International Finance Discussion Papers

Number 137

April 1979

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by

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After five years of floating exchange rates, the implications of flexible rates for countercyclical macro-economic policies remain in doubt. Most neoclassical models of exchange-rate dynamics speak only indirectly to the issue of countercyclical policies, for the models are characterized by downward flexible prices and full employment equilibria. The prescriptions of standard Keynesian models, on the other hand, warrant scepticism. The Mundell-Fleming model, for example, suggests that expansionary monetary policy, by inducing a real exchange-rate depreciation, is effective in raising output in a small, underemployed economy. The facts seem otherwise. In Italy, Great Britain, and other OECD countries expansionary monetary policies do not seem to have provided much real economic stimulus. In these countries, nominal money growth and depreciations have been followed by compensating increases in domestic wages and prices. Shifts in the real terms of trade between competitors have been blocked. Thus, the IMF notes "As a consequence of offsetting price and exchange rate developments, the pattern of competitiveness among most of the major industrial countries is now very similar to what it was early in 1973" (IMF, 1977, p. 30).

* This paper was written while I was a student intern in the International Finance Division, Federal Reserve Board, Washington, and a visiting scholar at the Falk Institute, Jerusalem. I am indebted to Janet Yellen and Dale Henderson of the FRB, and to Michael Bruno of the Hebrew University for helpful discussion. I would also like to thank Susanne Freund of the Falk Institute for editorial assistance. This paper represents the views of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or its staff.

Table 1 highlights this phenomenon. Although the five countries listed experienced very different rates of price inflation during 1973-76, relative competitive positions remained remarkably stable. It is safe to agree with the IMF that real exchange-rate movements have not played much of a role in restoring full employment or adjusting the current accounts of the OECD countries.

Table 1. Average Real Exchange Rate Indexes: Wholesale Price Index (WPI) and Export Price Index (XPI)[a/]

(March 1973 = 100)

	Index	March 1977	Average 1973-77[b/]	Inflation rate: per cent average annual change of index (1973-76)
Germany	WPI	107.4	105.3	7.0
	XPI	100.0	100.8	7.7
Italy	WPI	101.5	102.2	21.0
	XPI	99.2	100.0	22.0
Japan	WPI	98.8	96.8	11.8
	XPI	95.5	96.6	9.2
United Kingdom	WPI	98.6	98.0	19.3[c/]
	XPI	100.5	98.3	21.5
United States	WPI	101.8	99.5	10.2
	XPI	101.1	97.5	12.8

a/ Each entry is P/P^*E, where P is the domestic price index, P^* is the weighted average of comparable indexes of other countries, and E is the exchange rate, in domestic currency units per unit of (weighted average) foreign currency.

b/ For WPI, 3/73-9/77; for XPI, I/73-II/77.

c/ Industrial output prices.

Source: The real exchange rate data are from Federal Reserve Board (1977). The rates of growth of WPI and XPI are calculated from data in IFS (November 1977).

In this paper, I show how the phenomenon of real-wage rigidity, whether through formal wage indexation or real-wage resistance (Hicks, 1975), can explain the vicious circle of inflation and exchange rate depreciation during periods of substantial unemployment.[1] Real-wage stickiness tends to preclude real terms-of-trade adjustments, and thus may underlie the data of Table 1.[2] Furthermore, indexation and real-wage resistance have striking consequences for macro-economic policy under flexible exchange rates. In the framework of the short-run Mundell-Fleming model, the presence of real-wage rigidity reverses the conclusions regarding the efficacy of monetary and fiscal policy. Now, fiscal policy can be shown to be effective in raising output. Monetary policy, on the contrary, leads to price and exchange rate changes, with no effect on real activity.

In the following sections, I consider the implications of real wage rigidity in both the short and the long run. First, a brief look at the empirical evidence on wage determination supports the relevance of real-wage resistance for a number of countries, particularly Great Britain and Italy. In Section II, the static and dynamic properties of a simple

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1 An analysis along similar lines may be found in two recent papers by Argy and Salop (1977a, 1977b).

2 The 'law of one price' cannot adequately explain the parallel movements of competitors' prices in this period. An increasing number of studies demonstrate that there is less than infinite substitutability among the goods of different countries and that export prices depend upon domestic costs as well as on competitors' prices (see Dornbusch and Krugman, 1976, p. 564). Also, investigators have found serious violations of the 'law of one price' at the industry level (see Isard, 1977, and Krauss *et al.*, 1977).

short-run model of the macro-economy are described. The effects of real-wage rigidity on the dynamic paths of prices, the terms of trade, and employment are examined. A longer-run perspective on real-wage resistance is given in Section III. A model with a shifting short-run supply of labor is used to investigate the behavior of an economy with real-wage resistance in the short run and flexible wages in the long run.

I

Recent theoretical studies, with widely varying perspectives, have concluded that wage bargains are designed to reduce the variance of real wages along a trend path. The implicit-contract theory literature predicts that a stable real wage over the length of a contract may be the market equilibrium of the supply and demand for labor under uncertainty.[3] Hicks, on the other hand, predicts that stable real wage growth will result from labor-supply behavior and the activity of trade unions. He describes why workers will resist real wage declines:

> The wage-earner's test for fair wages is not simply a matter of comparison with other people's earnings; it is also a matter of comparison with his own experience, his own experience in the past. It is this which makes him resist a reduction in his money wage, but it also makes him resist a reduction in the purchasing power of his wages, and even a reduction in the growth of that purchasing power to which he has become accustomed (Hicks, 1975, p. 5).

With sufficient market power, Hicks continues, the worker (and his trade

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[3] For a review of the implicit-contract theory literature, with citations, see Baily (1976).

union) will be successful in protecting real wage growth in the short run. Whatever the reason, it is evident that various labor market institutions have evolved to enforce constancy of a real wage trend (at least in the short run). Formal indexation of wages to changes in the consumer price index are common throughout the world.[4] The *scala mobile* of Italy now guarantees one hundred per cent indexation of wages for a large segment of the work force (see Lubitz, 1977, and Faustini, 1976). Incomes policies in Britain have actively encouraged the use of contracts linking wages to the consumer price index (see Miller, 1976, p. 513). Similarly, it has been shown that the Australian Conciliation and Arbitration Commission sets the National Minimum Award Wage to protect (or indeed, to accelerate) real wage growth (see Pitchford in Krause and Salant, 1977). Further examples abound (see country essays in Krause and Salant, 1977).

These mechanisms for preserving the real wage have certainly been tested in recent years. During 1973-76 various factors put downward pressure on equilibrium full-employment wages. In many economies real wage growth did *not*, in the short run, moderate in response to these downward pressures, but rather continued at earlier trend rates. Some simple calculations will illustrate this. First we turn to the wage restraining factors. Since 1973, there has been a dramatic increase in the relative prices of intermediate inputs and food, and a widespread slowdown in trend productivity growth. Table 2 illustrates these effects for the five countries of Table 1. Except for Germany, they experienced a dramatic reduction in productivity increases, partly because of low capacity

[4] For a survey of indexation arrangements in industrial countries see Brown (1976).

Table 2. Productivity Growth, Terms-of-Trade Changes and Rates of Unemployment: 1960-76

	Germany	Italy	Japan	United Kingdom	United States
Productivity growth[a/] (per cent)					
1960-72	5.8	6.1	9.9	3.9	3.3
1972-76	5.5	3.7	5.5	0.8	1.5
Terms of trade[b/] (1967 = 1)					
1960	0.94	1.07	1.16	0.91	0.93
1972	1.03	1.03	1.09	1.01	0.93
1976	1.05	0.79	0.76	0.78	0.79
Unemployment rate[c/] (per cent)					
1972	0.8	4.0	1.4	4.2	5.6
1976	3.7	4.0	2.0	6.4	7.6

a/ Annual change in manufacturing output per man-hour.
b/ Ratio of export to import prices.
c/ Adjusted to U.S. concepts.

Source: 1977 International Economic Report of the President. Washington, D.C.: U.S. Government Printing Office, 1977.

utilization in 1974-76.

Also, while the terms of trade between industrial countries have changed little since 1972 (see Table 1), the terms of trade of the industrial countries vis-a-vis the rest of the world deteriorated markedly. The U.N. measure of primary-goods prices relative to manufactured-goods prices rose from 113 in 1973 to 168 in 1974. In Table 2 this is reflected in the dramatic fall in the export/import price ratios experienced from 1972 to 1976 by all countries except Germany. The final lines of Table 2 show unemployment rates, to bring out the fact that the excessive wage growth, to which we now turn, occurred during a deep worldwide recession. Indeed, the models in the next section suggest that the wage behavior was one cause of the high unemployment.

The response of average wage rates to these influences has been varied and has certainly depended upon particular government policies, the extent of formal indexation, and trade union power. But for many industrial countries, the crucial feature has been the fact that real wage growth continued along its pre-1973 course after the shocks of 1973, only beginning to moderate after one or two years of high unemployment.

The first three columns of Table 3 reveal this phenomenon. Of the countries listed, only Japan and the United States showed a significant slowing of the growth of real hourly compensation in the period during and immediately after the oil price increases. From 1975 to 1976, high unemployment and low productivity growth reduced the rate of real wage increase in most countries.

Comparisons of actual and 'equilibrium' wage rates can provide evidence of real-wage resistance. With a couple of strong assumptions, we

Table 3. Real Compensation per Man-Hour in Manufacturing: 1960-76

(per cent)

	Real compensation per man-hour, average annual rate of change			Excess wage,[a/] $(W - W^{eq})/W^{eq}$	
	1960-73	1973-75	1975-76	1975	1976
Canada	2.68	3.25	3.10	-2.2	-3.4
France	4.99	4.97	3.28	0.0	0.0
Germany	6.62	6.75	0.76	1.3	-1.8
Italy	7.80	6.75	1.40	13.8	9.8
Japan	8.44	4.26	-0.45	0.0	-6.9
Sweden	5.42	8.70	9.20	6.1	8.2
United Kingdom	3.62	4.93	-0.28	12.0	9.2
United States	1.88	0.37	2.66	-1.7	-1.5

a/ Measures the percentage excess of the wage, W, over the full-employment equilibrium wage, W^{eq}. For a description of the calculation of W^{eq} see the text.

Source: Nominal Compensation per Man-Hour, from Bureau of Labor Statistics (1977). For France, Sweden, and the United Kingdom, compensation has been adjusted to include employment taxes. Potential output per man-hour, used in the calculation of W^{eq}, from Artus (1976). Consumer Prices, GNP Deflators, and Import Price Indices, from IFS, various issues.

may make a back-of-the-envelope estimate of the full-employment equilibrium real wage (compensation per man-hour) in 1975 and 1976 for the eight countries shown. In an approach similar to Fleming's (1976), I assume that (1) real wages in 1972 were at an equilibrium level, and (2) the full-employment share of labor income in total income is constant.[5] The latter assumption is easily shown to imply that equilibrium full-employment real wage growth equals productivity growth adjusted for terms-of-trade shifts.[6] Artus (1977) has estimated the growth of potential output per man-hour in manufacturing for the eight countries of Table 3. Using his estimates of productivity growth trend, full-employment real wages for 1975 and 1976 are computed. w^{eq} is calculated by adjusting the 1972 real wage for four years of trend productivity growth and for terms-of-trade changes.[7] This procedure will tend to overestimate the equilibrium real

[5] A more disaggregated method is used in Bruno and Sachs (forthcoming).

[6] According to the notation introduced on p. 13, constancy of the full-employment share of labor income in total income may be written $(WL/PY)^{eq} =$ = constant. Thus, $(\dot{w} - \dot{p})^{eq} = (\dot{y} - \dot{\ell})^{eq}$. The change in real wage is $\dot{w} - (\dot{CPI}/CPI)$, and $\dot{CPI}/CPI = \lambda\dot{p} + (1 - \lambda)(\dot{p}^* + \dot{e})$. Therefore, $\dot{w} - (\dot{CPI}/CPI) = (\dot{w} - \dot{p}) + (1 - \lambda)(\dot{p} - \dot{p}^* - \dot{e})$. Substituting from above, $[\dot{w} - (\dot{CPI}/CPI)]^{eq} = (\dot{y} - \dot{\ell})^{eq} + (1 - \lambda)(\dot{p} - \dot{p}^* - \dot{e})^{eq}$. Note that $(\dot{p} - \dot{p}^* - \dot{e})$ is the percentage change in the terms of trade, and $(\dot{y} - \dot{\ell})^{eq}$ is trend productivity growth.

[7] The observed terms-of-trade shift is assumed to equal the full-employment equilibrium shift: $(\dot{p} - \dot{p}^* - \dot{e}) = (\dot{p} - \dot{p}^* - \dot{e})^{eq}$. To make the calculations of Table 3, we integrate both sides of $[\dot{w} - (\dot{CPI}/CPI)]^{eq} =$ $= (\dot{y} - \dot{\ell})^{eq} + (1 - \lambda)(\dot{p} - \dot{p}^* - \dot{e})^{eq}$ to find

$$\left(\frac{W}{CPI}\right)_{75} = \left(\frac{W}{CPI}\right)_{72}\left(\frac{Y}{L}\right)^{eq}_{75}\left(\frac{P}{P^*.E}\right)^{(1-\lambda)}_{75}/\left[\left(\frac{Y}{L}\right)^{eq}_{72}\left(\frac{P}{P^*.E}\right)^{(1-\lambda)}_{72}\right].$$

A simiIar expression is found for 1976. λ is taken to be the share of merchandise imports in GNP for 1972. $(Y/L)^{eq}$ is taken from the Artus wage, and thus to underestimate the percentage of excess wage, to the extent that productivity growth in the manufacturing sector exceeds the country average. The terms of trade are measured as the ratio of domestic output prices (GNP deflator) to import prices.

The last columns of Table 3 measure the percentage excess of wages over their equilibrium level for the three years 1974, 1975, 1976. Through 1975, most of the countries exhibited real wage rates at or in excess of equilibrium levels. Only in 1976, after a prolonged recession, did some of them successfully moderate the growth of real compensation. Italy, Sweden, and Great Britain clearly did not.

Of course, Italy and Great Britain are the notorious examples of real-wage resistance, and the behavior of their labor-market institutions in the 1970s may in part explain why. Miller (1976) notes, for instance, that extensive wage indexation was a crucial part of the British incomes policy during the oil prices increases of 1973-74. Stage 3 of the policy, which took effect in October 1973, "was designed under the presumption that the terms of trade would shift in favor of the United Kingdom" (Miller, 1976, p. 513). When import prices rose dramatically thereafter, the policy virtually guaranteed the preservation of real wage growth. In Italy also, much of the persistence of real wage growth is due to the widespread indexation of wages. In January 1975, an agreement was reached between Confindustria and the trade unions which effectively provided for 100 per cent indexation for most of the labor force.

In the next sections, I turn to models of flexible exchange rates

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(1977) measures of potential output per man-hour. P/[P*E] is given by the ratio of the GNP deflator to the import unit value index.

with real-wage stickiness. As will become clear, the models rely not on the absolute fixity of real wage growth, but on the need for a period of unemployment in order to reduce real wages below trend levels. As the 1973-75 wage behavior suggests, this more modest notion of real-wage rigidity is almost certainly applicable to the industrial countries.

II

In this section, I illustrate how real-wage resistance or wage indexation can alter the ranking of monetary and fiscal policy of the Mundell-Fleming model. In the fixed-price world, monetary policy is effective in increasing aggregate demand and output. To put it simply, an increase in the money supply exerts downward pressure on interest rates. At a given world interest rate, an incipient capital outflow is induced, leading to a currency depreciation, and a deterioration in the terms of trade. With constant domestic prices, an improved competitive position results (i.e., the *real* exchange rate depreciates), net exports expand, and output is increased (assuming the Marshall-Lerner condition). The expansion continues until the increased output raises the demand for money sufficiently to establish money market equilibrium at the world interest rate. Note that the monetary expansion works not through any permanent effects on the interest rate, which is fixed at the world level,[8] but through the currency depreciation.

With indexed wages, contrariwise, no real output change need occur.

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[8] This analysis assumes perfect substitutability between assets denominated in domestic and foreign currencies.

With a money-induced depreciation, import prices will rise, pushing up the consumer price index. Nominal wages will rise to restore real wages, in turn increasing domestic production costs and output prices. Full indexation requires a constant real wage, so that domestic prices, foreign prices, and wages will all rise in the same proportion, namely in the same proportion as the original nominal money supply increase. An initial increase in real income is choked off by the rising domestic prices. Real money balances remain unchanged in equilibrium.

Paradoxically, with wage indexation, a fiscal expansion *can* raise the real money supply and hence real income. In the fixed-price world, an increase in government spending induces a currency appreciation which wholly crowds out net exports. With indexation, however, the appreciation lowers import prices and hence the nominal wages tied to the declining CPI.[9] Domestic prices fall along with wages, and the real money supply expands. Income increases until the demand for money rises to equilibrate the money market at the world interest rate.

The models below provide a formal description of these mechanisms in a comparative static and then a dynamic framework. In the text, the model follows the one-sector, Mundell-Fleming framework. The results carry over, to a large extent, to the two-sector, Swan-Salter model of the small open economy.

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[9] More realistically, the appreciation lowers the rate of increase of import prices; nominal wages do not fall, but rather their rate of increase is reduced.

We use the following notation

M money supply

W nominal wage level

P goods price

E exchange rate (units of domestic currency per unit of foreign currency)

R interest rate

G government spending

Y output

L labor input

K capital stock

λ weight of domestic goods in CPI

θ coefficient of indexation (1 = full indexing)

Superscript f indicates 'potential'; asterisk indicates 'world' or 'foreign'; dotted variables indicate time derivative ($\dot{x} = dx/dt$), and $\bar{x}$ denotes the steady-state value of x. Lower-case letters denote logarithms of variables (upper case).

Model I

(1) $w = \theta[\lambda p + (1 - \lambda)e] + \psi(y - y^f) + h$ wage equation

The standard Mundell-Fleming Model adopts a rigid nominal wage, $w = \bar{w}$. In this model, we allow for partial or full linkage of wages to the CPI and for an aggregate downward effect on the wage level. The true price index may be approximated by $P^{\lambda}(P^*E)^{(1-\lambda)}$, where λ is the share of domestic goods in domestic consumption (the index is exact for a Cobb-Douglas utility function). Thus, log CPI = $\lambda p + (1 - \lambda)(p^* + e)$. For convenience,

p^* will be set equal to zero. The degree of indexation is given by θ; a 1 per cent increase in the CPI induces a θ per cent increase in nominal wages, according to (1), and $\theta = 1$ implies full indexation.

When $\theta = 1$, equation (1) may be rewritten as a labor supply curve. For a standard production function $Y = F(L, \bar{K})$, $F_L > 0$, $F_{LL} < 0$, locally we have $y = \alpha\ell + s$, where α is the elasticity of output with respect to labor input, $F_L L/Y$. Thus, $y - y^f = \alpha(\ell - \ell^f)$. Then (1) can be rewritten as $\ell = (w - \log CPI - h)/\psi\alpha + \ell^f$, or $L = L^f(W/CPI{\cdot}H)^{1/\psi\alpha}$. The interpretation of the full-indexation wage schedule as a standard labor supply schedule will prove heuristically useful in the next section.

(2) $$P = \frac{L^f}{F(L^f, \bar{K})} W(1 + n).$$ price equation.

Domestic prices are written as fixed mark-ups over standard unit labor costs, in accord with current econometric price equations. No substantive results of the model are changed if the more neoclassical assumption, $P = F_L W$, is made.

(3) $$y = u + \delta(e - p) + \gamma G - \sigma R + v^* y^*$$ output equilibrium.

The RHS of (3) assumes aggregate demand to be an increasing function of the real exchange rate, e - p, an increasing function of government expenditure, g, a decreasing function of the domestic interest rate, R and an increasing function of world income. A similar demand schedule is found in Dornbusch (1976).

(4) $$m - p = \phi y - \beta R$$ money-market equilibrium.

Real money balances, M/P, are related to output and the domestic interest rate, according to the transactions-demand-for-money specification. As is well known, writing real money balances as M/CPI gives some scope for fiscal policy in the simple Mundell-Fleming model. I choose the specification in (4) in order to achieve the strong Mundell-Fleming results in the no-indexation ($\theta = 0$) case. In this way, the novel effects of real-wage resistance and indexation show up better.

(5) $R = R^*$ perfect capital mobility.

This condition applies to static equilibria. The equivalent dynamic assumption is the covered interest arbitrage condition $R = R^* + \dot{e}$.

Solving (1)-(5) for y yields

(6) $$dy = \Delta[\delta(1 - \theta)dm + \theta(1 - \lambda)\gamma dG + \theta(1 - \lambda)v^*dy^*]$$

$$\Delta = [\theta(1 - \lambda) + \delta\psi + \delta(1 - \theta)\phi]^{-1} > 0.$$

It is easy to see that with no indexing ($\theta = 0$), $dy/dm > 0$, $dy/dg = 0$, $dy/\partial y^* = 0$. These are the standard Mundell-Fleming results. Expansionary monetary policy is effective in raising output. On the other hand, fiscal policy is totally vitiated by a crowding out of net exports. Finally, the domestic economy is fully insulated from foreign output shocks. When y^* declines, causing an incipient fall in domestic aggregate demand, the real exchange rate depreciates, restoring the initial level of demand.

In the case of full indexing ($\theta = 1$) the results are totally reversed: $dy/dm = 0$, $dy/dg > 0$, $dy/dy^* > 0$. Fiscal policy is now fully effective, and foreign demand shocks are transmitted to real income; monetary policy merely raises domestic prices. This result is not surprising, in view of the equivalence of full indexing and a labor supply curve homogeneous of degree zero in nominal values. When $\theta = 1$, the structure of the economy is characterized by the classical dichotomy of real and nominal values. The money supply serves only to determine the price level. When $0 < \theta < 1$, all multipliers are positive: $dy/dm > 0$, $dy/dg > 0$, $dy/dy^* > 0$.

The multipliers for prices are given by

$$(7) \qquad dp = [1 - \phi\Delta\delta(1 - \theta)]dm - \phi\Delta\theta(1 - \lambda)\gamma dg + \phi\Delta\theta(1 - \lambda)v^*dy^*.$$

It is readily verified that with no indexing $0 < dp/dm < 1$, $dp/dg = 0$, $dp/dy^* = 0$. In the case of $\psi = 0$, $\theta = 0$, wages are totally rigid, so that $dp \equiv 0$. With full indexing, $dp/dm = 1$, $dp/dg < 0$, $dp/dy^* < 0$. Expansionary fiscal policy and increases in foreign income lower the domestic price level (or slow the rate of domestic inflation), by inducing a currency appreciation. Indeed it is the decline in domestic prices following $dg > 0$, $dy^* > 0$ that allows real money balances to increase, thus enabling output to rise. Note that an indexed economy faced with a decline in foreign income is squeezed between the two misfortunes of a fall in output *and* a jump in domestic prices.

By now, the effects on the real exchange rate $(e - p)$ of the various domestic and foreign impulses should be clear.

$$(8) \qquad d(e - p) = \Delta(1 - \theta)dm + \frac{\gamma}{\delta}[\Delta\theta(1 - \lambda) - 1]dg + \frac{v^*}{\delta}[\Delta\theta(1 - \lambda) - 1]dy^*$$

Since $\Delta\theta(1 - \lambda) \leq 1$, $d(e - p)/dm \geq 0$, $d(e - p)/dg \leq 0$, $d(e - p)/dy^* \leq 0$. With complete indexing, $d(e - p)/dm = 0$: monetary policy cannot affect the terms of trade. With $\theta = 1$ and $\psi = 0$, we have essentially a labor supply schedule that is perfectly elastic at the given real wage. In this case, $d(e - p)/dg = d(e - p)/dy^* = 0$. In all other cases, the inequalities in the multipliers are strict.

So far we have enquired into the effects of shifts in the policy instruments M and G and in foreign income. It is also interesting to ask about autonomous shifts in wage determination, as measured by $dh \gtrless 0$. Suppose, for instance, that an increase in union power or labor militancy raises the nominal wage by dh, at given y and CPI. When equilibrium is restored the increase in wages causes a fall in aggregate demand and income by making domestic prices rise relative to the foreign competitor's price. The domestic price level rises absolutely. The multipliers are $dy/dh = -\Delta\delta$, $dp/dh = \phi\Delta\delta$, $d(e - p)/dh = -\Delta$. In model II we will consider endogenous shifts in the variable h.

The framework of Model I can be used to say something about the optimum degree of indexing in a flexible-exchange-rate economy. Suppose, for instance, that the economy is buffeted by random shocks ε_g and ε_m in the output and money markets. For simplicity, we set $E(\varepsilon_g) = E(\varepsilon_m) = 0$ and $\text{cov}(\varepsilon_y, \varepsilon_m) = 0$ (where E is the expectation operator). The shocks are serially uncorrelated. To set the problem, suppose that G, M, and θ are chosen *before* the shocks ε_m and ε_g are known. How should these variables, and in particular how should θ, be chosen so as to maximize the expected social welfare, U? As a simple illustration, let $U = \alpha_0 + \alpha_1(y - y^f) + \alpha_2(y - y^f)^2$, so that welfare is quadratic in the percentage output gap. Implicitly, $E(U) = \tilde{U}(G, M, \theta)$. For $y = y^f + \Delta\delta(1 - \theta)(m + \varepsilon_m) + \Delta\theta(1 - \lambda)\gamma(g + \varepsilon_g)$ by (6), the optimum values are given by:[10]

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[10] In the special case that $(1 - \lambda) = \phi\delta$, the closed-form solution for

$$g^* = 0, \quad m^* = 0,$$

$$\theta^* = f(\sigma_g^2/\sigma_m^2), \quad 0 \leq f \leq 1, \quad f(0) = 1, \quad f(\infty) = 0.$$

G and M are set at their certainty-equivalent levels, because U is quadratic and because there is no uncertainty in the fiscal and money multipliers (see Brainard, 1967).[11] θ^* depends on the relative variances of the two shocks. When all of the shocks come from money demand, indexing can perfectly insulate the economy from real output movements. If the shocks are aggregate demand fluctuations, then output will vary unless real wages are allowed to absorb the demand changes. For σ_g^2/σ_m^2 large, θ^* is near zero. A similar relationship between the degree of optimal indexing and the relative importance of nominal over real shocks has been established in other closed and open economy models (see for example, Fischer, 1977, and Gray, 1976).

Finally, we may say a few words about the difficult issue of optimal exchange market intervention. Given the influence of exchange rate movements on domestic prices, Dornbusch and Krugman (1976, p. 574) have argued that: "In the face of exogenous disturbances to exchange rates, governments should peg the rate and thus prevent the inflationary impact from being built into commodity prices, wages and costs." This conclusion may be examined, in part, according to the results of Model I. The Dornbusch-Krugman case of large pass-throughs of import costs into wages and prices is the case of large θ. Let us consider their intervention policy when the exogenous disturbances are IS-curve shocks and $\theta = 1$.

θ^* is $\theta^* = \delta^2(\sigma_g^2/\sigma_m^2)/[\delta^2(\sigma_g^2/\sigma_m^2) + (1 - \lambda)^2\sigma^2]$. It is easy to verify that $f(\sigma_g^2/\sigma_m^2)$ has the properties described in the text.

[11] Any combination of G and M such that $E(y) = y^f$ is an optimum

Random shifts in the IS curve ε_g induce $\sigma_y^2 > 0$. Under flexible rates, with no active monetary policy counteracting price fluctuations, $-\phi dy = dp$, from the money market equation. Thus, $\sigma_p^2 = \phi^2\sigma_y^2$. The covariance of income and prices is negative, for $cov(y, p) = -\phi cov(y, y) = -\phi\sigma_y^2$. Now suppose that the government pegs the exchange rate through an active monetary policy. Random IS shocks will have exactly the same real effects when $\theta = 1$. However, price movements will now differ. Since $dp = dw = [\theta(1 - \lambda)de + \psi dy]/(1 - \theta\lambda)$, a pegged rate (de = 0) under full indexing leads to $dp = \psi(1 - \lambda)^{-1}dy$. Hence $\sigma_p^2 = \sigma_y^2\psi^2/(1 - \lambda)^2$; intervention will reduce price fluctuations if and only if $\psi^2/(1 - \lambda)^2 < \phi^2$. If real wages are rigid, then $\psi \simeq 0$ and the intervention successfully reduces price fluctuations. Note that intervention induces a positive correlation of price and output movements, which may have positive welfare consequences.

This model may be regarded as a comparative-static description of an economy with partial or full real-wage resistance. But while the empirical evidence of Section I of the paper suggested that nominal wages are indeed adjusted to CPI increases the relationship we assume in equation (1) in fact only holds with a lag in actual labor markets.

Indexed contracts typically provide that wage increases required by a rise in the CPI occur at least one quarter after the price rise is experienced. With informal wage indexation or real-wage resistance, subsequent wage increases may have to wait until the next round of collective bargaining. As an example of these lags, in Stage 3 of the British 1972-74 incomes policy, wage indexation was subject to the condition that nominal wages could not be adjusted until a threshold price increase had been passed. Table 4 demonstrates this effect for Italy and Great

Table 4. Per Cent Change in Real Wages

(quarterly changes at annual rate)

		United Kingdom	Italy
1974	I	-9.4	-2.7
	II	-6.4	-2.1
	III	24.0	-1.9
	IV	4.0	-0.6
1975	I	1.6	28.9
I/1974-I/1975		2.8	4.3
1972-75		4.3	5.3

Source: Wages, OECD (1976). Consumer prices, IFS, various issues.

Britain during the period of the oil-price increase (1974 through the first quarter of 1975). The impact effect of the price shock was a substantial reduction in real wages. However, after a lag, real wages returned close to the trend level.

These lags suggest a dynamic rendering of Model I. Instead of equation (1), we write

(1a) $$w^t = \theta[\lambda p + (1 - \lambda)e] + \psi(y - \bar{y})$$

(1b) $$\dot{w} = \rho(w^t - w),$$

where w^t is the target wage. Actual wages adjust to close the gap between w^t and w^t.

With a further assumption about the dynamics of exchange-rate adjustment, we can fully explore the time profile of output and prices after a policy change. The assumption of perfect asset substitutability except for exchange risk implies the covered arbitrage condition:

(5a) $$R = R^* + F,$$

where F is the instantaneous forward discount. With perfect foresight, $F = \dot{e}$ along any adjustment path. Thus (5) of the static model may be written

(5b) $$R = R^* + \dot{e}$$ perfect foresight.

A number of interesting conclusions emerge from the solution of (1a), (1b), (2)-(4), and (5b). Because of the lags in wage adjustment, monetary policy will work in the short run, even with full indexation. On impact, a monetary expansion will increase y, and only later will price increases cause y to return to its initial level. Fiscal policy multipliers, on the other hand, are smaller in the short run than in the steady state. Indeed, impact multipliers of a fiscal expansion may be negative, as will be shown. Finally, exchange rates may overshoot or undershoot long-run values after a policy change, for reasons described in Dornbusch (1976).

To solve for the dynamic path, note that (5b) and (4) imply

$$\dot{e} = R - R^* = R - \bar{R} = \frac{\phi(y - \bar{y}) + (p - \bar{p})}{\beta}. \tag{9}$$

After solving (3)-(4) for $y - \bar{y}$ in terms of $(e - \bar{e})$ and $(p - \bar{p})$ and substituting in (9),

$$\dot{e} = \frac{\phi\delta}{\beta + \sigma\phi}(e - \bar{e}) + \frac{(1 - \phi\delta)}{\beta + \sigma\phi}(p - \bar{p}). \tag{10}$$

Also, (1a), (1b), and (2a) combine to yield

$$\dot{p} = \rho\theta(1 - \lambda)(e - \bar{e}) - \rho(1 - \theta\lambda)(p - \bar{p}). \tag{11}$$

For simplicity, ψ has been set equal to zero. Equations (10) and (11) describe the dynamics of the economy according to a two-variable linear differential equation system

$$\begin{bmatrix} \dot{p} \\ \dot{e} \end{bmatrix} = \begin{bmatrix} -\rho(1 - \theta\lambda) & \rho\theta(1 - \lambda) \\ \frac{1 - \phi\delta}{\beta + \sigma\phi} & \frac{\phi\delta}{\beta + \sigma\phi} \end{bmatrix} \begin{bmatrix} p - \bar{p} \\ e - \bar{e} \end{bmatrix} = A \begin{bmatrix} p - \bar{p} \\ e - \bar{e} \end{bmatrix} \tag{12}$$

Because $\det[A] < 0$, the characteristic roots are necessarily of opposite sign. The existence of a positive root indicates the saddle-point nature of (10), a property of many dynamic models with rational expectations. Because there is only one negative root, there will be only one stable trajectory in the (e, p) phase plane.

The $\dot{e} = 0$ locus has negative slope in the (e, p) plane if and only if $1 - \phi\delta > 0$, while the $\dot{p} = 0$ locus is necessarily upward sloping (see Figure 1). The phase arrows suggest the necessary location of the stable arm in each case (indicated by the dashed line). Following Brock (1974), Dornbusch (1976), Henderson (1977), and others, the stable arm may be used as the basis for the dynamic analysis of paths between steady-states. Following a change in exogenous variables, the exchange rate jumps to keep the system moving along the stable arm to the new equilibrium.

Consider the $(1 - \phi\delta) > 0$ case. Since $\bar{p} = (1 - \lambda)\theta\bar{e}/(1 - \theta\lambda)$, it is clear that a monetary expansion will lead to a shift of the $\dot{e} = 0$ locus along the stable $\dot{p} = 0$ locus. The dynamic path is described by the single stable trajectory associated with the new loci. Upon the expansion of m, the exchange rate depreciates instantaneously, jumping at $t = 0$ from e_0 to $e(t_0)$ in Figure 2. Note, that by assumption, $p(t_0)$ remains at the pre-expansion value. After the initial depreciation, the exchange rate appreciates, while prices and wages rise to their new equilibrium levels. Even with full indexing, the monetary expansion leads to an increase in output in the short run. The spot depreciation of the exchange rate, with momentarily fixed nominal wages, permits a temporary lowering of the real wage and an improvement in the economy's competitive position. Eventually wage inflation whittles away this terms-of-trade change.

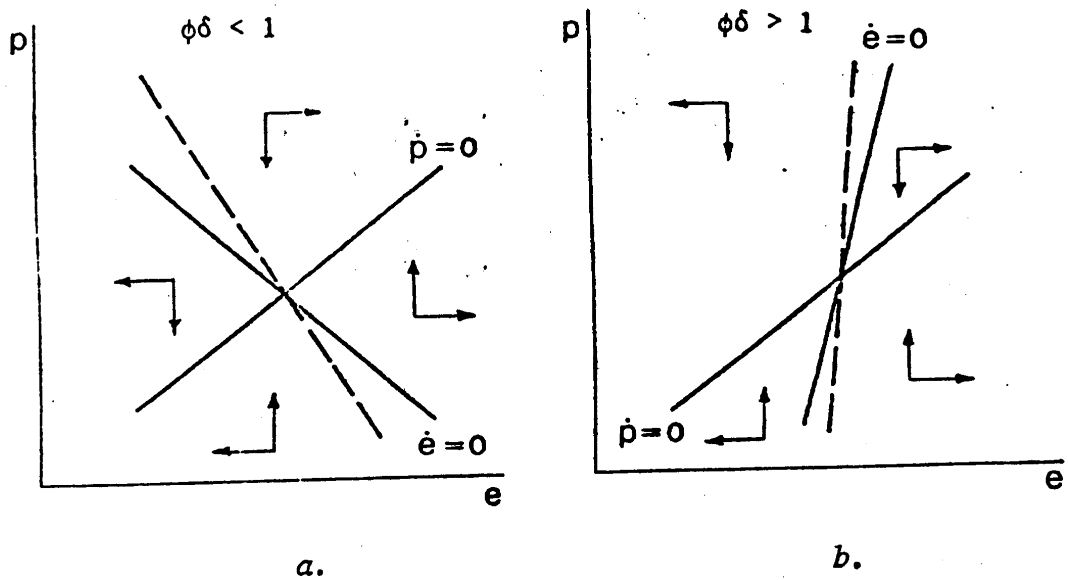

Figure 1.

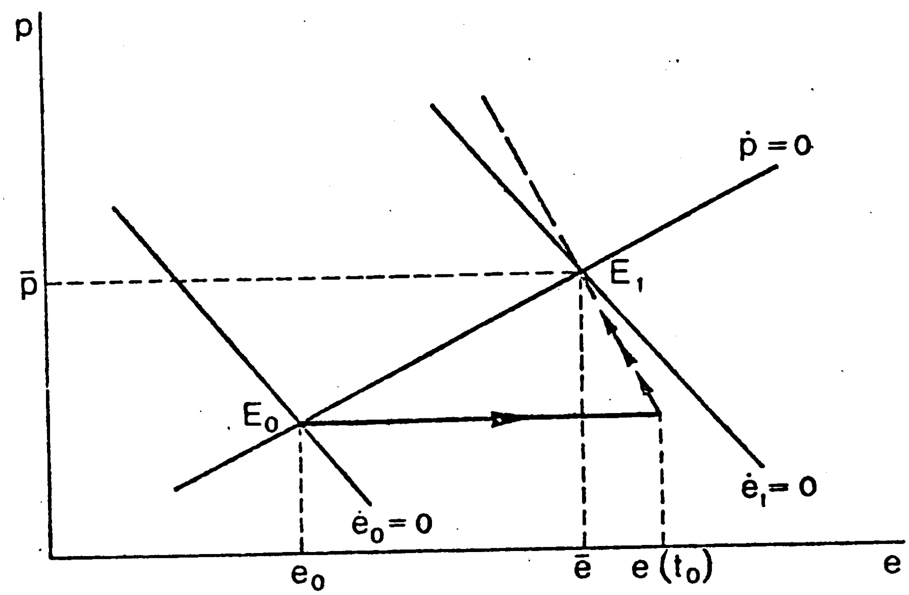

Figure 2.

Continuing with $(1 - \phi\delta) > 0$, the impact effect of fiscal policy is *less* than its long-run effect. Starting at an equilibrium E_0, the fiscal expansion shifts the equilibrium to E_1 (Figure 3). Now, the appreciation at $t = t_0$ exceeds the long-run appreciation. Real competitiveness is substantially reduced; the impact multiplier on income is necessarily less than the long-run value.

These conclusions must be altered in the $(1 - \phi\delta) < 0$ case. Now, the $\dot{e} = 0$ locus is upward sloping. It is easy to show that a monetary expansion leads to an initial undershooting of the exchange rate. The impact effect on income of a monetary expansion is still necessarily positive. More interestingly, a fiscal expansion will now have a perverse impact effect. In Figure 4, we see that an increase in G leads to an undershooting appreciation of e. The exchange rate will continue to appreciate along the entire path to E_1. But, with $\dot{e}(t_0) < 0$, we know from (5b) that $R < R^*$. Consider the money demand equation (4). Since M and P are fixed at t_0 before and after the fiscal expansion, and since $R < R^*$, we must have *an initial fall* in Y in order to maintain money market equilibrium. The initial expansionary effect of G is more than offset by the initial exchange-rate appreciation. Only when p falls sufficiently will income surpass its initial level.

We can readily find analytical solutions for the exchange rate behavior at t_0. (12) is solved for the negative root μ. Then, it is easy to show that

$$(13) \qquad p(t) = [p(0) - \bar{p}]e^{\mu t} + \bar{p}$$

$$(14) \qquad e(t) = [e(0) - \bar{e}]e^{\mu t} + \bar{e}.$$

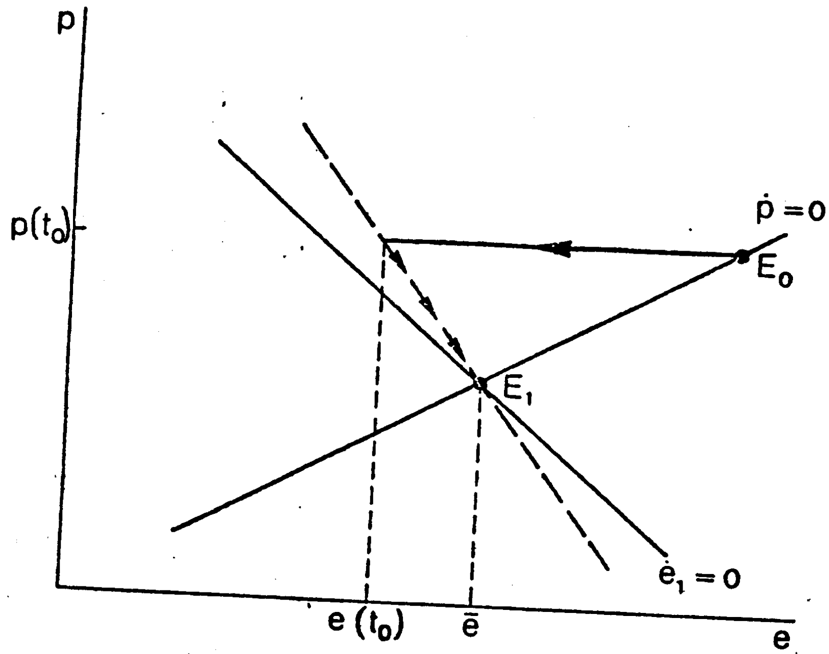

Figure 3.

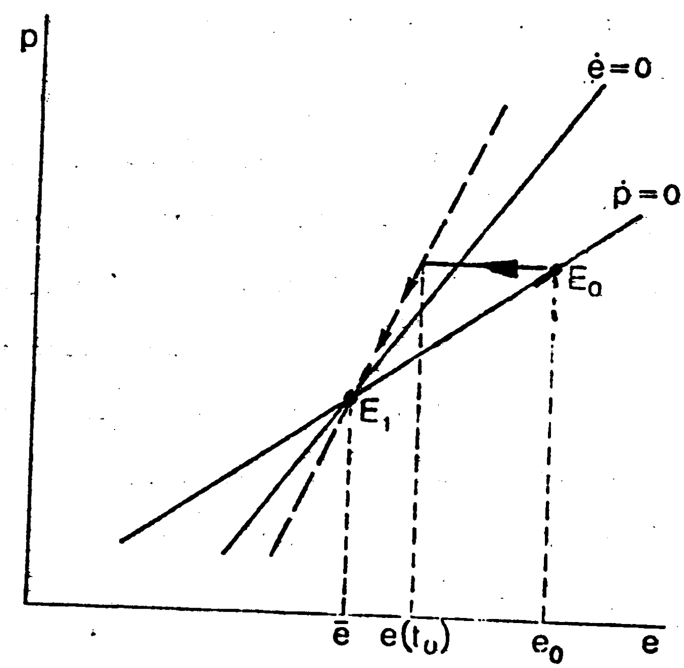

Figure 4.

Differentiating (14), $\dot{e}(t) = \mu[e(0) - \bar{e}]e^{\mu t}$. But from (10), also $\dot{e}(t) = (p - \bar{p})(1 - \phi\delta)/(\phi\sigma + \beta) + (e - \bar{e})\phi\delta/(\phi\sigma + \beta)$. Solving for $e(0) - \bar{e}$ from (12), (13), and (14),

$$(15) \qquad e(0) - \bar{e} = \frac{\left(\frac{1 - \phi\delta}{\phi\sigma + \beta}\right)[p(0) - \bar{p}]}{\mu - \frac{\phi\delta}{\phi\sigma + \beta}}$$

Since $\mu < 0$, $\text{sign}[e(0) - \bar{e}] = \text{sign}\{-(1 - \phi\delta)[p(0) - \bar{p}]\}$. For a monetary expansion, $p(0) - \bar{p} < 0$. There will be overshooting of the exchange rate $[e(0) - \bar{e} > 0]$ for $(1 - \phi\delta) > 0$, and undershooting for $(1 - \phi\delta) < 0$, as asserted earlier.

III

The data of Section I suggested that in the short run, real wage growth largely follows its trend path, and is little influenced by high unemployment or varying rates of inflation. From Table 3 we saw that the 1973-75 increase in real compensation closely matched the 1960-73 averages. In terms of Model I, $\theta \simeq 1$ and $\psi \simeq 0$. However, in 1975-76, after two years of deep recession, real wage growth moderated in many countries. We might surmise that the long-run response of real wages to employment variations is greater than the short-run response. ψ seems to vary with the time horizon. Of course, this view is the basis of many models of the Phillips curve (see, for example, Parkin, Summer, and Ward, 1976).

There are important reasons why real wages will fall more in the long than in the short run in reaction to an output or employment gap. Most simply, long-term contracts tend to enforce stable real wages, so that full flexibility in real wages must often wait until the next round of wage negotiations. Also, a period of high unemployment may temper union wage demands and shift union preferences from wage increases to higher employment. Feldstein has suggested that this shift will take time because of a basic asymmetry in information between firms and unions. Unions will tend to distrust management claims that real wages must fall in order to preserve employment, until an actual spell of unemployment occurs (Feldstein, 1975, p. 742). After that, the unions may be more willing to accept the 'warranted' wage decline. Finally, we might suppose that the Hicksian notion of 'fair wages' held by workers will change in the course of a deep recession, allowing firms to lower wages without a charge of unfairness from the workforce.

With a simple extension of Model I, we may analyze the dynamic course of an economy with real-wage resistance that varies over time, Model II. In equation (1), the nominal wage is tied to the CPI and output:

$$(1) \qquad w = h + \theta[\lambda p + (1 - \lambda)e] + \psi(y - y^f).$$

Now, suppose that the intercept h varies according to the level of the output gap

$$(16) \qquad \dot{h} = \zeta(y - y^f).$$

According to (1) and (16), and given the CPI and y, the real wage will decline over time as long as $y < y^f$. Full equilibrium in the model now requires that $y = y^f$. Two interpretations of (1) and (16) help to explain this approach. Differentiating (1) and substituting (16), we have

(17) $$\dot{w} = \zeta(y - y^f) + \psi\dot{y} + \theta(\frac{\dot{CPI}}{CPI}).$$

Equation (17) is familiar as a Phillips curve. Alternatively, for $\theta = 1$, it was seen in the previous Section that (1) can be written as a labor supply schedule $L = L^f(W/CPI)^{1/\psi\alpha}\exp^{-h/\psi\alpha}$. (1) implies a short-run labor supply schedule with elasticity $\psi\alpha$; movements in h according to (16) guarantee that the long-run elasticity is zero.

It was shown in Model I that variations in h cause movements in y in the opposite direction. With (16) an output shortfall will induce h to decline, and the fall in real wages will lift income back towards y^f. The process will continue until full employment is restored. The formal properties of the path are found by solving the system of equations (1), (2), (3), (4), (5b) and (16), denoted as Model II. Since the important results in comparing $\theta = 1$ and $\theta \neq 1$ were established in Model I, I treat here only the situation of full indexing.

Solving (1)-(5b) for $(y - \bar{y})$, equation (18) is found by

(18) $$(y - \bar{y}) = \frac{-(\beta\delta + \sigma)}{\Delta_1}(h - \bar{h}) - \frac{\sigma(1 - \lambda)}{\Delta_1}(e - \bar{e}),$$

where $\Delta_1 = [\beta(1 - \lambda) + \sigma\phi(1 - \lambda) + \sigma\psi + \beta\delta\psi]$.

From (16) and (18), we may write

(19) $$\dot{h} = \frac{-\zeta(\beta\delta + \sigma)}{\Delta_1}(h - \bar{h}) - \frac{\zeta\sigma(1 - \lambda)}{\Delta_1}(e - \bar{e});$$

with similar substitutions, the equations yield

(20) $$\dot{e} = R - R^* = \frac{(1 - \phi\delta)}{\Delta_1}(h - \bar{h}) + \frac{[(1 - \lambda) + \delta\psi]}{\Delta_1}(e - \bar{e}).$$

Since $(d\bar{h}/de)_{\dot{e}=0} = -[(1 - \lambda) + \delta\psi]/(1 - \phi\delta)$, the $\dot{e} = 0$ locus is upward sloping in the (e, h) plane if and only if $1 < \phi\delta$. The $\dot{h} = 0$ locus is necessarily downward sloping, since $(dh/de)_{\dot{h}=0} = -\sigma(1 - \lambda)/(\beta\delta + \sigma) < 0$.

We are now ready to investigate the effects of monetary and fiscal policy and foreign demand shocks on the economy. Since we have assumed $\theta = 1$, changes in M lead to equiproportional changes in P and E with no short-run effect on income. Contractionary fiscal policy, on the other hand, reduces income in the short run. But since real-wage resistance is only temporary in Model II, $y = y^f$ in the long run. Consider the phase diagrams in Figure 5, for the cases $\phi\delta < 1$ and $\phi\delta > 1$. After a fiscal contraction (or a fall in foreign demand), both the $\dot{h} = 0$ and $\dot{e} = 0$ loci shift downward, intersecting at a new equilibrium of higher e and lower h. Specifically, $d\bar{h}/dg = \gamma(1 - \lambda)/\delta$, $d\bar{e}/dg = -\gamma/\delta$ [similarly, $d\bar{h}/dy^* = v^*(1 - \lambda)/\delta$, $d\bar{e}/dy^* = - v^*/\delta$]. The decline in autonomous spending is counteracted in the long run by a real exchange rate depreciation. The improvement in competitiveness is made possible by lower real wages, brought about by the fall in h. As Figure 5 indicates, h falls along the entire adjustment path to the new equilibrium. Since $\dot{h} < 0$, (16) indicates that $y < y^f$ following the decline in g or y^*. The dynamic adjustment of exchange rates differs for the cases $\phi\delta > 1$ and $\phi\delta < 1$. In both cases, the decline in g or y^* causes a spot depreciation of the exchange rate. When $\phi\delta > 1$, the exchange-rate depreciation is overshooting, while it is undershooting otherwise.

The path of income depends crucially on $1/\psi$, the short-run elasticity of output with respect to the real wage. The larger is ψ, the less does an aggregate demand shock affect output. If ψ is very large, $y \simeq y^f$ even though $h > \bar{h}$.

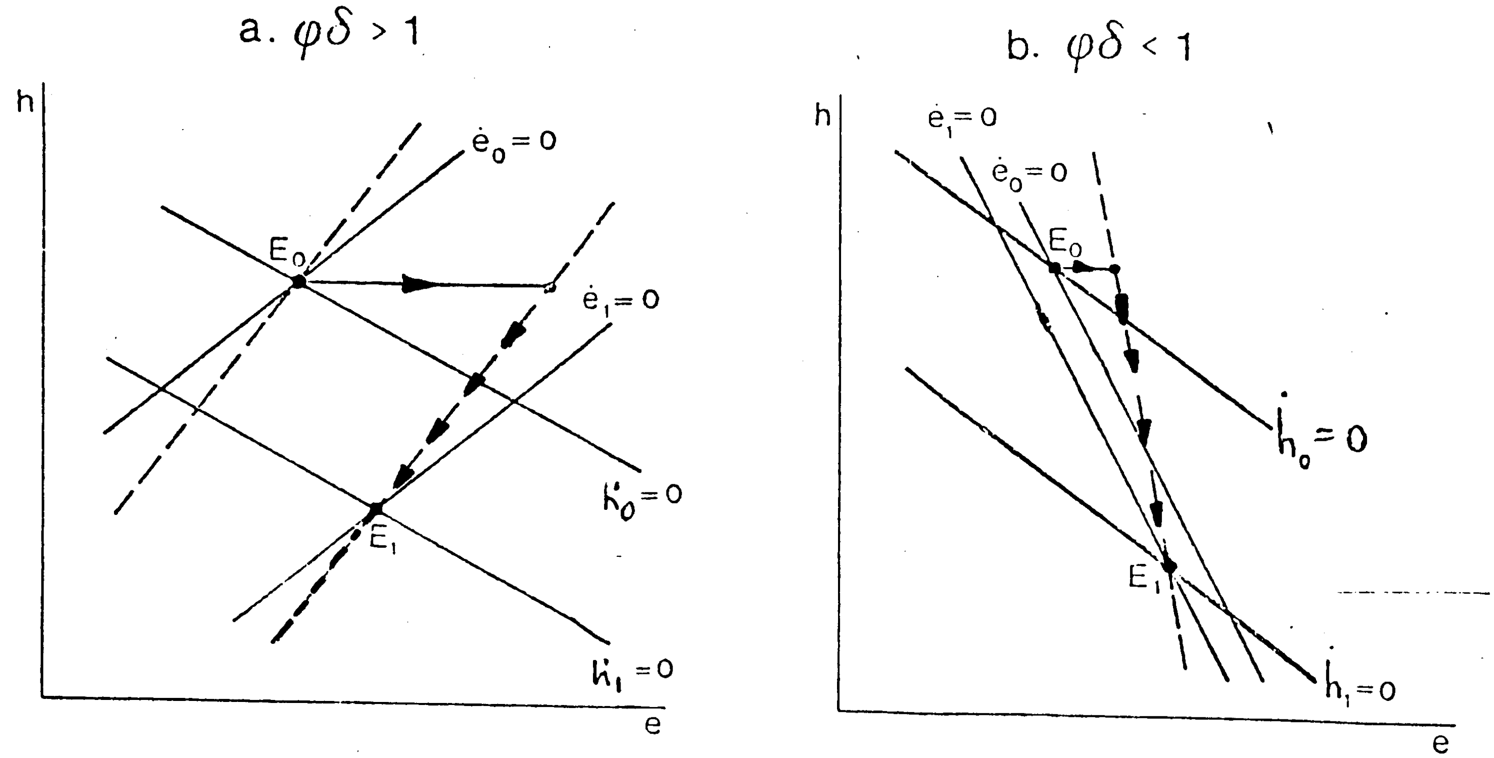

Figure 5.

Not only does real wage rigidity promise a decline in output after a shift in aggregate demand; the economy is also like to experience the misfortune of a jump in prices in the midst of falling output. First note that a constant money stock implies a constant long-run price level, independent of y^* and g. This is so because $\bar{m} - \bar{p} = \phi\bar{y} - \beta R^*$ in the long run, so that $\bar{p}$ is fixed at $\bar{m} - \phi\bar{y} + \beta R^*$. Now, consider a fiscal contraction in the $\phi\delta < 1$ case. Since we have undershooting, we know that $R(t_0) > R^*$; we also know that $y(t_0) < \bar{y}$. In order to maintain money-market equilibrium at t_0, the real supply of money must decline. With constant m, we have $p(t_0) > \bar{p}$. Over the adjustment period, prices will fall back to their initial level.

IV

The most important lessons of the models of real-wage resistance are that domestic aggregate demand shocks will affect output, fluctuations in aggregate demand abroad will be transmitted to the domestic economy, and domestic monetary policy will be largely ineffective in raising domestic output. In the absence of countercyclical fiscal policy, a decline in aggregate demand may both lower output and raise prices, via a currency depreciation. Only after a spell of unemployment has tempered real wage settlements will full employment be restored. Importantly, the welfare implications of the decline in output depend on whether the short-run 'labor-supply elasticity' (i.e., real-wage resistance) is (1) the reflection of trade union power, (2) the effect of households' miscalculations in expecting a rising trend in real wages, (3) the result of long-term contracts with programmed real wage increases, or (4) the result of optimizing intertemporal allocation of household labor supply. The choice among these alternatives will have to wait for more detailed empirical studies of wage determination.

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