $i + p$. Eq. 17 and 18 provides the short-run equilibrium conditions which imply that:

$$(19) \qquad p_n - p_z = - c(i^* + p^*)/(\theta_n \cdot c + a + \theta_z \cdot \bar{h}).$$

A rise in the foreign interest rate, or a transitory foreign price increase leads to a higher real interest rate, which reduces current demand for both goods. The market for non-traded goods clears continuously, thus the relative price of non-traded goods should drop. A larger substitutability of the two goods in consumption (a) or production $(\bar{h})$ reduces the needed adjustment of relative prices.

3. Optimal Indexation and Openness

To be able to drive some normative aspects of indexation, it is useful to consider as a benchmark the real output attained in a fully flexible economy. Let us denote by $\tilde{x}$ the value of x in a fully flexible economy. Following Gray we adapt the loss function[4]:

$$L = E_o(y - \tilde{y})^2 \tag{20}$$

Where E_o stands for the unconditional expectation operator. The loss function indicates that we wish to choose the wage indexation scheme so as to minimize deviations from output's fully flexible level $(\tilde{y})$.

In a flexible economy, the labor market clearing condition implies that

$$\tilde{w} = \tilde{p} + \frac{h}{\delta + h} v \tag{21}$$

$$\tilde{y} = h \cdot v - \bar{h} \frac{h}{\delta + h} v. \tag{22}$$

From eq. 22 and 16 we get that

$$L = (\bar{h})^2 E_o((w-p) - (\tilde{w} - \tilde{p}))^2 = (\bar{h})^2 E_o((1-b) p + \frac{h}{\delta+h} v)^2. \tag{23}$$

Optimal indexation is chosen so as to make the real wage in a contracting economy "closest" to real wage in a flexible economy. Its value, derived from eq. 23, is given by:

$$(24) \qquad b^* = 1 - \frac{k+1}{\psi+1-h} \quad \text{where}$$

$$\psi = \left(\frac{\delta+h}{h^2}\right)\left[h^2 + \frac{V_m}{V_v} + k^2\left(1 - \frac{c}{\phi}\right)^2 \frac{V_{i*} + V_{p*}}{V_v}\right]$$

where $\phi = c + (a + \theta_z \cdot \bar{h})/\theta_n$ and V_x denotes the variance of x.

ϕ is the only term that involves the degree of openness. Notice that

$$(25) \qquad \frac{\partial b^*}{\partial a} > 0; \; \frac{\partial b^*}{\partial \theta_z} > 0; \; \frac{\partial b^*}{\partial \bar{h}} > 0.$$

Openness can be measured either by the share of traded goods (θ_z) or by the substitutability in consumption (a) and production $(\bar{h})$ of traded and non-traded goods. An increase in openness, as measured by any of the above parameters will increase optimal wage indexation. Thus, we expect a lower degree of real wage flexibility in a more open economy. Notice also that the degree of wage indexation decreases with the ratio of productivity variance to the variance of the other shocks.

The above results can be interpreted in the following way: There are two type of shocks with opposing effects on indexation--productivity shocks and all the other shocks. We would like to increase wages when there is a positive productivity shock (see eq. 21). When such a shock occurs, it is associated with a lower price level which accommodates the increase in the demand for money. In such a case we would like to have a low degree of wage indexation. We would like to index fully for all the other shocks. Thus, there are opposing forces at work in setting the desired degree of indexation, which is chosen in such a way as to balance those forces. Any increase in V_v/V_m, V_v/V_{i*} or V_v/V_{p*} increases the relative importance of productivity shocks, enhancing the case for a lower degree of price indexation.

To understand the role of openness, notice that the real interest rate $(i - \pi)$ is given by

$$(26) \qquad i^* + \theta_n(p_n - p_z) + p^* = (i^* + p^*)(1 - \frac{c}{\phi})$$

Any increase in either i^* or p^* will increase the real interest rate, causing a drop in demand for both goods. Because the market for non-traded goods should clear all the time, the implication is that the relative price of non-traded goods should drop $(p_n - p_z < 0)$ to clear excess supply in non-traded goods. This adjustment also cushions the initial shock, because it reduces the real interest rate by $\theta_n(p_z - p_n)$.[5] The force of this cushion effect is related to the degree of openness. The more closed the economy, the more significant the above effect.[6] This adjustment reduces the economic importance of shocks to foreign prices or the interest rate (i^*, p^*), which in turn increases the relative importance of productivity shocks, thereby reducing optimal indexation.

By substituting b^* in the loss function, we can verify that

$$(27) \qquad \frac{\partial L}{\partial \theta_z} > 0; \ \frac{\partial L}{\partial a} > 0; \ \frac{\partial L}{\partial \bar{h}} > 0.$$

In a more open economy, higher wage indexation increases real wage rigidity and deviations in output from its target level. This is consistent with the notion that endogenous relative price adjustment has stabilizing effects on output.

From eq. 17 and 18 we get that prices and exchange rate are given by:

$$(28) \qquad s = \frac{m - hv + (i^* + p^*)\cdot(k + [\bar{h}(1-b) + 1] \cdot c/\phi)}{\bar{h}(1-b) + k+1} - p^*$$

$$(29) \qquad \bar{p} = \frac{m - hv + (i^* + p^*)\cdot k\cdot(1 - c/\phi)}{\bar{h}(1-b) + k+1}$$

Because reduced openness implies lower wage indexation, we can deduce from eq. 28-29 that closeness dampens the exchange rate and price level response to monetary, productivity and foreign interest rate shocks.

Finally, it is of interest to analyze how openness affects output adjustment to various unexpected shocks. For an unexpected monetary shock (m) we find that

$$(30) \qquad y - \tilde{y} = \frac{\bar{h}(1 - b)}{\bar{h}(1-b) + k+1} \cdot m$$

Because in a more open economy we get higher wage indexation (b), a monetary shock will cause higher output deviation from the target level in a more closed economy. On the other hand, for an unexpected productivity increase (v). We get

$$(31) \qquad y - \tilde{y} = \frac{1+k - (1-b)\,(1+\delta)}{1+k - (1-b)\,(1-h)} \cdot \frac{h}{h+\delta} \cdot \bar{h} \cdot v$$

Thus, a productivity shock will cause a smaller output deviation from the target in a more closed economy. In this sense, the more closed the economy, the more productivity shocks are cushioned and monetary shocks magnified.

4. Summary and Concluding Remarks

This paper has analyzed the degree of short-run real wage rigidity for a two-sector economy under floating rates by deriving optimal wage indexation in a contracting framework. It has shown that the more closed the economy, the lower the degree of optimal wage indexation. This occurs because endogenous adjustment of relative prices mitigates the effects of exogenous real interest rate shocks. As a result, output will fluctuate less around its desired level in a more closed economy. In this sense, closeness in the economy increases the flexibiltiy of its adjustment to various shocks.[7] The extra flexibility is reflected also in a lower short-run real wage rigidity. This implies also that a given unexpected monetary shock will cause a smaller output shock in a more open economy, whereas a given real shock will induce smaller output shock in a more closed economy.

The above results should not be interpreted as suggesting that there are benefits to be derived from policies that reduce openness. Cross-country differences in openness might be the result of differences in absolute size, transportation costs to other markets and other exogenously given parameters. The welfare effects of endogenous policies that affect openness, like commercial policies, should be treated explicitly in any framework that wishes to derive "optimal" openness. This analysis suggests a new dimension in differentiating a tariff from a quota. For a small country, under certainty, each tariff rate is equivalent to a certain quota. In the case of uncertainty and a frictional labor market, a country might prefer a quota to a certainty equivalent tariff. This is because the imposition of an import quota (in contrast with the imposition of an import tariff) may be viewed as transforming a traded good whose relative price is determined in world markets into a non-traded good whose relative price is determined in the domestic market. Consequently, the imposition of a quota instead of a tariff allows a small country to benefit from the stabilizing effects of endogenous price adjustments.

Comments

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

2. To make the model manageable it is assumed that in the short run, output/labor elasticities are equal for both sectors. Allowing for different elasticities have no systematic effect on the results.

3. It is assumed that the variances of the shocks are small enough to make such approximations useful.

4. This is also the loss function applied by Flood and Marion [1982].

5. This is because we expect the relative price to adjust upward in the next period. The role of relative price adjustment for the determination of real interest rate has been studied in different contexts by Bruno (1976) and Dornbusch (1983).

6. More closed economy implies $d\phi < 0$, resulting with a lower real interest rate response to $i^* + p^*$ (see eq. 26).

7. The effects of openness on the balance of payments adjustment in a managed float model has been studied by Frenkel and Aizenman [1982].

Appendix Notation

Upper case variables denote levels, lower case letters denote the logarithmic deviation of the upper case variable from the "non-stochastic" equilibrium.

P_t = price level at time t

$P_{n,t}$ = price of non-traded goods at time t

$P_{z,t}$ = price of traded goods at time t

Y_t = real output at time t (deflated by P)

N_t = output of non-traded goods

Z_t = output of traded goods

i^*_t, i_t = foreign and domestic money interest rate

π_t = expected inflation at time t

S_t = domestic money price of one unit of foreign exchange at time t

$P^*_{z,t}$ = international price of traded goods at time t

W_t = money wage rate at time t

v_t = white noise productivity disturbances

m_t = white noise monetary disturbances

p^*_t = white noise foreign price disturbances

$\sigma^2_x = V_x$ = variance of x

E_o = unconditional expectation operator

E_t = expectation operator conditional on information available at time t

X_o = the level of variable X that corresponds to the equilibrium when $v = m = p^* = i^* = 0$

$x = (X_t - X_o)/X_o$ = the percentage deviation of X at time t from its "non-stochastic" level X_o, X being any upper-case variable defined above

b = degree of wage indexation

$\hat{X}$ = the value of X in a fully flexible equilibrium, X being any variable defined above.

References

Bruno, M. "The two-sector open economy and the real exchange rate" A.E.R. 66 (September 1976): 566-77.

Dornbusch R. "Real interest rates, home goods and optimal external borrowing", J.P.E. 91 (February 1983): 141-153.

Fischer, S. "Wage Indexation and Macroeconomic Stability" In Stabilization of the Domestic and International Economy, edited by K. Brunner and A. H. Meltzer. Amsterdam: North-Holland 1977.

Flood, R.P. and N. Marion "The Transmission of Disturbances Under Alternative Exchange-Rate Regimes with Optimal Indexing". Q.J.E. (1982): 44-65.

Frenkel, J.A. and Aizenman J. "Aspects of the Optimal Management of Exchange Rates", J.I.E. 13 (1982) 231-256.

Gray, J.A. "Wage Indexation: A Macroeconomic Approach" J.M.E. (April 1976): 221-35.

Marston, R.C. "Wages, Relative Prices and the Choice between Fixed and Flexible Exchange Rates", The Canadian Journal of Economics (February 1982): 87-103.