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WAGES, MONEY, AND EXCHANGE RATES:

With Endogenous Unions and Governments

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Abstract

This paper analyzes the role and macroeconomic impact of monetary and exchange rate policy as well as of wage formation in open economies where wages are primarily determined through collective bargaining among powerful labor unions and relatively weak employers. Applying some elements of game theory, the paper treats the government and unions as endogenous utility-maximizers with different and independent preferences, and explores the macroeconomic consequences of their interaction. In particular, the paper argues, and demonstrates by numerical examples, that the ultimate effects of monetary expansion or devaluation (as well as of exogenous wage hikes) on incomes and prices depend crucially on the reaction patterns of both unions and government.

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WAGES, MONEY, AND EXCHANGE RATES:

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The aim of this paper is to extend our earlier work on endogenous governments and unions (Lindbeck 1973; Gylfason and Lindbeck 1984a, 1986) to an open economy in which the government's primary instrument of economic stabilization is monetary rather than fiscal policy, and where either the money supply or the exchange rate is the tool of monetary policy, depending on whether the exchange rate is floating or fixed (i.e., adjustable peg).

The general inspiration of the paper is provided by the observation that economic policy action of governments and wage claims of labor unions are not entirely discretionary in practice, but do seem to react to developments in the national and international economy. This suggests that our understanding of past economic developments as well as our ability to make successful forecasts about the future and, especially, to provide effective policy advice could be materially improved by treating government policy and union behavior as endogenous rather than exogenous variables in economic analysis. This way of looking at economic policy is, of course, closely related to the rational expectations hypothesis which emphasizes the dependence of private behavior on expectations about the reaction patterns ("policy rules") of the government.

While the usefulness of viewing government policy this way has been recognized for some time as evidenced, for example, by the literature on political business cycles (see Lindbeck 1973, 1976; Nordhaus 1975; McRae 1977; and Frey 1978), the need for according labor unions similar treatment in macroeconomic analysis has been slower in gaining

acceptance among academic economists. Yet, the postwar experience of many countries where wages are determined primarily through collective bargaining among macroeconomically strong unions and relatively weak employers' associations, including Argentina, Australia, Belgium, Brazil, Britain, Canada, Denmark, Finland, France, Italy, Norway, and Sweden, seems to demonstrate this need.

If the government was the only organization large enough to influence the behavior of others, as is commonly assumed in macroeconomic analysis, the government would only have to consider atomistic market responses to its policy actions (as, for example, in Barro and Gordon (1983a, b) and in Backus and Driffill (1985a, b)). But in the presence of strong labor unions (or strong business monopolies for that matter), the government needs to anticipate the reactions of unions and vice versa. Thus, in the study of government policy and wage formation and consequently also of the determination of national income, employment, and prices, an application of some elements of game theory becomes appropriate. Hence our approach in the present paper which is outlined as follows:

1. *Macroeconomic framework*
 - Supply*
 - Demand*
 - Income and the price level*
2. *Endogenous unions and governments*
 - Unions and wages*
 - Money and exchange rates*
 - Fixed vs. floating exchange rates*
3. *Games*
 - Monetary policy*
 - Exchange rate policy*
 - Wage policy*
 - Stackelberg equilibria*
 - Preferences vs. view of the world*
 - Numerical illustration*
4. *Conclusion*

1. Macroeconomic framework

We take as our starting point the following simple aggregate supply and demand model of income and price determination in an open economy.

Supply

The aggregate supply equation is derived from four ingredients.

First, as in Fischer (1977, equation (2)), nominal wages are assumed to be set at a level consistent with a fixed real wage target which lies above the market-clearing level by assumption, hence giving rise to unemployment:

$$(1) \quad W = w + aC^e.$$

Here W is the logarithm of the nominal wage and C^e is the logarithm of the level of consumer prices expected at the beginning of the period when wage contracts are negotiated to prevail over the period. The real wage target w is determined by utility-maximizing unions as, for example, in Gylfason and Lindbeck (1984a, b). The adjustment coefficient a reflects the extent to which unions are concerned with real vs. nominal wages in the short run. If $a = 1$, they are interested only in expected real wages proper and negotiate wage contracts accordingly. With $a < 1$, unions are to some extent concerned about, or contractually committed to, nominal wages.

Parenthetically, it should be noted here that nominal wage stickiness of this type is not at all inconsistent with rational expectations, nor does it necessarily imply irrational behavior or money illusion of any kind. There are at least three major reasons for this, each of which is sufficient (but not necessary) to generate nominal wage rigidity. The cost of wage adjustment provides an incentive for workers (and firms) to have wages adjusted periodically

rather than instantaneously to changes in expected prices. Also, as Keynes (1936, p. 14) maintained, if workers are concerned about wage differentials, rational behavior does not require them to insist on full and immediate compensation for all price increases unless they expect all other employees to be fully compensated immediately; workers (and unions) may thus accept an overall reduction of real wages when prices rise (e.g., following devaluation), in the hope of improving employment prospects (see Tobin (1947) and Patinkin (1979) for a general discussion of this argument and Gylfason and Lindbeck (1984b) for a formalization). Moreover, as stressed, for example, by Fischer (1977), if labor contracts cover "long" periods and overlap, only the wages of those workers whose contracts have just expired can be adjusted immediately when prices rise; the wage compensation of all others is delayed at least until their contracts expire, so that average wages for the work force as a whole adjust sluggishly to price changes.

Second, price expectations C^e are assumed to adjust to actual price developments as follows

$$(2) \quad C^e = bC + (1-b)C_{-1}^e,$$

where C is the logarithm of the actual consumer price index, b reflects the extent to which price expectations adjust immediately to actual price developments, and C_{-1}^e is last period's C^e . With $b = 1$, expected prices equal actual prices; this is the case of perfect foresight which, within our nonstochastic framework, corresponds to rational expectations. If $b < 1$, price expectations are adaptive, and adjust gradually to actual price changes, but catch up fully in the long run.

Third, the consumer price index is a weighted average of

domestic producer prices P (i.e., the implicit GNP deflator) and of import prices which, in a small open economy facing exogenously given world market prices, equals the exchange rate e (defined as units of domestic currency per unit of foreign currency), all in logarithms:

$$(3) \quad C = cP + (1-c)e.$$

Here, c and $1-c$ are the weights of domestic and foreign goods and services in the domestic consumption bundle. In a closed economy, $c = 1$ and $C = P$.

Fourth, holding capital constant and treating labor as the only variable factor of production in the short run, we assume aggregate supply of output and hence also aggregate demand for labor by perfectly competitive profit-maximizing firms to vary inversely with (actual) real wages:

$$(4) \quad Y = P - W.$$

The real wage elasticity of output is set equal to -1 for simplicity.

Substitution of equations (1) to (3) into (4) yields the following expression for aggregate supply of output:

$$(5) \quad Y = (1-abc)P - w - ab(1-c)e - a(1-b)C_{-1}^e.$$

Here we have real GNP as a function of the domestic (producer) price level, given the real wage target of the unions as well as the exchange rate and last period's (consumer) price expectations. For given w , e , and C_{-1}^e , the corresponding aggregate supply schedule is unambiguously upward-sloping in an open economy because $c < 1$, even in the case of full wage adjustment ($a = 1$) and rational expectations ($b = 1$ or $C^e = C_{-1}^e$). If, however, the exchange rate adjusts fully to domestic prices ($e = P$), the supply schedule becomes vertical for $a = 1$ and $b = 1$ or $C^e = C_{-1}^e$, and output depends solely

on w in this case.

Demand

On the demand side of the economy, we express GNP in the usual way as expenditure plus exports minus imports, all in real terms. Denoting the logarithms of income, expenditure, exports, and imports by Y , E , X , and Z , we thus have the loglinear approximation

$$(6) \quad Y = (1+k)E + qX - (q+k)Z,$$

where k and q are the initial ratios of the trade deficit and exports to GNP. These ratios enter the equation in the transition from levels to logarithms.

Expenditure is given by

$$(7) \quad E = g(Y + P - C) + (1-g)(M - C),$$

where $Y + P - C$ is the logarithm of the purchasing power of nominal income, M is the logarithm of the money supply, and g and $1-g$ are the income and wealth elasticities of expenditure (see Dornbusch and Mussa 1975). The two elasticities must sum to 1 if the level of expenditure is a linear function of the levels of income and wealth.

Exports are an increasing function of the real exchange rate:

$$(8) \quad X = h(e - P),$$

where the export price elasticity h is positive.

Imports vary directly with expenditure in domestic output units (see Gylfason and Risager 1984) and inversely with the real exchange rate:

$$(9) \quad Z = E + C - P - m(e - P).$$

Here the expenditure elasticity is set equal to 1 for simplicity and m is the absolute value of the price elasticity of imports.

Substituting equations (7) to (9) into (6) gives the

following expression for real income:

$$(10) \quad Y = [1/(1-g+gq)]\{(1-q)(1-g)(M - P) + [qh+(q+k)m-(1+k)(1-c)](e - P)\}.$$

This is our aggregate demand equation. It shows real GNP as an increasing function of the real money supply, and as an increasing or decreasing function of the real exchange rate, depending on whether the extended Marshall-Lerner condition

$$(11) \quad qh + (q+k)m > (1+k)(1-c)$$

is satisfied or not. If the trade balance is initially in equilibrium ($k = 0$), this condition simplifies to

$$(12) \quad h + m > (1-c)/q.$$

Observe also that the right-hand side of (12) differs from 1 because of the Harberger-Laursen-Metzler effect through which real exchange rate changes influence aggregate demand via the direct link between expenditure and the purchasing power of income in equation (7). In practice, however, as $1-c$ and q are approximately equal in many cases, the simple Marshall-Lerner condition, $h + m > 1$, is not far off the mark.

Provided that the price elasticities of exports and imports are sufficiently high for the extended Marshall-Lerner condition to be met, equation (10) thus gives an unambiguously negative relationship between aggregate demand and the domestic price level for given money supply and exchange rate.

Income and the price level

The determination of real income and the domestic price level is illustrated in Figure 1. The initial short-run equilibrium is given by point A, for given money supply and exchange rate on the demand side and real wage target and exchange rate on the supply side. Even though GNP is below its full-employment level Y^* at this point, wages do not fall

Figure 1: Price and income determination

and unemployment persists. Also, we assume to begin with that the monetary consequences of the current account deficit present at point A are sterilized through domestic credit expansion, so the money supply remains constant and the deficit persists as long as foreign capital inflows and reserves last. Later on, we recognize that sterilization may not be sustainable, and that current account deficits must be eliminated through either monetary or exchange rate adjustment.

The simple model outlined above reflects the major channels through which exogenous changes in money supply, the exchange rate, and the real wage target of unions affect income and price formation in an open economy. Thus, exogenous monetary expansion raises both income and prices in the short run, while an exogenous increase in the unions' real wage target reduces income and raises prices. Devaluation may raise or lower income, depending on which is stronger, the demand effect through exports, imports, and expenditures or the supply effect through the link between import prices, the cost of living, and wages, but raises the price level in any case.

These properties can be conveniently summarized in the following reduced-form equations for income and the price level:

$$(13) \quad Y = a_1 M + a_2 e - a_3 w,$$

$$(14) \quad P = b_1 M + b_2 e + b_3 w,$$

where, for simplicity, we have assumed rational expectations ($C^e = C_{-1}^e$ or $b = 1$). The reduced-form coefficients are complicated functions of the structural parameters of equations (1) to (10), and are all unambiguously positive except a_2 which, for the reasons stated above, is

indeterminate. If the nominal wage W was an exogenous variable and the supply side of the model was accordingly represented by equation (4) alone rather than by (1) to (5), the real wage target w would be replaced by W in (13) and (14).

This paper departs from mainstream macroeconomics by treating the money supply, the exchange rate, and the real wage target as endogenous variables that are determined by the utility-maximizing behavior of labor unions and the government--in a similar way as we have treated fiscal policy and wage formation earlier (Gylfason and Lindbeck 1986). Our game-theoretic approach to monetary policy and wages in an open economy enables us, we hope, to shed new light on the macroeconomic consequences of maximizing behavior of governments and unions as well as of vicious (or virtuous) money-wage and exchange-rate-wage spirals that emanate from such behavior.

2. Endogenous unions and governments

Unions and wages

To simplify our story, we assume unions to determine nominal wages unilaterally, thus submerging not only the existence of employers' associations but also of rivalling unions. This drastic simplification reflects the notion that actual wage changes are positively related to changes in union wage demands, and that the behavior patterns of different unions are strongly correlated (see Gylfason and Lindbeck 1984b, 1986). The unions are interested both in real wages, represented here by the real wage target w , and in employment and output (between which no distinction needs to be made in our model).

For simplicity, and without material loss of generality, we assume the unions to maximize a quadratic utility function:

$$(15) \quad U = -0.5(w - w^*)^2 - 0.5u(Y - Y_u^*)^2$$

subject to the negative relationship between Y and w in (13). The interest of the unions in Y relative to w is indicated by the positive coefficient u . The fixed parameters w^* and Y_u^* may be interpreted as unattainable aspiration levels. Hence, the first partial derivatives of the utility function, $U_1 = -(w - w^*)$ and $U_2 = -u(Y - Y_u^*)$, are both positive. Observe also that $U_{11} = -1$ and $U_{22} = -u$, implying diminishing marginal utility. The additive separability of the utility function ensures that $U_{12} = 0$.

Maximization of (15) with respect to the wage target w subject to (13) yields a loglinear union reaction function:

$$(16) \quad w = [1/(1+ua_3^2)] [u(a_1a_3M + a_2a_3e - a_3Y_u^*) + w^*].$$

Thus, the optimal wage target chosen by unions varies directly with the money supply and also with the exchange rate, provided that the extended Marshall-Lerner condition is satisfied and that the demand effect of exchange rate changes outweighs the supply effect so that $a_2 > 0$. In the light of empirical evidence, we assume this to be the case (see Goldstein and Khan (1985) and Gylfason and Risager (1984)). Observe also that the reaction function (16) becomes horizontal at $w = w^*$ if the unions are uninterested in output and employment (i.e., if $u = 0$). If the nominal wage W , not w , was the decision variable of the unions and the supply side of the model was accordingly represented by equation (4) alone, maximization of (15) with respect to W would give a reaction function possessing exactly the same qualitative properties as (16).

The union reaction function is illustrated in Figure 2,

Figure 2: Maximization of labor union utility
subject to income constraint

where indifference curves derived from the unions' utility function (15) have been superimposed on the reduced-form relationship between income and the real wage target implied by equation (13). The unions attain maximum utility by choosing the tangency point A between the indifference curve UU and the straight line YY whose slope, from (13), is $-a_3$. When the money supply or the exchange rate is increased, the YY line shifts to the right and a new optimum is reached at a higher wage as indicated by the positive slope of the linear expansion path EE.

Money and exchange rates

The government also maximizes. Even though the union membership constitutes a substantial part of the electorate in many countries, we treat government and unions 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 (although none of these groups is explicitly present in our model). After all, governments and unions in the real world often seem to pursue different objectives.

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

$$(17) \quad V = -0.5(Y - Y_g^*)^2 - 0.5v(DP - DP^*)^2$$

subject to the constraints implied by (13) and (14). Here, $DP = P - P_{-1}$ is the rate of inflation, $DP^* = P^* - P_{-1}$, and $v > 0$ reflects the government's interest in DP relative to Y. Equation (17) implies that $V_1 = -(Y - Y_g^*) > 0$ 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, $V_2 = -v(DP - DP^*) < 0$ as long as the prevailing inflation rate is above the target rate DP^* . Both these conditions are likely to be satisfied in practice. Wages affect the government's utility indirectly through income and prices. Observe also that $V_{11} = -1$, $V_{22} = -v$, and $V_{12} = 0$. It should also be noted that in a one-period model such as this where the initial price level is predetermined, there is a one-to-one correspondence between inflation DP and the price level P , enabling us to replace $DP - DP^*$ in the government's utility function by $P - P^*$.

Maximization of (17) with respect to the money supply subject to (13) and (14) gives the government reaction function:

$$(18) \quad M = [1/(a_1^2 + vb_1^2)][(a_1a_3 - vb_1b_3)w - (a_1a_2 + vb_1b_2)e + a_1Y_g^* + vb_1P^*].$$

The money supply varies inversely with the exchange rate because the more the economy is stimulated by devaluation, the less stimulus is needed via monetary expansion, while the effect of an increase in the unions' wage target on the money supply is ambiguous as explained below.

The reaction function (18) relating the money supply to the real wage target for a given exchange rate is illustrated by Figure 3 where an indifference curve VV , representing the government's utility function, has been superimposed on the aggregate supply and demand schedules (equations (5) and (10)). The indifference curve has a positive slope because an increase in income is required to compensate the government for the disutility derived from a higher price level (or, more specifically, a higher rate of inflation) and vice versa.

Suppose the economy is initially in equilibrium at point A where the government's indifference curve just touches the

Figure 3: Maximization of government utility subject to aggregate supply constraint

aggregate supply schedule from below. As the unions' wage target rises, the supply schedule shifts to the left and the government must remaximize. If the expansion path EE is flatter than the demand schedule, and passes, for example, through point B in the figure, then the government will react to the wage increase by lowering the money supply to shift the demand schedule to the left so that it intersects the new supply schedule at B. If, on the other hand, the expansion path is steeper than the demand schedule and lies through C, then the money supply must rise. For this reason the slope of the government's reaction function (18) can be either negative or positive, depending on whether vb_1b_3 is bigger or smaller than a_1a_3 . Intuitively, the greater the effects of changes in money supply and the wage target on inflation relative to their effects on GNP and the greater the government's interest in price stability relative to GNP, the more likely is the government to counter a wage push by monetary restraint.

Fixed vs. floating exchange rates

Before proceeding further, it is necessary to elaborate the relationship between the money supply and the exchange rate in an open economy, for this relationship affects the formulation of the reaction functions above, (16) and (18).

Full stock equilibrium requires equilibrium in the current account of the balance of payments. Disregarding factor services, the nominal values of exports and imports must thus be equal:

$$(19) \quad P + X = e + Z.$$

With the aid of equations (7) to (9) this can be shown to imply

$$(20) \quad e - P = A_1 Y + A_2 (M - P),$$

where $A_1 = g/(h+m-1)$ and $A_2 = (1-g)/(h+m-1)$. This equation

can be solved simultaneously with the supply and demand equations (5) and (10) to find either the money supply or the exchange rate that ensures equilibrium in the current account.

Consider a simple case where price expectations are formed rationally ($b = 1$ or $C = C^e = C_{-1}^e$ in equation (2)).

Then the aggregate supply equation (5) simplifies to

$$(21) \quad Y = (1-ac)P - w - a(1-c)e.$$

Further, let us rewrite the demand equation (10) as

$$(22) \quad Y = B_1(M - P) + B_2(e - P),$$

where B_1 and B_2 come from (10).

Combining equations (20) and (22) by solving out the exchange rate, we get a new demand equation:

$$(23) \quad Y = [(B_1 + A_2 B_2) / (1 - A_1 B_2)](M - P),$$

which, together with the supply equation (21) and the current account equilibrium condition (20), gives a new pair of reduced-form equations for income and the price level under a floating exchange rate:

$$(24) \quad Y = G_1 M - G_2 w,$$

$$(25) \quad P = H_1 M + H_2 w.$$

Like before, $B_2 > 0$ is a sufficient condition for all the coefficients in these equations to be nonnegative. Observe also that if nominal wages adjust fully to price expectations ($a = 1$ in equation (1)), then $G_1 = 0$, $H_1 = 1$, and $G_2 = H_2$. Thus, with a flexible exchange rate, full adjustment of nominal wages to prices neutralizes money.

Under a floating exchange-rate regime, the government's problem is now to maximize its utility function (17) subject to (24) and (25). The result is

$$(26) \quad M = [1 / (G_1^2 + vH_1^2)] [(G_1 G_2 - vH_1 H_2)w + G_1 Y^* + vH_1 P^*].$$

This reaction function can be given the same interpretation as

the earlier one (18)--except the exchange rate is no longer among the independent variables.

Similar analysis can be provided for a fixed exchange-rate regime. In this case, the money supply is solved out of (20) and (22), so that the new reduced-form equations for Y and P contain only e and w as arguments. Accordingly, maximization of (17) with respect to e yields a reaction function that takes the same general form as (26), with e rather than M appearing on the left-hand side. Again, the economic interpretation is the same as before.

The union reaction function (16) must also be adjusted. Under a floating rate, the exchange rate is solved out of the reaction function via equation (20), leaving the optimal wage as a function of the money supply as well as of Y_u^* and w^* :

$$(27) \quad w = [1/(1+uG_2^2)][u(G_1G_2M - G_2Y_u^*) + w^*].$$

Similarly, under a fixed rate, the optimal wage becomes a function of e , Y_u^* , and w^* .

3. Games

We are now in a position to study the determination of income and the price level in an open economy where the real wage target and the money supply (or the exchange rate) are instruments in the hands of utility-maximizing unions and government.

Returning to the aggregate supply and demand framework of Figure 1, we see that for each optimal money supply or exchange rate there is a corresponding optimal level of aggregate demand (for the government), and that for each optimal wage rate there is a corresponding optimal level of aggregate supply (for the unions). Income and the price level are determined by equilibrium between the optimal levels of

aggregate supply and demand, and hence by the interaction of unions and government, among other things.

We begin with the case of flexible exchange rates, and substitute Y and P from the reduced-form equations (24) and (25) into the utility functions (15) and (17) to obtain

$$(28) \quad U = U(M, w),$$

$$(29) \quad V = V(M, w).$$

These indirect utility functions, whose sole arguments are the strategy variables M and w , clarify the nature of the games. The government maximizes its utility by choosing M for any given w so as to satisfy

$$(30) \quad V_1(M, w) = 0,$$

which gives the government reaction function relating M to w as in (26). Similarly, the unions find the optimal w for given M by setting

$$(31) \quad U_2(M, w) = 0,$$

which gives the unions' reaction function relating w to M as in (27). Any disturbance that induces a change in either M or w is thus bound to generate reactions.

The reaction functions are drawn in Figure 4. By construction, the unions' reaction function R^u is the locus of points at which the unions' indifference curves given by the indirect utility function (28) are vertical. Equation (16) implies that the R^u schedule has a positive slope. The government's reaction function R^g connects the points at which the government's indifference curves implicit in the indirect utility function (13) are horizontal. The slope of the R^g schedule, given by equation (18), is ambiguous. Figure 4 shows the case where R^g slopes down. At point A where the two reaction functions intersect, both the money supply and the real wage are in equilibrium in the sense that neither

Figure 4: Effects of monetary expansion

government nor unions can improve their lot by unilateral action. Algebraically, the equilibrium solutions for M and w are

$$(32) \quad M = (m_1 w_2 + m_2) / (1 - m_1 w_1),$$

$$(33) \quad w = (w_1 m_2 + w_2) / (1 - m_1 w_1),$$

where m_1 and w_1 are the slopes and m_2 and w_2 are the intercepts of the reaction functions in (26) and (27). With M and w in equilibrium, income and the price level are also in equilibrium by (24) and (25). Observe also that this equilibrium is not on the contract curve CC connecting the tangency points of the indifference curves of the unions and the government and is, therefore, inefficient in this sense.

Monetary policy

Suppose now that the government attempts to stimulate the economy through monetary expansion (i.e., by raising its GNP target Y_g^* or price target P^*). The government's reaction function shifts to the right, from R_1^g to R_2^g in Figure 4. If the government foresees the unions' reactions and vice versa, it knows that by raising M from A to B , it would trigger an increase in w to C , causing M to be cut back to D , and so on until a new Cournot-Nash equilibrium would be reached at E . Therefore, the government and the unions both move directly from A to E . The "stability" of this process requires the slope of R^g to be greater in absolute value than that of R^u .

With both M and w higher at E than at A , the price level is also higher (see equation (25)), but output may be higher or lower depending on the slope of the unions' reaction function (provided nominal wages are rigid to some extent). If it is relatively flat, an increase in the GNP target of the government raises the actual level of GNP: the negative

effects on GNP of the induced wage increases are not strong enough to outweigh the positive GNP effects of monetary expansion. But if the unions' reaction function is sufficiently steep, the negative effects of the wage increases can become dominant: monetary expansion can ultimately lead to a reduction of GNP in this case. Without some degree of nominal wage rigidity, output is unaffected by monetary policy under a flexible exchange rate.

Thus, the ultimate effects of monetary policy actions depend crucially on the reaction of the unions. The more militant the unions (i.e., the greater the response of the real wage target of unions to a given increase in money supply), the greater is the inflationary effect of a given monetary expansion and the smaller is the resulting expansion of GNP. It is even conceivable that a monetary program intended to stimulate the economy can turn out to have the opposite effect in societies where unions are strong and militant. Whether this occurs in practice is, of course, an empirical question. Also, the conflict of interest between the unions and the government can produce vicious spirals of wage and price increases--with GNP expanding or contracting in the process depending on the relative magnitude of the wage and price increases.

Exchange rate policy

Under a fixed exchange rate regime (i.e., adjustable peg), the exchange rate takes the place of the money supply which adjusts so as to ensure current account balance. Accordingly, the exchange rate appears on the horizontal axis of Figure 5. If the government wishes to stimulate the economy through devaluation, assuming that the extended Marshall-Lerner condition of equation (11) is satisfied, its

Figure 5: Effects of devaluation

reaction function shifts to the right as before, from R_1^g to R_2^g in Figure 5. In anticipation of the adjustment process ABCDE, both government and unions move directly from A to E. Since both e and w are higher at E than at A, the price level must also be higher, but GNP may be higher or lower as before, depending on the slope of the reaction function of the unions. Thus, devaluation can in principle be contractionary if the reaction of the unions is sufficiently vigorous. It is an empirical question, of course, whether this happens in practice (see Gylfason and Schmid (1983) and Gylfason and Risager (1984)).

Wage policy

Consider now the reaction of the government to an exogenous increase in the unions' wage objective w^* , implying an upward shift of the unions' reaction function from R_1^u to R_2^u in Figure 6. With perfect foresight, w and M move from A to E where output is lower than before. The effect on P is ambiguous, and depends on the slope of the government's reaction function. If R^g is steep, implying that the government does not react strongly to wage changes, then an exogenous increase in the unions' wage target raises prices. But if R^g is flat, reflecting a strictly nonaccommodative monetary policy, an exogenous wage boost need not raise prices in the end, and output will fall more than in the mildly nonaccommodative case.

With a positively sloped government reaction function, on the other hand, an exogenous wage push raises both w and M and hence also P , while the effect on Y depends on the slope of R^g .

Thus, not surprisingly, the ultimate effects of union policies on incomes and prices depend on the government's

Figure 6: Effects of increased wage demands

reactions. The more accommodative the government (i.e., the less the monetary or exchange rate restraint in response to a wage increase), the greater is the effect of the wage push on the price level and the smaller is its contractionary effect on GNP. With an upward sloping government reaction function, vicious spirals of wage increases and either monetary expansion or repeated devaluations are clearly a possibility in this context.

Stackelberg equilibria

In view of the anticipated sequence of reactions and counterreactions by which the static Cournot-Nash equilibria analyzed so far are reached, the Stackelberg solution should also be considered. Though not really dynamic, this solution has the advantage that it allows the players to move sequentially. Specifically, the "leader" makes the first move, maximizing utility subject to the "follower's" reaction function as well as the same constraints as before. As it turns out, it matters who moves first.

If the government acts as leader and maximizes (17) subject to (24), (25), and (27), the optimal money supply is:

$$(34) \quad M = \{1/[(G_1 - G_2 w_1)^2 + v(H_1 - H_2 w_1)^2]\} \\ [(G_1 - G_2 w_1)(Y_g^* + G_2 w_2) + v(H_1 - H_2 w_1)(P^* - H_2 w_2)].$$

If the unions follow by setting w according to (27), the Stackelberg solution is given by the tangency point I of the government's indifference curve VV and the unions' reaction function R^u in Figure 4. At I, both M and w are lower than at A, so P is also lower, but Y can be either higher or lower depending on the slope of R^u . Owing to its leadership position, the government is better off (V is higher) at I than A, but the unions are worse off (U is lower). Starting from I, monetary expansion (or devaluation) increases both M and w

along R^u like before, cf. equations (34) and (27). Similarly, increased wage demands raise w and lower M along R^g .

The optimal leadership wage target of the unions is determined by maximizing (15) subject (24) and (26):

$$(35) \quad w = \{1/[1+u(G_1m_1-G_2)^2]\}[u(G_1m_1-G_2)(Y_u^* - G_1m_2) + w*].$$

If the government follows by setting M by (26), the Stackelberg solution for this case is given, in Figure 4, by J where the unions' indifference curve UU touches the government's reaction function R_1^g . As w is lower and M is higher at J than at A , GNP is higher, but P can be either higher or lower depending on the slope of R^g , and both unions and government are better off. If R^g sloped up, however, J would be northeast of A , implying higher M , w , and P , but GNP could be either higher or lower, and the unions would be better off at the expense of the government. In any event, the effects of monetary and wage policies are qualitatively the same in the Stackelberg model as in the Cournot-Nash model (see equations (35) and (26) and Figures 4 to 6).

If both government and unions try to lead, equilibrium cannot be reached unless either player succumbs to the leadership of the other, or they collude.

Preferences vs. view of the world

At this point it should be noted that the reaction patterns of governments need not be dictated solely by their preferences ("left-wing" governments perhaps being relatively more sensitive to unemployment and "right-wing" ones more sensitive to inflation, for example), but may also be affected by their view of the effectiveness of economic policy. Thus, a "Keynesian" government which believes that monetary expansion or devaluation can be used effectively to stimulate GNP in the short to medium run is likely to adopt a more

accommodative monetary policy stance than a "classical" government which thinks that monetary and exchange rate policies primarily affect prices, even though the two types of government may have identical preferences (see Gylfason and Lindbeck 1986, Section 6). Within the present framework, a Keynesian government might, for example, be motivated by the belief that the adjustment coefficients a and b in equations (1) and (2) are less than one in the short run, while a classical government would presumably set them equal to 1. Consequently, the aggregate supply schedule in (5) or (21) would be flatter in Keynesian eyes than in classical, and the Keynesian government's reaction function would accordingly be steeper than the classical in Figures 4 to 6. A similar story could be told about the policy consequences of elasticity optimism vs. pessimism of the government.

The same point applies to unions. Their reactions to government policies may be influenced not only by their preferences, but also by their view of the effects of wage changes on employment, output, and prices. In particular, unions that believe that wage increases stimulate output and employment through increased demand for goods and services are likely to meet monetary expansion or devaluation with a greater wage increase than unions that are primarily concerned about the negative effects of wage increases on labor demand.

Numerical illustration

To recapitulate, our main point has been that in a world of maximizing governments and unions the role and impact of monetary and exchange rate policy in the economy cannot be adequately analyzed and predicted unless both the reactions of unions and the extent of government accommodation are taken into account.

Now we must ask: Is the efficacy of monetary and exchange rate policies in our game-theoretic setting, where unions and government are endogenous maximizers, significantly different in quantitative terms than it is in a more standard macroeconomic framework with exogenous government policies and exogenous (or atomistic) wage formation?

To find out, let us compare the effects of monetary expansion (under a flexible exchange rate) and of devaluation (under a "fixed" rate) on GNP and the price level under two different regimes, one in which government and union policies are exogenous and another where they are endogenous. The difference between the two regimes is illustrated in Figure 7. Monetary expansion with exogenous policies shifts the demand schedule DD out to $D'D'$, while the supply schedule moves from SS to $S'S'$ due to the resulting depreciation of the currency. The effects on GNP and the price level corresponding to the distance AB in the figure are given by G_1 and H_1 in equations (24) and (25). With endogenous policies, however, unions react to the monetary expansion, thus shifting the supply schedule farther, inducing further changes in the money supply, and so forth. In the Cournot-Nash model, the GNP and price level effects shown by the distance AC in the figure are measured by $(G_1 - G_2 w_1) / (1 - m_1 w_1)$ and $(H_1 + H_2 w_1) / (1 - m_1 w_1)$ according to equations (24), (25), (32), and (33). Observe that the ultimate effects may or may not be larger than the initial effects, depending on the slope of the government reaction function (i.e., the sign of m_1). In the Stackelberg model, the ultimate GNP and price level effects under government leadership are given by $G_1 - G_2 w_1$ and $H_1 + H_2 w_1$ according to (24), (25), (33), and (34); under union leadership, wages do not react to changes in monetary policy.

Figure 7: Effects of monetary expansion

In order to obtain a rough quantitative indication of the short-to-medium-run effects of policy under the two regimes in our model, we use the following assumed parameter values to compute these effects:

$$\begin{aligned} a &= 0.5, & g &= 0.7, \\ b &= 1.0, & h &= 1.1, \\ c &= 0.7, & m &= 1.0, \\ k &= 0.0, & u &= 10.0, \\ q &= 0.3, & v &= 0.1; 1.0; 10.0. \end{aligned}$$

By setting $a = 0.5$, we assume nominal wages are rigid to some extent (cf. equation (1)); with $a = 1$, money is neutral in our model under a flexible exchange rate. By having $b = 1$, we impose the equivalent of rational price expectations (equation (2)); this reduces the GNP effect of either monetary or exchange rate action and increases the price level effect compared with the case where $b < 1$. With $c = 0.7$, domestic output accounts for 70 % of domestic expenditure and imports account for the remaining 30 % (equation (3)). With $k = 0$ and $q = 0.3$, trade is balanced initially, while exports amount to 30 % of GNP (equation (6)); assuming an initial trade deficit (say, $k = 0.05$) has only minor effects on our results. Setting $g = 0.7$ is roughly consistent with the consumption function of Ando and Modigliani (with $MPC = 0.7$); with money influencing GNP only through the wealth effect, the real effects of monetary policy are understated in our model. The values of the export and import price elasticities, $h = 1.1$ and $m = 1.0$, are the averages reported for industrial countries surveyed by Goldstein and Khan (1985, Table 4.1). By setting $u = 10.0$, we assume the unions to be fairly militant (equation (27)); the slope (w_1) of the union reaction function implied by this number (and the others) is 0.36.

Finally, a classical government is represented by $v = 10.0$, a "neutral" government by $v = 1.0$, and a Keynesian one by $v = 0.1$ (equation (26)); the corresponding values of the slope (m_1) of the government reaction function are -0.80 , -0.45 , and 0.98 .

The effects of monetary expansion and devaluation on GNP and the price level implied by the above estimates are shown in Table 1. The entries in the top left corner of the table show that a 10 % increase in money supply under a flexible exchange rate and with an exogenously fixed real wage target raises GNP and the price level by 2.8 and 7.2 %, respectively.

When we introduce endogenous policies, we confront the unions with three types of government: classical, neutral, and Keynesian. The classical government is relatively more interested in controlling inflation than employment, and reacts to the induced wage increase by a cutback in money supply, thus reversing some of the initial depreciation of the currency. The effect of this is to reduce the income expansion following 10 % monetary expansion from 2.8 to 0.5 %, while the price level increase remains practically unchanged. The decline of the GNP effect would, of course, be bigger still if the unions were more militant or if the government were "more classical" than we have assumed.

The Keynesian government, which is relatively more concerned about GNP than prices, reacts to the endogenous wage hike by expanding the money supply more, so the currency depreciates further. Nevertheless, the response of GNP to 10 % monetary expansion is reduced substantially in this case as well, or from 2.8 to 0.9 %, while the price level effect is doubled. These differences would be greater still if the union reaction function were steeper than we have assumed and

if the government were "more Keynesian." The case of the neutral government, which weighs GNP and inflation evenly, lies in between.

The numbers in columns 3 and 4 of the table describing the effects of devaluation can be given a similar interpretation. While devaluation has an expansionary effect on GNP in all our experiments despite a fairly militant reaction of the unions, classical and Keynesian policies have rather different consequences: as in the case of monetary expansion, 10 % devaluation raises GNP and the price level twice as much under a Keynesian government as under a classical one. With full adjustment of nominal wages to prices, however, devaluation is neutral throughout in our model.

The bottom line of the table shows the results for the Stackelberg model for comparison. In this case, too, the reactions of the unions reduce the GNP effects of monetary expansion and devaluation substantially, and increase the price level effects correspondingly. Because a leading government does not adjust M or e to wage changes, there is no difference between policy effects under the three types of government.

While the simple numerical simulations presented above are, of course, not intended to mirror reality exactly, they do nevertheless provide a strong indication that the macroeconomic consequences of endogenous, strategic policy making can be fundamentally different from those of exogenously determined policies, in practice as well as in principle. However, a reliable empirical verdict on this matter must await econometric investigation.

4. Conclusion

The focus of this paper has been on the role and macroeconomic impact of monetary and exchange rate policy and of wage formation in open economies where wages are primarily determined through collective bargaining among strong and well coordinated labor unions and relatively weak employers' associations. Applying some elements of simple game theory, we have attempted to demonstrate the potential fruitfulness of modelling the government and unions as endogenous, strategic utility-maximizers with different and independent preferences, and explored the macroeconomic consequences of their interaction. In particular, we have argued that the ultimate effects of monetary expansion or devaluation (as well as of increased wage claims of unions) on GNP and the price level depend crucially on the reaction functions of both unions and government. Our empirical simulations demonstrated that, in practice, the results of endogenous policy making can be fundamentally different from those of exogenously determined policies.

With endogenously determined policies, the role of the economic adviser also changes fundamentally. While policy advice usually involves suggestions for specific changes in policy instruments, such as the money supply or the exchange rate in our model, the adviser must now anticipate the macroeconomic consequences of exogenous shifts in the government's reaction function. These shifts are represented in our model by changes in the output and inflation targets of the government as well as by its interest in price stability relative to income and employment. It is then, of course, up to politicians to judge whether the suggested changes in these policy parameters are worthwhile or not, all things

considered.

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Table 1: Effects of monetary expansion and devaluation on GNP and the price level with exogenous and endogenous policies

	<u>Flexible exchange rate</u>		<u>Fixed exchange rate</u>	
	<u>Effects of 10 % monetary expansion on</u>		<u>Effects of 10 % devaluation on</u>	
	GNP	Price level	GNP	Price level
Exogenous policies	2.8	7.2	3.1	7.1
Endogenous policies:				
Cournot-Nash model:				
Classical government	0.5	7.3	0.7	7.1
Neutral government	0.5	8.1	0.7	7.9
Keynesian government	0.9	14.6	1.3	14.2
Stackelberg model	0.6	9.4	0.9	9.2

Source: Authors' computations.