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MONEY, EXCHANGE RATES, WAGES, AND GAMES

by

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Abstract

This paper is focused on the interaction of monetary policy and wage determination in open economies with strong labor unions. Applying some elements of game theory, the paper views both government and labor as endogenous utility maximizers, and studies the macroeconomic consequences of their interaction. In particular, the paper shows (a) how labor unions adjust wages optimally to prices following monetary expansion or devaluation; (b) how the ultimate effectiveness of policy is reduced (without necessarily being destroyed) by optimal union reactions; and (c) how the interplay of government and labor can create a persistent tendency to unemployment and inflation simultaneously.
MONEY, EXCHANGE RATES, WAGES, AND GAMES

I. Introduction

It is well known that the adjustment of wages to changes in macroeconomic policy constitutes a major potential impediment to the effectiveness of fiscal, monetary, and exchange rate policy actions of the government. History bears witness to many instances where government efforts to reduce unemployment by bringing real wages down through price inflation were frustrated by wage increases demanded by labor in an attempt to preserve the purchasing power of wages. Similarly, stabilization programs intended to reduce inflation have frequently been endangered or jeopardized by the failure of wages to decelerate with prices, resulting in much higher real wages and unemployment than were expected initially; the jump in unemployment in Britain during 1979-82, and its failure to reverse itself significantly since, is a case in point. Other examples abound.

In view of the crucial role of wages in the macroeconomic adjustment process, it is clearly of paramount importance to understand how wages respond to prices. No single theory of wages commands universal appeal at present. Differences of opinion reflect not only dissimilar labor market institutions (e.g., unionization) among countries but also methodological differences among economists. According to the equilibrium theory of labor markets, nominal wages adjust to prices so as to move real wages to a level where labor demand equals labor supply. A major difficulty with this theory is that it
requires erroneous price expectations to account for involuntary unemployment, and thus seems inconsistent with persistent involuntary unemployment of the type that has, for instance, been experienced by many countries in Western Europe and South America over the last decade. Various disequilibrium theories of labor markets are capable of explaining persistent involuntary unemployment, but then it remains to explain why real wages do not adjust to clear labor markets. Of the models that have been offered to date, three deserve mention here. First, according to the efficiency wage theory, profit-maximizing firms have no incentive to lower real wages to the equilibrium level if labor productivity falls even more in the process, thus reducing profits. Second, utility-maximizing labor unions may find high real wages accompanied by some unemployment preferable to lower wages and full employment (even though some individual union members may think differently); this is the essence of the labor union theory. Third, the insider-outsider hypothesis emphasizes that employed workers ("insiders") have an incentive to try to prevent unemployed workers ("outsiders") from gaining employment through lower wage offers. While not mutually exclusive, each of these three hypotheses stresses a different mechanism of wage determination and a different source of disequilibrium in labor markets. However, none of them is by itself intended to explain cyclical fluctuations of real wages and employment or nominal wage rigidities.

1 See, e.g., Rosen and Quandt (1978, 1986).
2 See, e.g., Stiglitz (1976, 1987)
3 See, e.g., Calmfors and Horn (1986), Corden (1981), Gylfason and Lindbeck (1984a), and Oswald (1982).
The principal focus of this paper is on the interaction of wage formation and monetary policy in open economies where wages are set primarily through collective bargaining among strong and well coordinated labor unions and relatively weak associations of employers. The paper treats both government and labor as endogenous maximizers of utility, and investigates the macroeconomic implications of their interest conflicts by applying some elements of game theory. In particular, the paper is intended to show how the ultimate consequences of monetary policy actions depend on the preferences of both labor and the government as well as on their (frequently different) views as to how the economy operates. More specifically, the paper seeks to show both how utility-maximizing labor unions adjust wages optimally to prices in the wake of monetary expansion or devaluation, and how the ultimate effectiveness of policy is circumscribed (though not necessarily destroyed) by optimal union reactions.

The usefulness of viewing government policy as being responsive to economic developments has been recognized for some time in the literature on political business cycles. A similar perspective on labor markets seems justifiable in view of the postwar experience of many countries in Western Europe and South America (as well as Australia and Canada) where unions have played a prominent macroeconomic role. The emphasis of this paper on the macroeconomic importance of labor unions and their potential role in perpetuating unemployment distinguishes it from several recent game-theoretic approaches in which a welfare-maximizing government is confronted by a nonunionized labor force.  

See also Gylfason and Lindbeck (1984a, b; 1986a, b).  
See, in particular, Barro and Gordon (1983a, b). See also Backus and Driffield (1985a, b), Horn and Persson (1986), and the surveys by Fischer (1986) and Rogoff (1987).
However, the focus of this literature has been almost exclusively on the alleged inflationary bias of monetary policy due to dynamic inconsistency. Here, instead, attention is focused on (1) the sensitivity of the real effects of monetary policy, devaluation, and money wage changes to the interaction between government and unionized labor in an open economy and (2) the potential tendency to persistent unemployment and inflation resulting from this interaction.

II. Macroeconomic background

Output and the price level are determined by equilibrium between aggregate demand and supply.

Aggregate demand for domestic output depends (in reduced form) on real money balances as well as the real exchange rate:

\[
Y = M - C + e - P = M - P + 0.5(e - P),
\]

where \( Y, M, C, e, \) and \( P \) are the logarithms of output, money supply, consumer price index, exchange rate, and domestic producer price level. All elasticities are set equal to 1 for simplicity and without material loss of generality. The consumer price index \( C \) equals \( 0.5(P + e) \) on the assumption that domestically produced and imported goods and services weigh equally in domestic expenditures and that import prices in foreign currency are fixed at 1.

If labor is the only variable input in the short run, aggregate supply of output by perfectly competitive profit-maximizing firms varies inversely with real wages:

\[
Y = P - W.
\]

The real wage elasticity of output (and employment) is \(-1\).

With money supply and the exchange rate determined by the government and nominal wages dictated by labor, the short-run
equilibrium solution for $Y$ and $P$ from (1) and (2) is

$$Y = 0.4M + 0.2e - 0.6W,$$

$$P = 0.4M + 0.2e + 0.4W.$$

Exogenous monetary expansion or devaluation raises both $Y$ and $P$ in the short run for given $W$, while an exogenous wage increase reduces $Y$ and raises $P$ for given $M$ and $e$. In the short run the monetary consequences of current account deficits are sterilized through domestic credit expansion, so that the money supply remains unchanged and the current account deficit persists (as long as reserves last). Over time, however, deficits must be eliminated either through monetary or exchange rate adjustment (see Section VI). Even though equilibrium GNP is below its full-employment level, money wages do not fall (because they are fixed by utility-maximizing unions as shown in Section III) and unemployment persists.

Having sketched the major channels through which exogenous changes in money supply, the exchange rate, and wages affect GNP and the price level, we now proceed to model the money supply, the exchange rate, and the nominal wage as endogenous variables that are determined by the utility maximizing behaviour of government and labor.

III. Unions and wages

Unions determine nominal wages unilaterally. Their interest in real wages and in employment, or output, is described by a quadratic utility function:

$$U = -(W - C - w^*)^2 - u(Y - Y_u^*)^2.$$  

The higher $u \geq 0$, the greater the increase in $W - C$ required to compensate labor for a given decrease in $Y$. The fixed parameters $w^*$ and $Y_u^*$ represent unattainable aspiration levels. Hence, $U_1 = -2(W - C -$
\( w^* > 0 \) and \( U_2 = -2u(Y - Y^*) \geq 0 \), while \( U_{11} = -2u \) and \( U_{22} = -2u \), implying diminishing marginal utility. Moreover, \( U_{12} = 0 \).

Maximization of (5) with respect to \( W \) subject to (3) and (4) gives a loglinear union reaction function:

\[
W = [(4+6u)/(16+9u)]M + [(12+3u)/(16+9u)]e + 
[20/(16+9u)]w^* - [15u/(16+9u)]Y^*
\]

The optimal wage varies directly with the money supply and the exchange rate. The slope of the reaction function relating \( W \) to \( M \) is an increasing function of the taste parameter \( u \). Intuitively, the greater the unions' interest in GNP relative to real wages (i.e., the higher \( u \)), the greater will be the nominal wage decrease in response to monetary contraction. The homogeneity of the underlying model ensures that the sum of the coefficients of \( M \) and \( e \) in (6) is 1.

IV. Monetary policy

Even though the union membership constitutes a large part of the electorate in many countries, especially in Western Europe, government and labor are viewed here as separate entities with different and independent preferences, partly because both governments and unions enjoy a certain discretionary autonomy with respect to the preferences of voters and members, and partly also because the government represents nonunion workers as well as entrepreneurs and capitalists. After all, government and labor frequently are at odds in the real world.

The government maximizes a quadratic utility function with income and inflation as arguments:

\[
V = - (Y - Y^*)^2 - v(\Delta C - \Delta C^*)^2
\]

subject to (3) and (4). Here, \( \Delta C = C - C_{-1} \) is the rate of inflation and \( \Delta C^* = C^* - C_{-1} \). The higher \( v \geq 0 \), the greater the increase in \( Y \).
necessary to compensate the government for a given increase in \( \Delta C \).

Since last period's price level \( C_{-1} \) is predetermined, there is a unique correspondence between inflation \( \Delta C \) and the price level \( C \), enabling us to replace \( \Delta C - \Delta C^* \) in (7) by \( C - C^* \). Observe that \( V_1 = -2(Y - Y^*_g) > 0 \) as long as income is below the government's full-employment target \( Y^*_g \) (which may or may not coincide with the unions' target \( Y^*_u \)). Similarly, \( V_2 = -2v(\Delta C - \Delta C^*) \leq 0 \) as long as the prevailing inflation rate is above the target rate \( \Delta C^* \). Observe also that \( V_{11} = -2, V_{22} = -2v, \) and \( V_{12} = 0 \).

Maximization of (7) with respect to \( M \) subject to (3) and (4) gives the government reaction function:

\[
(8) \quad M = \left[ (6-v)/(4+v) \right] W - \left[ (2+3v)/(4+v) \right] e + \left[ 10/(4+v) \right] Y^*_g + \left[ 5v/(4+v) \right] C^*.
\]

The effect of an increase in the nominal wage on money supply is positive or negative (depending on whether \( v \leq 6 \)) and is a decreasing function of \( v \). Intuitively, the greater the government's interest in price stability relative to GNP (i.e., the higher \( v \)), the more likely is the government to counter a wage hike by monetary restraint. The money supply varies inversely with the exchange rate because the more the economy is stimulated by devaluation, the less stimulus is needed through monetary expansion.

V. The short run

To highlight the games, income and prices are substituted from (3) and (4) into (5) and (7) to obtain a pair of indirect utility functions, \( U(M, e, W) \) and \( V(M, e, W) \). The unions find the optimal \( W \) for given \( M \) and \( e \) by setting \( U_3(M, e, W) = 0 \). This gives the unions' reaction function relating \( W \) to \( M \) and \( e \) as in (6), and determines aggregate
supply by (2) for given $P$. Similarly, the government finds the optimal $M$ for given $W$ and $e$ by setting $V_1(M, e, W) = 0$. This gives the government's reaction function relating $M$ to $W$ for given $e$ as in (8), and determines aggregate demand by (1) for given $P$. Any exogenous shock that induces a change in $M$, $e$, or $W$ triggers reactions which cause further changes in $Y$ and $P$ by (3) and (4).

The unions' reaction function $R^u$ in Figure 1 is the locus of points at which the unions' indifference curves, given by their indirect utility function $U(M, e, W)$, are vertical [in $(W,M)$ space for given $e$]. Equation (6) implies that $R^u$ has a positive slope ranging from 0.25 (for $u = 0$) to $2/3$ (for $u \to \infty$). The government's reaction function $R^g$ connects the points at which the government's indifference curves implicit in its indirect utility function $V(M, e, W)$ are horizontal [in $(W,M)$ space for given $e$]. The slope of $R^g$ spans the range from 1.5 (for $v = 0$) to $-1$ (for $v \to \infty$). Figure 1 shows the case where $R^g$ slopes up (because $v < 6$). Regardless of its slope, $R^g$ is always steeper than $R^u$ in this model (unless $v = 0$ and $u \to \infty$; then $R^g$ and $R^u$ are parallel). At the point of intersection of $R^g$ and $R^u$ both money and wages are in equilibrium for given $e$ in the sense that neither government nor labor can gain by unilateral action.

The equilibrium solutions for $M$ and $W$ from (6) and (8) are

\begin{align}
(9) \quad & M = \frac{(m_1 w_2 + m_2)}{(1-m_1 w_1)}, \\
(10) \quad & W = \frac{(w_1 m_2 + w_2)}{(1-m_1 w_1)},
\end{align}

where $m_1$, $w_1$, $m_2$, and $w_2$ are the slopes and intercepts of the reaction functions (6) and (8) [in $(W,M)$ space]. With $M$ and $W$ in equilibrium, $Y$ and $P$ are also in equilibrium by (3) and (4) for given $e$.

Suppose now that the government increases the money supply (by raising either its GNP target $Y^*_g$ or its inflation target $\Delta C^*$), so that
m₂ rises). The government's reaction function shifts from $R^G_1$ to $R^G_2$ in Figure 1. If the government foresees the reactions of the unions and conversely, it knows that by raising $M$ from A to B, it would trigger an increase in $W$ to C, causing $M$ to be increased further to D, and so on until a new Cournot-Nash equilibrium would be reached at E where both $M$ and $W$ are higher than initially. With perfect foresight, therefore, government and labor move directly from A to E.

With both $M$ and $W$ higher at E than at A (and with $e$ unchanged by assumption until Section VI), the price level is also higher by (4). The effect on GNP depends on the slopes of both $R^u$ and $R^g$ by (3), (9), and (10): $dY/dm_2 = (0.4 - 0.6w_1)/(1-m_1w_1)$. This multiplier gives the response of GNP to the initial increase in $M$, which is represented by the distance AB in Figure 1. By comparison, the multiplier that shows the effect on GNP of the ultimate (i.e., initial plus induced) increase in $M$ is $dY/dM = 0.4 - 0.6w_1$, where $dM$ corresponds to the horizontal distance between A and E in the figure. This multiplier ranges from 0.25 (when $u = 0$) to 0 (when $u = \infty$). Thus, monetary contraction reduces GNP in the short run despite the optimal reaction of labor as long as the unions have an interest in the real wage; otherwise, the optimal response of labor restores GNP to its initial level.

A similar story can be told about the short-run effects of devaluation for given money supply. This requires solving the government's reaction function (8) for $e$ as a function of $W$, $M$, $y^*$, and $C^*$. Accordingly, $e$ appears instead of $M$ on the horizontal axis in Figure 2. Devaluation shifts $R^g$ from $R^g_2$. In anticipation of the adjustment process ABCDE, both government and labor move directly from A to E. Because both $W$ and $e$ are higher at E than at A, prices must also be higher by (4). The effect on GNP depends on the slope of $R^u$ by (3):
\[
\frac{dY}{de} = 0.2 - 0.6 \left( \frac{dW}{de} \right), \text{ and thus ranges from } -0.25 \text{ (when } u = 0) \text{ to } 0
\]

(when \( u \to \infty \)). Therefore, devaluation reduces GNP in the short run in this model as long as the unions care about real wages; if they do not, their optimal reaction brings GNP back to its initial level.

Consider now the reaction of the government to an exogenous increase in the unions' wage target \( w^* \). This implies a shift of the unions' reaction function from \( R_1^u \) to \( R_2^u \) in Figure 3 where \( M \) reappears on the horizontal axis. With perfect foresight, \( W \) and \( M \) move directly from \( A \) to \( E \). At \( E \), \( W \) is higher than initially as the unions intended, and so is \( M \), so \( P \) must also be higher by (4). The effect on \( Y \) depends on the slope of \( R^G \) by (3): \( \frac{dY}{dW} = -0.6 + 0.4m_1 \), and thus spans the range from 0 (when \( v = 0 \)) to -1 (when \( v \to \infty \)). Hence, a wage increase reduces GNP as long as the government cares about inflation; otherwise, the negative output effect is nullified by monetary accommodation.

In the case of a negatively sloped government reaction function, an exogenous wage hike raises \( W \) and lowers \( M \) and hence also \( Y \) by (3), for given \( e \). The effect on \( P \) depends on the slope of \( R^G \) by (4): \( \frac{dP}{dW} = 0.4(1+m_1) \), and ranges from 1 (for \( v = 0 \)) to 0 (when \( v \to \infty \)). Hence, a wage increase raises the price level as long as the government has an interest in GNP; otherwise, the price level effect is completely offset through monetary contraction.

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7 This result has been built into the model by setting all elasticities equal to 1 in equations (1) and (2). With other (and more realistic) parameter values, devaluation can be shown to increase GNP despite the induced adjustment of wages. See Gyfason and Lindbeck (1986b).
VI. Beyond the short run

Thus far the money supply and the exchange rate have been treated as independent instruments of monetary policy. Before proceeding further, it is necessary to consider the relationship between these instruments and the current account of the balance of payments.

Full stock equilibrium requires current account balance, implying that nominal income must equal nominal expenditure:

\[(11) \quad P + Y = C + E,\]

where \(E\) represents real domestic expenditure which depends on real income and real balances: \(^8\)

\[(12) \quad E = g(P + Y - C) + (1-g)(M - C).\]

Here \(P + Y - C\) is the logarithm of the purchasing power of nominal income and \(g\) and \(1-g\) are the income and wealth elasticities of expenditure. Using \(C = 0.5(P + e)\) in (11) and (12) gives the following simple condition for current account equilibrium:

\[(13) \quad Y = M - P.\]

This condition can be established either through monetary adjustment under a fixed exchange rate or through exchange rate adjustment under a flexible rate. Therefore, in the medium term, defined here to be long enough for the current account to reach equilibrium through either of those two adjustment mechanisms, the effects of monetary expansion (under a flexible exchange rate) or devaluation (under a fixed rate) can be fundamentally different from the short-run effects that were studied before. Specifically, in evaluating the medium-term effects of monetary expansion, it is now necessary to take account not only of the optimal reaction of wages but also of the

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\(^8\) Equation (12) has already been used to derive the aggregate demand equation (1) as in Gylfason and Lindbeck (1986b).
induced adjustment of the exchange rate that is required for the current
account to reach equilibrium. Similarly, in assessing the effect of
devaluation on GNP and the price level in the medium term, it is
necessary to consider the automatic adjustment of the money supply
through the balance of payments in addition to the optimal reaction of
wages.

Under a flexible exchange rate, the solution to (1), (2), and (13)
is

(14) \( Y = 0.5(M - W) \),
(15) \( P = 0.5(M + W) \),
(16) \( e = P = C \).

The corresponding reaction functions of the unions and the government
are

(17) \( W = M + \frac{2}{(1+u)}w^* - \frac{2u}{(1+u)}Y^\ast_u \),
(18) \( M = \frac{(1-v)/(1+v)}{W} + \frac{2}{(1+v)}Y^\ast_g + \frac{2v/(1+v)}{C^\ast} \).

When \( M \) and \( W \) are exogenous, \( dY/dM = 0.5 \) and \( dP/dM = 0.5 \) by (14)
and (15) for given \( W \). But when \( M \) and \( W \) are endogenous, \( dY/dM =
0.5(1-w_1) \) and \( dP/dM = 0.5(1+w_1) \) where \( w_1 = dW/dM \). With \( w_1 = 1 \) by (17),
this means that \( dY/dM = 0 \) and \( dP/dM = 1 \) in this model, indicating that
money is neutral in the medium term under a flexible exchange rate.

But this is not the only conceivable outcome. In particular, it
may be reasonable to assume that unions do not anticipate the current
account implications and, hence, the medium-term consequences of their
actions. This assumption of imperfect foresight need not reflect any
lack of sophistication on the part of labor because the effect of a wage
increase on the current account and hence also on the exchange rate is,
after all, indeterminate in many macroeconomic models, even though this
effect is unambiguous in the present model. On this assumption, unions
maximize their utility in (5) subject to (8) and (4) as before rather than (14)-(16) and the relevant union reaction function remains as in (6) with \( w_1 < 1 \), implying that \( dY/d\Pi > 0 \). Thus, if labor has imperfect foresight, monetary policy can have real effects even in the medium term.

Under a fixed exchange rate the solution to the model is

(19) \[ Y = e - W, \]
(20) \[ P = e = C, \]
(21) \[ M = 2e - W. \]

The corresponding reaction function are

(22) \[ W = e + \left[1/(1+u)\right]w^* - \left[u/(1+u)\right]Y^*_u, \]
(23) \[ e = \left[1/(1+v)\right]W + \left[1/(1+v)\right]Y^*_g + [v/(1+v)]C^*. \]

When \( e \) and \( W \) are exogenous, \( dY/de = 1 \) and \( dP/de = 1 \) by (19) and (20) for given \( W \). But when \( e \) and \( W \) are endogenous, \( dY/de = 0 \) by (19) and (22). Devaluation has no effect on GNP in the model once the current account has been restored to equilibrium through monetary adjustment. But, again, other outcomes are thinkable. Specifically, if the unions do not foresee the consequences of their actions for the current account, then (6) is still the relevant union reaction function. Hence, \( dY/de > 0 \) by (19) and (6). The contractionary short-run effect of devaluation together with the induced optimal wage response reported in Section V is reversed in the medium term through automatic monetary expansion. Hence, if labor has imperfect foresight, devaluation increases GNP in the medium term.

If labor has perfect foresight (and the government's inflation target is zero so that \( C^* = C_{-1} \)), the medium-term solutions for income \( Y \) and inflation \( \Delta C \) from (14)-(18) or (19)-(23) are

(24) \[ Y = \left[u/(1+u)\right]Y^*_u - \left[1/(1+u)\right]w^*, \]
(25) \[ \Delta C = \frac{1}{1/(v + uv)} w^* + \frac{1}{v} Y^* \left(1 + \frac{u}{u + uv} \right) \]

Now real GNP depends solely on the preferences of labor (reflected in \( u^* \), \( Y^* \), and \( w^* \)) in the medium term. The government's preferences (reflected in \( v^* \) and \( Y^* \)) influence only inflation. If the government's full-employment target coincides with that of labor \( (Y^* = y^* = Y^*) \), full-employment equilibrium without inflation \( (Y = Y^*, \Delta C = 0) \) is established only if labor does not care about real wages \( (u \to \infty) \) or if its real wage target corresponds exactly to full employment \( (w^* = -Y^*) \). But if labor is interested in real wages as well as employment \( (u \to \infty) \) and its exogenously determined real wage target is higher than required by full employment \( (w^* > -Y^*) \), there is an automatic persistent tendency to simultaneous unemployment and inflation in the model \( (Y < Y^*, \Delta C > 0) \). If the government cares solely about inflation \( (v \to \infty) \), the inflation bias disappears, but unemployment remains. Finally, if the unions and the government jointly maximize a weighted average of their utilities: \( kU + (1-k)V \), where \( k \) reflects the relative bargaining strength of labor, the resulting cooperative solution for \( M \) and \( W \) under a flexible exchange rate can be shown to imply zero inflation, but the unemployment bias persists under the same conditions as above \( (u < \infty, w^* > -Y^*) \).

VII. Numerical examples

Having shown how the ultimate effectiveness of monetary policy depends on both the reactions of labor and the counterreactions of the government, we must now ascertain whether these considerations alter the effects of monetary policy significantly in quantitative terms.

To evaluate the sensitivity of the short-to-medium-run effects of monetary policy to the preferences of government and labor, the
following alternative values of the taste parameters in the objective
functions (5) and (7) are assumed: \( u = 0.1, 1, 10; \ v = 0.1, 1, 10. \)
Unions that are primarily interested in real wages are represented by \( u = 0.1, \) "neutral" unions by \( u = 1, \) and the ones mainly concerned about employment by \( u = 10 \) [see (6)]. A "left-wing" government which is relatively more concerned about GNP than prices is represented by \( v = 0.1, \) a "neutral" government by \( v = 1, \) and a "right-wing" one which is more interested in controlling inflation than employment by \( v = 10 \) [see (8)].

The effects of monetary expansion on GNP and the CPI implied by the above values of \( u \) and \( v \) are shown in Table 1. The impact effects on GNP and the CPI of a 10% increase in money supply under a fixed exchange rate and with an exogenously fixed nominal wage are shown in the top left corner of the table [see (3) and (4)]. On impact, 10% monetary expansion raises GNP by 4% and lowers real wages by 2% (columns 1 and 2).

When endogenous government and union behavior is introduced, the numbers change substantially. The greater the unions' marginal utility of employment (i.e., the higher is \( u \)), the steeper is their reaction function relating wages to money supply and, hence, the more actively the unions will drive up wages to compensate for the rise of the CPI.\(^9\) This induced wage response reduces the GNP effect of the monetary expansion very considerably (e.g., by more than one half in the neutral case where \( u = 1 \)) and increases the CPI effect correspondingly. The 10% monetary expansion under discussion refers to the ultimate (i.e., initial plus induced) increase in the money supply.

\(^9\) The slope \( (w^1) \) of the union reaction function (6) relating \( W \) to \( M \) is 0.27 if \( u = 0.1; \) 0.4 if \( u = 1; \) and 0.6 if \( u = 10. \)
When the adjustment of the exchange rate to the incipient current account deficit created by the monetary expansion is also taken into account, a similar pattern is observed. The depreciation of the currency magnifies the effects of the monetary expansion on both GNP and the CPI for any given value of u, provided that labor has imperfect foresight. In this case, 10% monetary expansion increases GNP by 2% despite a strong wage response (u = 10; column 3). On the other hand, if labor has perfect foresight, money is neutral (column 5).

A similar story can be told about the effects of devaluation (Table 2). On impact, devaluation raises GNP by 2% and the CPI by 6% for given nominal wages and money supply (columns 1 and 2). The reaction of wages reinforces the CPI effect and reverses the GNP effect if the money supply is held fixed. These secondary effects are stronger the steeper is the union reaction function relating wages to the exchange rate (i.e., the lower is u). However, the effect of devaluation on GNP becomes positive again when the monetary expansion resulting from the incipient improvement of the current account is taken into consideration and labor has imperfect foresight (column 3). Only with perfect foresight of labor does devaluation become neutral (column 5).

Finally, Table 3 shows the effects of an exogenous wage increase of 10% on GNP and consumer prices. Under a fixed exchange rate, a "left-wing" government (\(v = 0.1\)) reacts to the wage hike by expanding the money supply, virtually nullifying the negative impact effect of the wage increase on GNP in the process (column 1). By contrast, a "right-wing" government (\(v = 10\)) reacts by reducing money supply, thus compounding the contractionary GNP effect of the wage increase. This

\[10\text{ The slope is } 0.73 \text{ if } u = 0.1; 0.6 \text{ if } u = 1; \text{ and } 0.4 \text{ if } u = 10.\]
general pattern is preserved when the adjustment of the exchange rate is taken into account (column 3 and 7). For example, under a "left-wing" government the ultimate effect of a wage increase on GNP is positive when the induced monetary expansion and depreciation are included and labor has imperfect foresight. Under a fixed exchange rate, consumer prices are fully determined by the exchange rate and, hence, independent of wages (column 6 and 10).

While the simple numerical illustrations presented above are, of course, not intended to mirror reality exactly, they indicate that the macroeconomic consequences of endogenous policy making can be fundamentally different from those of exogenously determined policies in practice.

VIII. Conclusion

The principal focus of this paper has been on the role and macroeconomic impact of monetary policy and wage formation in open economies. By applying some rudimentary game theory, an attempt was made to demonstrate the potential fruitfulness of modelling government and labor as endogenous utility maximizers with different and independent preferences. The macroeconomic consequences of their interaction were explored. In particular, it was shown how the ultimate effects of monetary expansion and devaluation on GNP and prices depend crucially on the reaction patterns of both unions and government, and hence also on their preferences as well as on their perceptions as to how the economy operates. For example, it was shown that the real effects of monetary policy are generally not nullified by the subsequent optimal reaction of labor unions, not even in the medium term, provided that the unions do not foresee the implications of their actions for the
exchange rate or the money supply through the current account. Also, it was shown that the interaction of government and labor can create a persistent tendency to unemployment and inflation simultaneously. By numerical examples it was demonstrated that the consequences of endogenous policy making and of different preferences and perceptions of government and labor can be fundamentally different from those of exogenously determined policies.

The foregoing analysis differs from other recent game-theoretic models of monetary policy in at least two important respects. First, Barro and Gordon (1983a, b) and also Backus and Driffill (1985a, b) deal with a closed economy which they describe simply by a Phillips curve: \( \Delta P = Y - Y^* + \Delta P^E \), where \( Y^* \) is income at full employment and \( \Delta P^E \) is the expected rate of inflation. Unions and wages are absent from their models. The behavior of the public is described by assuming rational expectations (\( \Delta P^E = \Delta P \)) and hence also full employment (\( Y = Y^* \)) throughout; Backus and Driffill (1985a, b) justify rational expectations by assuming the public to minimize a loss function whose sole argument is the discrepancy between actual and expected inflation. Horn and Persson (1986) assume unions to determine wages by maximizing earnings in an open economy, but consider the exchange rate as the sole instrument of government policy and assume the domestic price level to be fully determined by the exchange rate through the law of one price. Money is absent from their model. In the present model, by comparison, both inflation and unemployment are generally sensitive to both monetary and exchange rate policy and union behavior in the short to medium term, unless the unions foresee the consequences of their actions for the current account. Similar results are obtained by different means in Gylfason and Lindbeck (1986b) where the control variable of the unions
is their purchasing power target (defined as $W = aC^g$) and policy effectiveness in the medium term rests on the assumption that nominal wages do not adjust fully to expected consumer prices ($a < 1$). Second, while the government utility functions assumed by Barro and Gordon (1983a, b), Backus and Driffield (1985a, b), and Horn and Persson (1986) include a quadratic inflation term (with $\Delta C^g = 0$), these functions are either linear in income or incorporate tax distortions without which the inflation bias which is the focal point of their analyses disappears. By contrast, the tendency to simultaneous inflation and unemployment in the present model emanates from the interaction of government and labor, and does not depend on tax distortions or an asymmetric specification of the government's utility function.
References

Backus, D. and J. Driffill, 1985a, Rational expectations and policy credibility following a change in regime, Review of Economic Studies 52, April, 211-221.


Table 1. Effects of 10% monetary expansion on GNP and consumer prices

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<th>Medium-term effects (Flexible exchange rate)</th>
<th>Long-run effects (Perfect foresight)</th>
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Source: Authors' computations.
Table 2. Effects of 10% devaluation on GNP and consumer prices

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Table 3. Effects of 10% wage increase on GNP and consumer prices

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Source: Authors' computations.
Figure 2