Volume Title: International Volatility and Economic Growth: The First Ten Years of The International Seminar on Macroeconomics

Volume Author/Editor: Georges de MÃ©nil and Robert J. Gordon, editors

Volume Publisher: Elsevier Science Publishers B.V., 1991

Volume ISBN: 0-444-89284-2

Volume URL: http://www.nber.org/books/de_m91-2

Conference Date: various

Publication Date: January 1991

Chapter Title: International Adjustment with Wage Rigidity

Chapter Author: William H. Branson, Julio J. Rotemberg

Chapter URL: http://www.nber.org/chapters/c11675

Chapter pages in book: (p. 13 - 44)

European Economic Review 13 (1980). North-Holland

INTERNATIONAL ADJUSTMENT WITH WAGE RIGIDITY*

William H. BRANSON and Julio J. ROTEMBERG

NBER, and Princeton University, Princeton, *NJ 08540, USA*

1. Background and introduction

Since 1974 the OECD area has seen several attempts at recovery from the 1974–75 recession, but the result has been stagnation. The recovery of 1975–77 in the United States took it well ahead of the rest of the OECD in the business cycle, even though the unemployment rate reached a low of only 5.7 percent. The U.S. recovery led to a massive increase in its current account deficit and the sharp depreciation of the dollar in 1978. The 'balance of payments constraint' on uncoordinated recovery reappeared as an 'exchange-rate constraint'.

In November 1978, U.S. policy shifted sharply toward restraint and support for the dollar; the shift was announced publicly by President Carter. Demand policy has remained tight ever since, especially with monetary policy tightening in West Germany in 1979. The tightening of U.S. policy simply recognizes that the U.S. cannot attempt recovery significantly faster than Europe or Japan. The OECD countries appear to be locked into a system in which economic growth is significantly limited by the growth rate of the slowest major participant. The result of the shift in policy is renewed recession and rising unemployment throughout the OECD area.

The constraining factor in the stagnation since 1974 seems to be the difficulty of recovery, or reluctance to stimulate demand, in Europe and Japan. The question we address is: why is recovery so hard in Europe and Japan? During 1976–77 the OECD policy debate on recovery was mainly the U.S. suggesting (more or less politely) that the countries in 'strong' current account positions, Japan and West Germany, take the lead, and those governments either refusing or reluctantly proposing fairly timid measures. Essentially their position was that rapid demand expansion would lead only to more inflation, with no significant gains in real output.

One popular explanation for the policy difference between the U.S. and,

*Paper presented at the International Seminar on Macroeconomics, Paris, September 10–11, 1979. We wish to thank the participants for helpful comments and the NSF for research support.

mainly, West Germany was that their sensitivity to or expectations of inflation differed. Another could be that the implicit model behind the German view was a texbook 'classical' model with no money illusion and fully flexible wages and prices, while the implicit U.S. model has sticky wages or money illusion. This view of the German economy did not seem realistic.

A more satisfactory model of the European side was presented by Herbert Giersch when he talked in Princeton in March, 1978. Our interpretation of his view was that the German real wage was rigid, at least downward, above its equilibrium value. This model would give the 'classical' results that demand expansion only raises prices with no effect on output, but not in a flexible wage-and-price context. As we see in section 2 below, an assumption of real-wage rigidity of this sort in Europe and Japan plus nominal wage stickiness in the U.S. would make sense of the 1976–77 policy debate.

As an initial check on the empirical plausibility of this model, we perused the time-series data on real wage rates in major OECD countries. If differences between real-wage and nominal-wage rigidities were a major feature of the OECD economies, they should appear in the 1974 recession, with rigid real wages resisting the downturn more than sticky nominal wages. This is especially true with the oil price increase.

The time-series data are summarized in table 1. There we see that the only country with a protracted decline on real wages in the 1973–75 period was the United States. There the real-wage index peaked at 1.042 in 1973:2, and did not pass the level again until 1975:2. In Germany, real-wage growth continued straight through the recession until 1976. In Italy and Japan, there was a pause in 1974, with growth resuming by the beginning of 1975. In the U.K., the real-wage index continued to grow to mid-1976, with pauses in 1974:2 and in mid-1975. These data provide some initial support for the hypothesis, and were the basis for an informal discussion of it at the International Seminar on Macroeconomics in 1978. This paper reports on our continuing theoretical and empirical investigation of demand policy in a series of models with differing types of wage rigidity across countries.

In section 2 of the paper we develop a model of two countries with one commodity and purchasing-power-parity (PPP). Here we obtain the clear-cut Giersch results. Expansion in the country with rigid real wages raises the world price level, increases output in the country with rigid nominal wages, and also reduces that country's trade deficit.

The clarity of these results is blurred in section 3, where we study a model with two commodities and do not assume PPP. This is the same general framework used by Bruno and Sachs (1979) and Argy and Salop (1978). The main differences are that the section 3 model is analytic and focuses on effects of demand policy, while the Bruno–Sachs several-country model is solved by simulation and focuses on analysis of stagflation. Argy and Salop look only at supply-side conditions, while we study demand and supply. As

Table 1
Index of real hourly compensation of employees for selected OECD countries.

Year	Germany	Italy	Japan	U.K.	U.S.
1971:1	1.000	1.000	1.000	1.000	1.000
1971:2	0.997	1.036	1.024	1.025	1.001
1971:3	1.029	1.058	1.053	1.012	1.003
1971:4	1.031	1.049	1.065	1.025	1.003
1972:1	1.057	1.057	1.116	1.037	1.016
1972:2	1.067	1.095	1.116	1.076	1.023
1972:3	1.076	1.111	1.124	1.069	1.027
1972:4	1.086	1.176	1.197	1.072	1.030
1973:1	1.119	1.177	1.142	1.064	1.042
1973:2	1.125	1.236	1.173	1.080	1.036
1973:3	1.139	1.259	1.222	1.088	1.034
1973:4	1.147	1.270	1.307	1.088	1.029
1974:1	1.161	1.255	1.169	1.121	1.018
1974:2	1.196	1.317	1.280	1.120	1.024
1974:3	1.228	1.277	1.305	1.164	1.024
1974:4	1.245	1.293	1.305	1.190	1.032
1975:1	1.262	1.356	1.340	1.204	1.041
1975:2	1.265	1.369	1.311	1.186	1.049
1975:3	1.276	1.414	1.307	1.191	1.047
1975:4	1.282	1.390	1.312	1.203	1.051
1976:1	1.277	1.391	1.312	1.208	1.057
1976:2	1.279	1.407	1.300	1.221	1.072
1976:3	1.294	1.434	1.300	1.217	1.075
1976:4	1.300	1.401	1.313	1.192	1.082
1977:1	1.298	1.391	1.309	1.168	1.085
1977:2	1.318	1.418	1.314	1.150	1.086
1977:3	1.319	1.415	1.324	1.155	1.095
1977:4	1.348	1.423	1.339	1.174	1.103
1978:1	1.331	1.441	1.343	1.195	1.112
1978:2	1.364	1.421	1.345	1.227	1.106
1978:3	1.362	1.421	1.349	1.232	1.109
1978:4	1.385	1.432	1.362	1.248	1.109

we see in table 3, the Bruno–Sachs and Argy–Salop results can be viewed as special cases of ours.

The reason that the clear-cut Giersch results are lost in the two-commodity case is that the relevant prices for workers' and producers' decisions are different (as in Bruno–Sachs and Argy–Salop). Producers look at the price of domestic output; workers look at a CPI with imports in it as well. Thus even if the real wage relative to the CPI is rigid, if a demand expansion at home pulls up the price of domestic output relative to the CPI, employment and output expands. Only if exchange-rate adjustment were immediate and complete, putting us back in the section 2 PPP world, would the difference not appear. The result is that, in section 3, we see that the degree of 'money illusion', or real wage vs. nominal-wage stickiness, is at

least as important as actual-wage rigidity for sorting out the effects of demand policy.

In section 4 we report some empirical tests of wage rigidity and money illusion for five major OECD countries (U.S., U.K., Japan, Italy, Germany) on time-series data since 1961. The sample is split at 1971 to see if parameters have changed in the 1970s. An important thing to note about our table 4 regressions is that they report equations for gradual adjustment of wage *levels*, with lagged wages and the *level* of demand as regressors. This formulation follows from the theory of sections 2 and 3, where wage rigidities are stated in terms of the relevant wage level. Bruno and Sachs (1979, p. 16) have the same basic theoretical structure but estimate Phillips-type equations with the wage *change* depending on the *level* of demand.

The empirical results give us a classification as follows. The U.S. stands out as the only country with short-run stickiness of nominal-wage rates. The U.K., Japan, Germany, and Italy all seem to have gradual adjustment of real wages, consistent with effective indexation. In all five countries, response of the relevant wage to demand pressure is much less in the 1970s than over the entire period. These results are consistent with the Giersch hypothesis extended to the OECD.

2. Wage rigidities in the PPP model

In this section we develop the simplest macro model with wage rigidities that yields interesting results for the effects of demand policy. The model has two countries and one commodity (the 'schmoo'), and assumes that the 'law of one price' holds, so that there is one world price, P, for the one commodity.[1] We hold the exchange rate constant at unity; alternatively we could assume two different domestic prices for the commodity, P and P^*, with the exchange rate e defined by $P = eP^*$. We begin with the specification of aggregate supply conditions, then move on to demand in each country

Table 2
Definition of variables.

y	= domestic output
P	= price index for y
W	= nominal-wage rate
w	= real-wage rate
K	= capital stock
g	= exogenous component of demand in real terms
a	= real absorption
x	= real net exports
$*$	= superscript for the 'foreign' country

[1] See table 2 for definition of variables.

and determination of the equilibrium price level. Next we study the effects of demand policy and the consequences of different forms of wage rigidity.

2.1. Labor market and aggregate supply

On the demand side of the labor market we have a production function and a marginal productivity condition which yields the labor demand function

$$y=y(N,K), \quad y_N>0, \quad y_{NN}<0, \quad y_K>0, \quad y_{NK}<0; \qquad \text{[production function]} \tag{1}$$

$$w=W/P=y_N(N,K). \qquad \text{[demand wage]} \tag{2}$$

In an equilibrium model, we would add a labor-supply function $w=w^s(N)$, and solve for equilibrium w and N. Here we assume that alternately either the nominal wage or the real wage is rigid above its equilibrium value. We assume that with the relevant wage rigid above its equilibrium level, employment is determined along the labor-demand function. This is the familiar minimum condition in non-market-clearing models.[2] Thus if the wage rigidity is effective, labor is constrained in the amount of hours that employers will buy. This is consistent with the specification of the demand side in the next subsection.

In the case of the real-wage rigidity we have $w=\bar{w}>$ *equilibrium* w, and employment is determined along the labor-demand function

$$w=y_N(N,K). \tag{3}$$

This gives us N as a function of $\bar{w}$ and the production technology, and through (1) it fixes y from the supply side. This is similar to the textbook 'classical' model [see Branson (1979)] and is illustrated in fig. 1.

With a nominal wage rigidity we have

$$\bar{W}=P\cdot y_N(N,K) \tag{4}$$

as the labor-market equilibrium (but non-clearing) condition. This is illustrated in fig. 2. The response of employment and aggregate supply to a change in the price level is obtained from total differentiation of (4) and the production function (1),

$$\mathrm{d}N/\mathrm{d}P\big|_{\substack{w=\bar{w}\\ \mathrm{d}K=0}}=-y_N/y_{NN}>0, \qquad \mathrm{d}y/\mathrm{d}P\big|_{\substack{w=\bar{w}\\ \mathrm{d}K=0}}=y_N(\mathrm{d}N/\mathrm{d}P)>0. \tag{5}$$

[2]See Muellbauer and Portes (1979), for example.

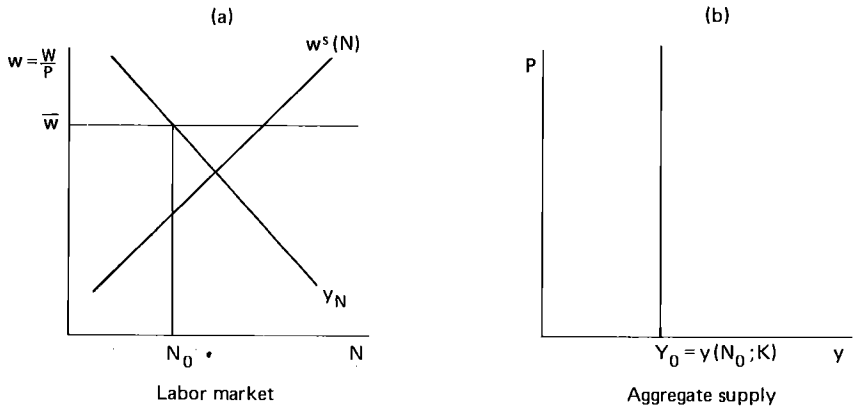

Fig. 1. Real-wage rigidity.

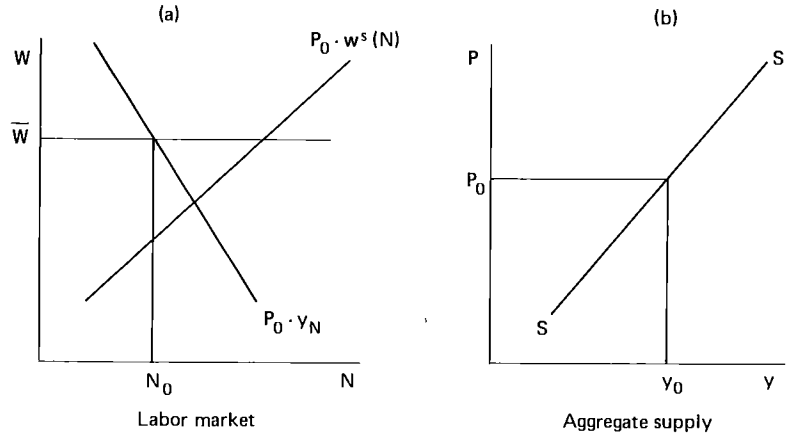

Fig. 2. Nominal-wage rigidity.

The response of aggregate supply to an increase in the capital stock is given by

$$\mathrm{d}y/\mathrm{d}K\big|_{\substack{w=\bar{w}\\ \mathrm{d}P=0}} = -y_N(y_{NK}/y_{NN}) > 0. \tag{6}$$

An increase in the capital stock shifts out the supply curve in figs. 1 and 2. Thus with the rigid nominal wage we can write the aggregate supply function of fig. 2(b) as

$$y = y(P,K), \qquad y_P \gtreqless 0, \quad y_K \gtreqless 0, \tag{7}$$

with a rigid real wage $y_P=0$; with a rigid nominal wage $y_P>0$.

In the two-country model we will assume that each country has an aggregate supply function of the form $y=y(P,K)$. The 'home' country will be identified by unstarred variabless; the 'foreign' country by stars. Thus the two aggregate supply functions are

$$y=y(P,K), \tag{8a}$$

$$y^*=y^*(P,K^*). \tag{8b}$$

Remember that there is only one world price level.

In the solution for equilibrium and comparative statics below we first assume $y_P>0$; $y_P^*>0$ in general. Then when we analyze the effects of differing wage rigidities on the results of demand policy we will assume the 'home' country has a real-wage rigidity so that $y_P=0$, and the 'foreign' country has a nominal-wage rigidity with $y_P^*>0$. The effects of changes in investment will come in only when we discuss policy to adjust to a real-wage rigidity, so we omit the K argument in y and y^* until we reach that discussion.

2.2. *Demand and equilibrium P*

With rigid wages above equilibrium in both countries, real absorption will be a function of income, the price level, and a demand policy variable. Income appears through a Keynesian effective-demand consumption function. The price level represents a real balance effect with predetermined outside money. The demand policy variable can be thought of as the real deficit, or real government purchases with given tax revenue. The income–expenditure equilibrium conditions for the two countries are then

$$y(P)=a(y(P),P,g)+x, \tag{9a}$$

$$y^*(P)=a^*(y^*(P),P,g^*)-x. \tag{9b}$$

Here net exports (the current account balance of the home country) x is residually determined by income y less absorption a. With only one good there are no terms-of-trade effects. This simplification will be removed in section 3 below. With two countries, x enters negatively in (9b). The partial derivatives of a are signed $a_y>0$, $a_p<0$, $a_g>0$ $(=1)$, and similarly for a^*.

The equilibrium world price level P is obtained by equating income less absorption at home to absorption less income abroad,

$$y-a=-(y^*-a^*). \tag{10}$$

Here we sum the excess demand functions in the two countries and find the price level at which world excess demand is zero.

The next step is to derive expressions for the effects of change in demand policy and g and g^* on the price level. The effects on outputs y and y^* will follow immediately from the supply functions. The effects on the current account x can then be solved from (9a) or (9b). Total differentiation of (10) and solution for dP yields

$$dP = \frac{1}{\phi + \phi^*}(dg + dg^*), \tag{11}$$

where

$$\phi = (y_P(1 - a_y) - a_p) > 0 \quad \text{and} \quad \phi^* = (y_P^*(1 - a_{y^*}^*) - a_P^*) > 0.$$

Remember $a_g = 1$. The effect of demand expansion on the price level does not depend on where it originates. The parameters ϕ and ϕ^* are Keynesian-type multipliers.

The effect of demand expansion on net exports can be solved from the total differential of (9a),

$$dx = -\frac{\phi^*}{\phi + \phi^*}dg + \frac{\phi}{\phi + \phi^*}dg^*. \tag{12}$$

An exogenous increase in home demand reduces x; an increase in foreign demand increases x. If both g and g^* rise by the same amount, the effect on x depends on the net absorption coefficients ϕ and ϕ^*. If $\phi > \phi^*$, a balanced expansion increases x since net absorption falls more at home than abroad.

The increase in outputs y and y^* that follows from an increase in g or g^* are simply $dy = y_P dP$ and $dy^* = y_P^* dP$. Thus if the supply curves have positive slopes, both levels of output and employment are increased by a demand expansion in either country.

2.3. *The role of wage rigidities*

We can now use the one-commodity model to study the effects of differing wage rigidities on response to changes in demand policy. To be specific, let us assume that in the home country the real wage is rigid above equilibrium, while in the foreign country the nominal wage is rigid. Thus $w = \bar{w}$, $W^* = \bar{W}^*$, by assumption. What are the consequences for the effects of a demand expansion?

First, with a real-wage rigidity at home $y_P = 0$ and ϕ in eq. (11) reduces to $-a_p$. When the price level rises, there is an effect on absorption in the real-

wage country, but no effect on output. The reaction of the world price level with this pattern of wage rigidities is given by

$$dP=\frac{1}{\phi^*-a_p}(dg+dg^*). \tag{13}$$

The source of the demand disturbances still does not matter, but the price multiplier is increased from eq. (11) by elimination of the y_P^* output effect. The expression for dx in eq. (12) is also changed by substitution of $-a_P$ for ϕ. It is still the case that $dx/dg<0$ and $dx/dg^*>0$, but it is more likely that a balanced increase in g and g^* decreases x because of the zero supply response in the home country.

To summarize, an increase in g in the real-wage country (a) increases P, and by more than in a world with no real-wage rigidity, (b) increases output *only* in the other country, and (c) reduces the trade surplus in the real-wage country. Thus *if* Germany were the real-wage country and the U.S. were the nominal-wage country, a fiscal expansion in Germany would be inflationary and reduce the German trade balance, but all the output and employment effects would appear in the U.S.

This model can be generalized easily to a world of several countries, some with real-wage rigidities, some with nominal-wage rigidities. A demand expansion originating anywhere in the system will raise the price for all, but increase output and employment only where nominal prices are rigid. The trade surplus (deficit) will be reduced (increased) in the area where the demand expansion originated, and a balanced expansion of demand will reduce the trade surplus of the real-wage countries.

2.4. *Effect of capital stock expansion*

Expansion of the capital stock in one country will increase supply in that country, drive down the world price level, and in general reduce output in the other country. We can see this by putting (8a) and (8b) for y and y^* into the equilibrium conditions (9a) and (9b), inserting these into (10) for the world price level, and totally differentiating with respect to P and K. The result is

$$\frac{dP}{dK}=-\frac{y_K(1-a_y)}{\phi+\phi^*}<0.$$

If the home (unstarred) country increases its capital stock, its output rises unambiguously. The expression for dy is

$$dy=y_K\left(1-\frac{y_P(1-a_y)}{\phi+\phi^*}\right)dK.$$

Since $y_P(1-a_y)<\phi$, $dy/dK>0$.

If the real wage in the home country is rigid above equilibrium, so that $y_P = 0$, capital stock expansion can increase output to the point where the wage rigidity is no longer binding on the side of the demand for labor. Thus one policy to escape the wage rigidity is incentives for investment. This was Giersch's conclusion for West Germany. However, by reducing the world price level P, this policy would tend to reduce output abroad unless $y_P^* = 0$.

3. Adjustment with differentiated product bundles

The clear-cut results of section 2 were derived in a framework with only one good and one world price level. The sharpness of these results is reduced when we go to a world of differentiated product bundles with different prices. In reality the industrial countries trade products that can be roughly aggregated into bundles of exportables and importables, with the possibility of terms-of-trade changes between them. To capture the effects of movements in the terms of trade, we turn to a model in which the two countries produce different goods. These can be thought of as different fixed-weight product bundles with their associated price indexes. Introduction of two goods, and two prices, changes fundamentally the characterization of both the supply and demand sides of the model, and makes the signs of the effects of expansionary policy in either country on both outputs depend on particular parameter values.

3.1. The demand side with two commodities

In this section we develop a fairly standard two-country Keynesian model with two goods. The two goods are the home exportable y with a price index P, and the foreign exportable y^* with a price index P^*. In this framework we again study the effects of differing wage rigidities, i.e., aggregate supply specifications, on the effectiveness of demand policy in influencing output.

On the demand side we have the usual absorption equation for an open economy,

$$y = a(y, \hat{P}, g) + x(P/eP^*). \tag{14}$$

The consumer price index entering absorption is a function of the home and foreign prices,

$$\hat{P} = \theta(P, P^*), \qquad \theta_p, \theta_{p^*} \geqq 0, \quad \theta_p + \theta_{p^*} = 1. \tag{15}$$

The restriction on the sum of θ_p and θ_{p^*} follows from specification of $\hat{P}$ as a weighted average of P and P^*, and the initial normalization $P = P^* = 1$.

Total differentiation of (14), holding the exchange rate constant at $e=1$, yields

$$dy=\frac{1}{1+a_y}[(a_p\theta_p+x_p)dP+(a_p\theta_{p*}-x_p)dP^*+dg]. \tag{16}$$

Here $x_p<0$ is the derivative of x with respect to eP/P^*. From (16) we can write the demand function for y,

$$y=V(P,P^*,g), \qquad V_p<0, \quad V_{p*}>0, \quad V_g>0. \tag{17}$$

The partial derivatives of V are the coefficients in eq. (16) above. $V_{p*}>0$ assumes that the terms-of-trade effect outweighs the absorption effect when the foreign price level P^* rises. If the home good share in the consumption bundle is at least equal to the import share, $\theta_p \geqq \theta_{p*}$, then $|V_p|>|V_{p*}|$. This condition is not necessary since x_p enters V_p while $-x_p$ enters V_{p*}.

3.2. *Aggregate supply with two commodities*

On the supply side we first develop expressions for labor market supply, demand, and equilibrium, and then show how these are affected by the existence of wage rigidities above equilibrium levels.

The production function is eq. (1) of section 2, where output is the exportable good. The usual demand function for labor is given in eq. (2) above: $W/P=y_N(N)$. As an alternative we also introduce the possibility that producers have market power in both home and foreign markets, and can effectively prevent entry in the short run. In this case, both the home and foreign prices would enter the demand function for labor,

$$W/\tilde{P}=y_N(N), \tag{18}$$

with $\tilde{P}$ defined by

$$\tilde{P}=\psi(P,P^*), \qquad \psi_p,\psi_{p*}\geqq 0, \quad \psi_p+\psi_{p*}=1. \tag{19}$$

In the competitive case $\tilde{P}=P$, and $\psi_p=1$. However, (19) provides the price index for a discriminating monopolist producing at home and selling in both markets.[3] In the algebra that follows, the competitive case can be obtained by setting $\psi_p=1$ and $\psi_{p*}=0$.

The labor-supply function makes the real wage demanded a function of the level of employment, with the nominal wage deflated by the consumer price index $\hat{P}$ defined earlier in eq. (15). Thus labor supply is given by

$$W/\hat{P}=g(N), \qquad g_N>0. \tag{20}$$

[3]For detailed analysis and proof, see appendix A.

Equilibrium in the labor market equates the nominal supply wage from (20) to the demand wage from (18),

$$\hat{P} \cdot g(N) = \tilde{P} \cdot y_N(N). \tag{21}$$

Total differentiation of (21) plus the production function (1) gives us the expression for changes in y as functions of dP and dP^* on the supply side,

$$dy = \frac{1}{g_N - y_{NN}}[(\psi_p - \theta_p)dP + (\psi_{p^*} - \theta_{p^*})dP^*]. \tag{22}$$

Here we have set all prices at unity initially. It may help to note that this implies also that initial $w = g = y_N = 1$.

From (22) we can write the general form of the supply function for y as

$$y = \Lambda(P, P^*), \qquad \Lambda_p \geqq 0, \quad \Lambda_{p^*} \leqq 0. \tag{23}$$

The signs of the partial derivatives of (23) are the coefficients of (22), where we assume $\theta_{p^*} > \psi_{p^*}$. This simply says the weight of foreign prices in the worker's CPI is larger than it is in the firms' profits function.

An interesting property of the Λ supply function should be noted here. If workers focus on the real wage, correctly measured, in making the labor-supply decision, then $\theta_p + \theta_{p^*} = 1$. Together with $\psi_p + \psi_{p^*} = 1$, this implies that $\Lambda_p = -\Lambda_{p^*}$; the supply function is symmetric with respect to the two prices.

3.3. The role of wage rigidities

We can now introduce wage rigidities on the supply side as special cases of (22) and (23). Consider first the case in which the real wage is rigid above equilibrium. We interpret this as an infinitely elastic supply curve for labor at the rigid wage $\bar{w}$, so that the supply function (20) becomes

$$W/\hat{P} = \bar{w}, \tag{20^R}$$

and in (22), $g_N = 0$.

This simply removes g_N from (22) and (23), not changing the qualitative slopes of (23). Thus going to a two-good model fundamentally changes the 'classical' effect of the real-wage rigidity. With the two price indexes entering differently in producers' demand for labor and in workers' supply, a change of either price influences output supplied, with $\partial y/\partial P > 0$ and $\partial y/\partial P^* < 0$ even with a real-wage rigidity. This will eliminate some of the sharp results of the one-commodity model.

To impose a nominal-wage rigidity, we re-write (20) as

$$W = \bar{W}; \tag{20^N}$$

in addition to $g_N = 0$, $\hat{P}$ no longer enters the supply function. This eliminates θ_p and θ_{p^*} from (22) and (23). In the usual case of $\psi_p = 1$, this takes us back to the supply function of section 2, eq. (5), with $\partial y/\partial P = -1/y_{NN}$.

With complete wage rigidity, or complete 'money illusion' in labor supply, θ_p and $\theta_{p^*} = 0$, since the price level does not enter the labor-supply function as it affects the level of employment. With flexible nominal wages and no money illusion, $\theta_p + \theta_{p^*} = 1$. In an intermediate case of partial money illusion, the labor force would 'perceive' a price index with $\theta_p + \theta_{p^*} < 1$. The perceived price index could be thought of as the actual CPI raised to a power less than unity: $\hat{P}^\alpha$ with $\alpha < 1$.[4]

To summarize, real-wage rigidity would eliminate g_N from (22) and nominal-wage rigidity would further eliminate θ_p and θ_{p^*}. Both types of rigidity would leave us with the supply function (23) with $\Lambda_p > 0$. The sign of Λ_{p^*}, the cross-price effect on supply, is less clear. Normally $\Lambda_{p^*} < 0$. However, in the case where $\psi_p = 1$, complete nominal-wage rigidity would eliminate P^* from the Λ supply function. If ψ_{p^*} is sufficiently large compared to θ_{p^*}, then $\Lambda_{p^*} > 0$.

3.4. *Demand and supply in the 'foreign' country*

Eqs. (17) and (23) give demand and supply in the home country as functions of the two price levels. At this level of generality, demand and supply in the foreign country are mirror images. The only point to note especially is that the trade balance at home must equal the deficit abroad. Thus the demand equation in the foreign country is solved from

$$y^* = a^*(y^*, \hat{P}^*, g^*) - x(eP/P^*). \tag{24}$$

The foreign demand equation is then

$$y^* = V^*(P, P^*, g^*), \qquad V_p^* > 0, \quad V_{p^*}^* < 0, \quad V_{g^*}^* > 0. \tag{25}$$

The supply equation is

$$y^* = \Lambda^*(P, P^*), \qquad \Lambda_p^* \leqq 0, \quad \Lambda_{p^*}^* \geqq 0. \tag{26}$$

The entire discussion for wage rigidities, etc., in the home case applies in the 'foreign' case as well.

Given the values of the two demand policy variables g and g^*, the two demand functions, eqs. (17) and (25), and the supply functions equations,

[4]See Branson and Klevorick (1969) for use of this parameterization of money illusion.

eqs. (23) and (26), give us four equations in the variables y, y^*, P, P^*. These already include the restriction that the trade balance x is the same for both countries. Next we study the properties of this equilibrium by considering the effect of a demand increase dg in the home country.

3.5. *Expansionary demand policy in one country*

We analyze the effect of expansionary demand policy in the home country under a variety of institutional assumptions concerning wage rigidity. It will be apparent that these have impacts on the results for the effectiveness of fiscal policy. The model is summarized in eqs. (17), (23), (25) and (26).

Totally differentiating these we obtain the following linear system:

$$\begin{bmatrix} 1 & 0 & -\Lambda_p & -\Lambda_{p^*} \\ 0 & 1 & -\Lambda_p^* & -\Lambda_{p^*}^* \\ 1 & 0 & -V_p & -V_{p^*} \\ 0 & 1 & -V_p^* & -V_{p^*}^* \end{bmatrix} \begin{bmatrix} \mathrm{d}y \\ \mathrm{d}y^* \\ \mathrm{d}P \\ \mathrm{d}P^* \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ V_g \\ 0 \end{bmatrix} \mathrm{d}g. \tag{27}$$

The determinant is given by

$$\Delta = (V_p - \Lambda_p)(V_{p^*}^* - \Lambda_{p^*}^*) - (V_{p^*} - \Lambda_{p^*})(V_p^* - \Lambda_p^*). \tag{28}$$

This is the product of the own effects of price changes less the product of the cross effects. The discussion after eq. (17) led us to notice that the own demand effects are larger than the cross demand effects. Furthermore, in general, the own supply effects are larger than or equal to the cross supply effects. Therefore, Δ can in general be taken to be positive.

The comparative status of the model of eq. (27) following an increase in g are summarized below,

$$\mathrm{d}y/\mathrm{d}g = V_g[\Lambda_{p^*}(V_p^* - \Lambda_p^*) - \Lambda_p(V_{p^*}^* - \Lambda_{p^*}^*)]/\Delta, \tag{29}$$

$$\mathrm{d}y^*/\mathrm{d}g = -V_g[\Lambda_p^* V_{p^*}^* - V_p^* \Lambda_{p^*}^*]/\Delta, \tag{30}$$

$$\mathrm{d}P/\mathrm{d}g = -V_g(V_{p^*}^* - \Lambda_{p^*}^*)/\Delta, \tag{31}$$

$$\mathrm{d}P^*/\mathrm{d}g = +V_g(V_p^* - \Lambda_p^*)/\Delta. \tag{32}$$

The numerator of eq. (29) for $\mathrm{d}y/\mathrm{d}g$ is essentially V_g times the own price effects less cross-price effects. Therefore in general we expect it to be positive. A major exception would be when home supply is insensitive to prices; then $\mathrm{d}y/\mathrm{d}g = 0$. The numerator of (30) contains only characteristics of the 'foreign' country. When the foreign supply function is symmetric with respect to the

two prices, the sign of dy^*/dg depends on the relative absolute values of the demand effects, and is therefore negative.[5] We return to a detailed analysis of (29) and (30) below.

The condition that $\Delta > 0$ is required to obtain the result that an increase in g will increase both P and P^* in (31) and (32). If $\Delta < 0$, an increase in g will decrease P and P^*. The P, P^* solution for an increase in g is illustrated in fig. 3. There, the PP line is the combination of P and P^* that yields equilibrium in the home market. The equation for this line is

$$(V_p - \Lambda_p)dP = -(V_{p^*} - \Lambda_{p^*})dP^* - V_g dg.$$

For a given g, the slope is $-(V_p - \Lambda_p)/(V_{p^*} - \Lambda\Lambda_{p^*})$. The P^*P^* line is the combination of P and P^* that yields equilibrium in the foreign country. The equation for P^*P^* is

$$(V_p^* - \Lambda_p^*)dP = -(V_{p^*}^* - \Lambda_{p^*}^*)dP^*.$$

If P^*P^* is flatter than PP then Δ is positive and an increase in g raises both prices along P^*P^* as in fig. 3. If P^*P^* were steeper than PP then an increase in g would lower both prices.

3.6. *Effects on real output*

In analyzing the comparative statics effects on y and y^* of a change in g,

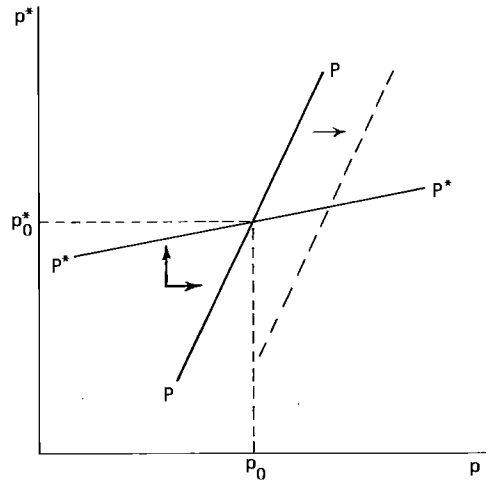

Fig. 3. Increase in g in two-commodity model.

[5]This is the result obtained by Argy and Salop (1978).

we will study the cases in which the 'home' country has no money illusion, so that $\theta_p + \theta_{p^*} = 1$. Whether the real wage is rigid will effect only the size of the multipliers, with $g_N \leqq 0$. For the 'foreign' country we will vary the assumptions across several of the differing cases of wage rigidity distinguished earlier. These are

(1) Rigid nominal wages, with $\theta_p^* = \theta_{p^*}^* = 0$, and $\psi_{p^*} = 1$,

(2) Rigid real wages, with $\theta_{p^*}^* \leqq \psi_{p^*}^*$,

(3) Rigid real wages, with $\theta_{p^*}^* > \psi_{p^*}^*$,

(4) Sticky nominal wages, with $\theta_p^* + \theta_{p^*}^* < 1$.

Clearly this is only a small subset of the possible combinations of assumptions for wage behavior in both countries, as is obvious from eqs. (29) and (30).

The four cases are summarized in table 3. In the first case, even with no money illusion at home, demand expansion increases home output through the differential effects of P and P^* on home supply. In section 2 with one commodity and corresponding price, $dy/dg = 0$. This may be the proper case to associate with Giersch.

An important thing to note about cases 2 and 3 is that our results are commodity and corresponding price, $dy/dg = 0$. The first case in table 3 may be the proper case to associate with Giersch.
in either country will not affect supply in that country.

If the foreign country (i.e., the one that does not expand) has a fixed real wage while workers are more sensitive to the cross-price than are firms (case 2), the expansion at home is contractionary abroad. This result is the one obtained by Argy and Salop, Sachs, and Bruno and Sachs. However,

Table 3
Effects of demand expansion on output.

Assumptions on wage behavior		Effects on outputs		
Home	Foreign	dy/dg		dy^*/dg
No money illusion ($\theta_p < \psi_p$)	(1) Rigid nominal wage $\theta_p^* = \theta_{p^*}^* = 0$ ($\psi_{p^*} = 1$)	+	(Giersch case)	+
Same	(2) Rigid real wage $\theta_{p^*}^* < \Psi_{p^*}^*$	+	(Argy–Salop case)	−
	$\theta_{p^*}^* = \psi_{p^*}^*$	+	(classical case)	0
Same	(3) Rigid real wage $\theta_{p^*}^* > \psi_{p^*}^*$	+	(Hong Kong)	+
Same	(4) Sticky money wage $\theta_p^* + \theta_{p^*}^* < 1$	+	(Keynesian case)	(+)

there are two caveats to this result. These are shown in cases 3 and 4. Enough money illusion in the foreign country will make the increase in g expansionary there, as in case 4. By 'enough' we mean that

$$\theta_p^* + \theta_{p^*}^* < 1 - \frac{(\psi_{p^*}^* - \theta_{p^*}^*)(V_p^* + V_{p^*}^*)}{V_{p^*}^*}. \tag{33}$$

In general the right-hand side of (33) will be close to unity since (a) $V_p^* + V_{p^*}^*$ is small relative to $V_{p^*}^*$, and (b) $(\psi_{p^*}^* - \theta_{p^*}^*)$ is between minus one and one. Therefore it takes but a little money illusion to reverse the contractionary effect abroad of an increase in g at home. A final caveat is that if in the foreign-country firms are more sensitive to the cross-price than are workers, a rare case of which Hong Kong may be an example, then our increase in g is expansionary abroad.

4. Empirical results on money illusion and wage rigidity

To test for the existence of money illusion or wage rigidity we begin by specifying a labor-supply equation making the level of the nominal wage dependent on the expected price level and a measure of labor demand. A time trend is added to account for productivity growth and trends in the variables. An estimating form of this static model would be

$$\ln W_t = \alpha_0 + \alpha_1 \ln P_t^e + \alpha_2 \ln D_t + \alpha_3 t + \varepsilon_t. \tag{34}$$

Here P^e represents the expected price level, D is a measure of labor demand, proxied below by real GNP, and the time trend is included to detrend W, P, and D.

If the coefficient α_1 were unity, money illusion would be absent and the real-wage cases of sections 2 and 3 with $\theta_p + \theta_{p^*} = 1$ are relevant. If in addition α_2 is insignificant, the real wage would be rigid in the relevant period and $g_N = 0$ in sections 2 and 3. If α_1 were less than unity, money illusion exists ($\theta_p + \theta_{p^*} < 1$), and the extreme case would have $\alpha_1 = 0$.

Estimation of (34) directly would assume that wages adjust within a quarter to changes on their determinants. The literature on wage equations shows clearly that this is not the case. We have estimated equations in the form of (34), and observed generally quite significant serial correlation in the residuals. These equations using instrumental variables for P^e and D, as described in detail below, and the Cochran–Orcutt adjustment for serial correlation, are shown in appendix B. The first-order serial correlation coefficients ρ are generally in the 0.7 to 0.9 range, and the U.K. shows evidence of higher-order correlation. This can be taken as evidence that there

is a lagged adjustment process moving wage rates, adjusting the average wage toward the static supply of labor schedule, whatever its slope. This friction could be due to the existence of long-term (more than one quarter) contracts, in nominal or real terms.

In a dynamic context we wish to test whether the adjustment process is in terms of real or nominal wages, and how sensitive it is to demand conditions. Thus the question is whether it is today's *real* wage that depends on past *real* wages and current labor-market conditions or today's *nominal* wage that depends on past *nominal* wages and current labor-market conditions. The former adjustment mechanism (which results for instance from indexed contracts) implies that our model is neutral to fiscal policy in the absence of terms-of-trade effects. The latter corresponds to the presence of 'money illusion'.

Let us reinterpret the static supply of labor function in eq. (34) as giving the target wage W^*,

$$\ln W_t^* = \ln P_t^e + \alpha_1 \ln D_t + \alpha_2 t + \varepsilon_t. \tag{35}$$

We consider only models of the partial adjustment type. Nominal-wage stickiness is given by

$$\ln (W_t/W_{t-1}) = \lambda(\ln W_t^*/W_{t-1}). \tag{36}$$

Real-wage stickiness is given by

$$\ln (W_t/P_t^e) - \ln (W_{t-1}/P_{t-1}) = \mu \cdot [\ln (W_t^*/P_t^e) - \ln (W_{t-1}/P_{t-1})]. \tag{37}$$

These two equations lead to two different short-run supply of labor schedules. Using (35) and (36) we obtain for the nominal case,

$$\ln (W_t/P_t^e) = (\lambda - 1) \ln (P_t^e/W_{t-1}) + \lambda\alpha_1 \ln D_t + \lambda\alpha_2 t + \lambda\varepsilon_t. \tag{38}$$

Using (35) and (37) we obtain for the real-wage case,

$$\ln (W_t/P_t^e) = (1 - \mu) \ln (W_{t-1}/P_{t-1}) + \mu\alpha_1 \ln D_t + \mu\alpha_2 t + \mu\varepsilon_t. \tag{39}$$

These two models are non-nested. We can embed both hypotheses in a more 'general' adjustment mechanism which combines (36) and (37) in the following manner:

$$\ln (W_t/W_{t-1}) = \gamma_1 \ln (W_t^*/W_{t-1}) + \gamma_2 \ln (P_t^e/P_{t-1}). \tag{40}$$

Here if $\gamma_2=0$, we have eq. (36) representing nominal-wage adjustment; if $\gamma_2=1-\gamma_1$ we have eq. (37) instead. Substituting (36) for W^* into (40) we obtain the estimating equation

$$\ln(W_t/P_t^e)=(\gamma_1+\gamma_2-1)\ln(P_t^e/W_{t-1})+\gamma_2\ln(W_{t-1}/P_{t-1}) +\gamma_1\alpha_1\ln D_t+\gamma_1\alpha_2 t+\gamma_1\varepsilon_t. \tag{41}$$

This is the common alternative hypothesis against which we test (38) and (39). We can compare the three equations directly. If $\gamma_2=0$, γ_1 in (41) is equal to λ in (38); if $\gamma_2=1-\gamma_1$, then γ_2 is also equal to $(1-\mu)$ in eq. (39).

We reject the hypothesis that it is the real wage that adjusts according to eq. (37) if the coefficient on $\ln(P_t^e/W_{t-1})$ is significantly different from zero. On the other hand we reject eq. (36) if the estimate of γ_2 in (41) is significantly different from zero. Of course the models are indistinguishable when the adjustment is instantaneous, i.e., $\gamma_1=1$, $\gamma_2=0$.

The estimating eq. (41) is derived from specification of an equation for the *level* of the nominal wage, (34) or (35), dependent on the *level* of demand, and a standard adjustment mechanism. This is a different procedure from that followed by Bruno and Sachs (1979),[6] Gordon (1977), and Spitaeller (1976). In particular, their specification assumes that the *level* of demand affects the *rate of change* of wages, while a simple differencing of eq. (41) would put the *change* in demand into the equation for the change in the wage rate. This difference must be kept in mind in interpreting our results below.

In estimating eq. (41) for five major OECD countries, we used price data from the OECD Main Economic Indicators and GNP data from the *International Financial Statistics* published by the IMF. The D_t variable is real GNP for all countries except Italy where it is real GDP. The dependent variable is hourly compensation, provided by the IMF.[7] The price variable is the Consumer Price Index. All variables were seasonally adjusted using the X-11 method.

We estimated all equations using instrumental variable estimates for P^e and GNP. For each country regressions were performed of the CPI and GNP on four lagged values of CPI and GNP plus the current and four lagged values of the money stock. Fitted values from these regressions were used in the wage equation for P^e and GNP. These are denoted as $\hat{P}$ and $\hat{GNP}$ in table 4 below. This procedure can be interpreted econometrically as

[6]Bruno and Sachs' specification involves a partial adjustment of the *rate of change* of wages to the equilibrium rate of change of wages which depends on GNP. This leads to an equation similar to (41). We are working on a paper that tests their specification directly against our 'real' and 'nominal' wage adjustment models.

[7]We also estimated the equations using hourly earnings and the hourly wage as dependent variables. The results are virtually identical to those using compensation data and are available upon request.

Table 4

Tests of real- vs. nominal wage adjustment using hourly compensation data: dependent variable $= \ln(W_t/\hat{P}_t)$.

Country	Time period	Explanatory variables					D.W.	R^2	R vs. N
		$\hat{P}/W_{t-1}$	W_{t-1}/P_{t-1}	$G\hat{N}P_t$	*Time*	*C*			
U.S.	61:2–78:4	−0.69 (0.15)	−0.06 (0.20)	0.07 (0.02)	0.0011 (0.0002)	−0.06 (0.20)	1.9	0.99	N
	71:1–78:4	−0.74 (0.20)	−0.19 (0.31)	0.07 (0.05)	0.001 (0.0003)	0.01 (0.24)	1.8	0.98	N
U.K.	61:2–78:3	−0.47 (0.24)	0.56 (0.21)	0.10 (0.06	−0.0007 (0.0006)	−0.34 (0.19)	1.3	0.99	R
	71:1–78:3	−0.50 (0.39)	0.55 (0.31)	0.26 (0.17)	−0.001 (0.001)	−0.85 (0.50)	1.3	0.95	R, N
Japan	61:2–78:4	0.77 (0.42)	1.49 (0.37)	0.14 (0.04)	0.0022 (0.0011)	−1.38 (0.39)	2.7	0.99	R
	71:1–78:4	1.04 (0.71)	1.67 (0.64)	0.0028 (0.18)	0.0040 (0.0024)	0.36 (2.10)	2.6	0.93	R
Italy	61:2–78:3	0.34 (0.36)	1.27 (0.33)	0.16 (0.08)	−0.001 (0.001)	−1.73 (0.83)	2.4	0.99	R
	71:1–78:3	0.43 (0.67)	1.34 (0.65)	−0.12 (0.25)	0.001 (0.002)	1.58 (2.88)	2.6	0.97	R
Germany	61:2–78:4	−0.53 (0.76)	0.35 (0.73)	0.13 (0.05)	0.0003 (0.001)	−0.71 (0.33)	2.2	0.99	N, R
	71:1–78:4	2.27 (1.58)	3.01 (1.49)	−0.05 (0.17)	0.0038 (0.0028)	0.49 (1.18)	2.7	0.98	R

eliminating the simultaneity bias running from the real wage to GNP and the CPI, or as imposition of rational expectations on the wage equation.

We estimated eq. (41) with quarterly observations for two periods, one running from 1961 to 1978, the other from 1971 to 1978. This was done because the latter period exhibits a higher rate of inflation and it is likely that workers are more sensitive to the price level when its increases are larger. Furthermore, the period 1971–78 saw a large increase in oil prices which should have led to a reduction in the equilibrium real wage, therefore making this an ideal period to test the rigidity of the real wage. Equations in Phillips curve form have been estimated for the period 1958–73 quarterly by Gordon, for the period 1957–72 semi-annually by Spitaeller, and for the period 1962–76 annually by Bruno and Sachs.

The estimates of eq. (41) are shown in table 4. In all cases the dependent variable is $W_t/\hat{P}_t$. There are two equations for each country, one for the full period 1961–78, and one for the shorter period 1971–78. The coefficients are presented with their standard errors in parentheses. In the last column of the table we give the result of the test of real- vs. nominal-wage adjustment. *R* means that the real-wage hypothesis is accepted and the nominal-wage hypothesis is rejected, and vice versa for *N*. The *R*, *N* entries signify that neither hypothesis can be rejected.

The first thing we notice in table 4 is that the coefficient of the demand variable *GNP* is significantly positive in all countries for the full period, but insignificant for 1971–78. This says that in each of these countries wage movements became less sensitive to demand variation in the 1970s than earlier; in terms of our theoretical model $g_N = 0$.

Turning to the real- vs. nominal-wage issue, we see that the U.S. is the only country where the nominal-wage adjustment model dominates. The coefficient of W_{t-1}/P_{t-1} is effectively zero for both periods, and the estimate of the λ adjustment coefficient in the money wage model is approximately 0.7. This result is consistent with the earlier findings of Bruno and Sachs (1979), Gordon (1977), and Spitaeller (1976). The U.K. regressions yield ambiguous results. The nominal-wage model is rejected over the full period, but neither hypothesis can be rejected in the 1971–78 period. On the presumption that the real-wage model is accepted, the estimate of the μ adjustment coefficient is approximately 0.45 over both periods. This fits the result of Bruno and Sachs, but not Spitaeller.

For Japan and Italy, the nominal-wage model is rejected for both periods. The W_{t-1}/P_{t-1} coefficient is insignificantly different from unity in all four regressions, suggesting a long adjustment process with μ close to zero. These results are roughly consistent with the literature.

For Germany, neither hypothesis can be rejected for the full period, but the nominal-wage model is rejected for 1971–78. As in Italy and Japan, the μ estimate is close to zero. These results are also roughly consistent with the

literature. Gordon and Spitaeller found money illusion in earlier data sets ending in 1972 and 1973, respectively, and Bruno and Sachs reject it on data through 1976.

In summary, it seems that sensitivity of wage movements to fluctuations in demand has been reduced sharply in the 1970s relative to the earlier period in all five countries. The U.S. is the only country in which the model of nominal-wage stickiness is supported; in the U.K., Japan, Italy and Germany it is the real wage that adjusts slowly. This is consistent with effective indexation in these countries as compared with the U.S.

In terms of the model in sections 2 and 3, only the U.S. seems to have enough money illusion to bring about an expansion in response to third country increases in demand. On the other hand, money illusion appears to be absent in the U.K., Germany, Italy, and Japan. This means that these countries may have to worry about the effect of expansionary fiscal policy in the other countries.

Appendix A

Consider a discriminating monopolist producing in the home country and selling in two countries. He faces the following problem:

$$\text{Max}\{p(q)\cdot q+p^*(q^*,u)q^*-W\cdot\eta(q+q^*)\},$$

where $p(q)$ and $p^*(q^*)$ are the inverse demand functions, η the employment function with $\eta'>0$, $\eta''>0$ and u a shift parameter such that for a higher u the foreigners are willing to pay more for each quantity q^*. $p^*_u>0$. We assume further $p^*_{uq^*}=0$. His first-order conditions are

$$p_q\cdot q+p=W\eta', \qquad p^*_{q^*}q^*+p^*=W\eta'.$$

Totally differentiating with a change in u gives us

$$(p_{qq}q+2p_q)\mathrm{d}q-W\eta''(\mathrm{d}q+\mathrm{d}q^*)=0,$$

$$(p^*_{q^*q^*}q^*+2p^*_{q^*})\mathrm{d}q^*-W\eta''(\mathrm{d}q+\mathrm{d}q^*)=-p^*_u\mathrm{d}u.$$

Assuming $p_{qq}=p_{q^*q^*}=0$, we obtain

$$\begin{bmatrix}2p_q-W\eta'' & -2p_q\\ -W\eta'' & 2p^*_{q^*}\end{bmatrix}\begin{matrix}(\mathrm{d}q+\mathrm{d}q^*)\\(\mathrm{d}q^*)\end{matrix}=\begin{bmatrix}0\\-p^*_u\mathrm{d}u\end{bmatrix},$$

which leads to

$$(\mathrm{d}q+\mathrm{d}q^*)/\mathrm{d}u>0, \qquad \mathrm{d}q^*/\mathrm{d}u>0.$$

This means that an increase in demand in any one country leads to an increase in demand for labor by the firm. We have written this as a demand-for-labor function that depends on both prices.

Appendix B

Table 5
Estimates of static wage equations; dependent variable = ln W_t.

Country	Time-period	Explanatory variables				ρ	$D.W.$	R^2
		$\hat{P}$	$G\hat{N}P$	T	C			
U.S.	61:2–78:4	0.90 (0.06)	0.06 (0.07)	0.005 (0.001)	0.62 (0.47)	0.76 (0.08)	2.1	0.99
	71:1–78:4	0.29 (0.16)	−0.13 (0.09)	0.18 (0.003)	1.17 (0.55)	0.81 (0.11)	1.9	0.99
U.K.	61:2–78:3	0.59 (0.12)	0.29 (0.16)	0.019 (0.004)	−0.45 (0.42)	0.95 (0.04)	1.4	0.99
	71:1–78:3	0.50 (0.23)	0.21 (0.29)	0.024 (0.010)	−0.52 (0.77	0.91 (0.08)	1.1	0.99
Japan	61:2–78:4	0.81 (0.25)	0.17 (0.18)	0.018 (0.007)	−1.38 (1.77)	0.91 (0.05)	2.6	0.99
	71:1–78:4	1.99 (0.14)	1.06 (0.18)	−0.24 (0.005)	−9.37 (1.95)	0.14 (0.18)	2.3	0.99
Italy	61:2–78:3	0.80 (0.17)	−0.002 (0.22)	0.020 (0.006)	0.53 (2.38)	0.94 (0.04)	2.3	0.99
	71:1–78:3	0.80 (0.31)	−0.11 (0.32)	0.16 (0.014)	2.09 (3.65)	0.88 (0.09)	2.6	0.99
Germany	61:2–78:4	1.40 (0.22)	0.37 (0.12)	0.006 (0.003)	−1.50 (0.68)	0.83 (0.07)	2.3	0.99
	71:1–78:4	2.10 (0.33)	0.17 (0.27)	−0.003 (0.005)	0.54 (1.60)	0.50 (0.16)	2.1	0.99

References

Argy, Victor and Joanne Salop, 1979, Price and output effects of monetary and fiscal expansion in a two-country world under flexible exchange rates, IMF mimeo.

Branson, William H., 1979, Macroeconomic theory and policy, 2nd ed. (Harper and Row, New York).

Branson, William H. and Alvin K. Klevorick, 1969, Money illusion and the aggregate consumption function, American Economic Review, Dec.

Bruno, Michael and Jeffrey Sachs, 1979, Supply vs. demand approaches to the problem of stagflation, Mimco.

Gordon, Robert J., 1977, World inflation and monetary accommodation in eight countries, Brookings Papers on Economic Activity, no. 2.

Muellbauer, John and Richard Portes, 1979, Macroeconomics when markets do not clear, in: William Branson, Macroeconomic theory and policy, 2nd ed. (Harper and Row, New York).

Sachs, Jeffrey, 1978, Wage indexation, flexible exchange rates and macroeconomic policy, Quarterly Journal of Economics, forthcoming.

Spitaeller, Erich, 1976, Semi-annual wage equations for the manufacturing sectors in six major industrial countries: 1957(1)–1972(2), Weltwirtschaftliches Archiv 112, no. 2.

European Economic Review 13 (1980). North-Holland

COMMENTS

'International Adjustment with Wage Rigidity' by Branson and Rotemberg

Jeffrey SACHS

National Bureau of Economic Research, Cambridge, MA 02139, USA

In '*International Adjustment with Wage Rigidity*', William Branson and Julio Rotemberg turn our attention to the recent trans-oceanic debate over macro-economic policy. Since 1974, when the industrialized countries entered the 'Great Recession', the U.S. has been urging expansionary monetary and fiscal policy in Japan and the European countries. Most of these countries have been adamant in rejecting the U.S. advice. The different countries' choices reflect more than different tastes for inflation and unemployment in the short run. Branson and Rotemberg share the view of Giersch (1979) and Bruno and Sachs (1979) that the U.S. has chosen expansionary policy because it works in the U.S., while the same policy is likely to cause inflation and little else in the other economies.[1]

As in the earlier papers, Branson and Rotemberg point to the labor market as the source of this difference. In countries with nominal-wage rigidity, expansionary policy can reduce the real wage and thus increase aggregate supply; in rigid real-wage countries, *ipso facto*, it cannot. Their empirical work is devoted to finding which countries are in which category. In all their regressions, the U.S. comes through as a rigid nominal-wage economy.

The spirit of their approach is just right. Their focus on excessive real wages after 1973 is appropriate. I concur in the view that industrialized economies behave differently, and that economists must continue to sort out those differences. However, I suspect that Branson and Rotemberg's empirical work needs more sorting out itself. While they ask the broad questions correctly, they do not specify the narrow empirical questions with

[1]In Bruno and Sachs (1979, p. 45) we wrote: 'We suspect that much of the difference in the macro-economic policy recommendations of American and European economists stems from the difference in the behavior of their respective economies reflected in $\hat{\alpha}_2$ [a parameter of nominal-wage rigidity]. In the United States monetary policy *is* effective, while in most European economies, monetary policy probably operates chiefly on prices and not on output.'

sufficient care. And when they try to answer the empirical questions, their results are diminished by econometric difficulties.

The theoretical model in the paper traces out the role of real wages in aggregate supply, along familiar lines. The empirical work seeks to answer two key questions about wage setting. The first is whether real-wage growth can vary fast enough to keep the wage approximately equal to the marginal product of labor at full employment. The second is whether expansionary policy, by raising the price level, can reduce the real wage and expand aggregate output.

On the first question, the authors do not attempt to compare wage movements directly with marginal labor productivity. Rather, they test whether the adjustment of real wages to a target level is rapid, and whether the target itself is a function of aggregate demand. They conclude that real-wage adjustment in Europe and Japan is sluggish, and that the target does *not* depend on aggregate output. In sum, they find that real-wage growth since 1971 is fairly constant. Their findings, I think, are hindered by problems in the empirical work, to which I return. A glance at the data should be enough to dissuade us from their simple rigid real-wage model. In table 1, I show the growth rates of real hourly compensation and real hourly earnings for the seven large industrial countries. The striking aspect of the table for Europe and Japan is not the fixity of real-wage growth, but the opposite. A real-wage explosion hits Europe and Japan during 1969–73, while during the recent recession, real-wage growth falls sharply. In every country outside of North America, high unemployment severely curtails the rise in real hourly compensation after 1975.

Table 1

Annual growth rates of real hourly compensation and real hourly earnings in manufacturing; 1962–78.[a]

	Real hourly compensation				Real hourly earnings			
Country	1962–69	1969–73	1973–75	1975–1977	1962–69	1969–73	1973–75	1975–77
Canada	2.9	3.4	3.8	4.3	2.6	3.6	3.4	4.2
France	4.2	5.9	6.4	4.9	4.1	5.4	4.4	4.8
Germany	5.1	7.9	7.2	4.1	4.8	5.3	3.2	2.8
Italy	6.2	11.7	7.4	2.1	4.4	11.2	5.1	6.4
Japan	7.6	9.5	5.2	0.0	8.0	10.1	4.3	−0.3
U.K.	2.9	4.3	6.0	−1.8	3.1	5.0	2.8	−3.1
U.S.	1.9	1.5	0.8	2.2	1.4	1.4	−1.2	2.1

[a]*Source:* Nominal hourly compensation and hourly earnings from U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, 'Estimated Hourly Compensation of Production Workers in Manufacturing, Ten Countries, 1960, 1965–1978', and other publications of the Office of Productivity and Technology. The consumer price index is from the IFS.

The deceleration in real wages does not vitiate the concern over excessive wage levels, but only the simple test of wage rigidity in the paper. In fact, real-wage growth did not drop fast enough after 1973 to match the slower growth of the full-employment marginal product of labor. Almost all of the industrialized countries faced a severe drop in total productivity growth and an adverse terms-of-trade shift after 1973.[2] These disturbances have required a slowdown in real hourly compensation growth of at least one to two percentage points a year since 1973. In fact, the slowdown in compensation only came with a long lag. Consequently the cyclically adjusted share of labor compensation rose almost everywhere following the oil shock, and profits were squeezed, with the implications for aggregate supply and employment that Branson and Rotemberg describe. In table 2, I show the share of labor compensation. In France, Germany, Japan and the United Kingdom, labor's share rises markedly during 1973–76.

Table 2
Share of labor compensation in manufacturing value-added, cyclically adjusted.[a]

	1962–64	1965–69	1970–73	1974	1975	1976	1977	1978
Canada	0.65	0.68	0.69	0.68	0.66	0.69	n.a.	n.a.
France	0.53	0.52	0.51	0.54	0.53	0.53	0.53	0.52
Germany	0.64	0.62	0.66	0.71	0.72	0.73	0.74	n.a.
Italy	0.64	0.65	0.73	0.73	0.73	0.70	0.68	0.65
Japan	0.52	0.50	0.54	0.58	0.52	0.55	0.58	0.60
U.K.	0.69	0.72	0.75	0.86	0.82	0.80	0.75	n.a.
U.S.	0.77	0.78	0.80	0.81	0.81	0.80	0.80	0.81

[a]*Source:* The share of labor compensation is calculated as the ratio of employee compensation to gross domestic product originating in manufacturing, measured at factor cost. An adjustment is made by multiplying the share by the ratio of output per manhour to potential output per manhour, calculated by Artus (1977), and updated by the IMF. The underlying compensation and GDP data are from the U.S. Bureau of Labor Statistics, Office of Productivity and Technology.

Branson and Rotemberg correctly ask what the role of policy might be in the face of excessive real wages, the second issue raised above. Their model suggests that nominal-wage stickiness gives scope for policy. Again, their empirical specification does not face the question at hand. In their 'static' model (section 4), they test the long-run neutrality of the real wage with respect to the price level; in the dynamic case, it is the neutrality of the real wage with respect to the inflation rate. In both cases, nominal-wage stickiness is made synonymous with a long-run Phillips curve trade-off. But surely the issue of nominal-wage rigidity is a matter of short-run stickiness in

[2]Artus (1975) has estimated a decline in total factor productivity of 2.6% for the large industrial economies. For alternative estimates of the productivity decline, and measures of the terms-of-trade shift, see Sachs (1979).

nominal-wage change, perhaps due to long-term contracts, rather than a proposition about the long-term determination of the real-wage level. Because the Branson–Rotemberg tests of wage sluggishness do not allow for short-run rigidities and long-run inflation neutrality, their conclusions should not be directly compared to the results in Bruno and Sachs (1979).[3]

Why do Branson and Rotemberg find so little effect of demand on real wages in the 1971–78 period, even though high unemployment led to a clear real-wage deceleration after 1975? The answer is not clear, though is probably related to the econometric procedures. First, the authors use GNP (with a time trend) to proxy for labor market activity. This is unwarranted. During a period of stable productivity growth, Okun's law allows us to translate unemployment to GNP, but during a period of declining productivity growth, the GNP variable will indicate looser labor markets than indeed exist.

More importantly, the estimation is subject to biases. How do we know that the regression of wages on output identifies a labor-supply schedule, with a positive coefficient on output, rather than an output-supply schedule, with a negative coefficient? Presumably, the answer is the instrumental variables procedure. But the choice of instruments is suspect. In the first stage of estimation, quarterly GNP data is fit with *thirteen* instruments, including four lags of GNP. The lagged values of GNP are almost surely not valid instruments (serial correlation in the wage equation bars their use), and the over-fitting of the first stage probably contributes to inconsistency. The concern over simultaneous equation bias is not a cavil, since so much of the authors' theory relies on the negative link of wages and output supply. Also, the equation is estimated with a lagged dependent variable, but with no attention to serial correlation. Our concern here is justified. The authors' theory suggests that the coefficient on W_{t-1}/P_{t-1} should lie between zero and one; this is in fact so for only three of the ten regressions. The suspicion of misspecification is heightened by Durbin–Watson statistics generally far from 2.0, and the unexplained instability of the regression coefficients across sub-periods.

I believe that econometric equations will take us only part way in elucidating the differences in wage determination among countries. We should spend more time trying to link observable institutions with wage outcomes. For instance, nominal-wage sluggishness in the U.S. is consistent with the preponderance of long-term overlapping contracts, as shown in the theoretical work of Fisher (1977) and Taylor (1979). The absence of discernible nominal-wage stickiness in Germany, on the other hand, probably

[3]In the empirical estimates in Bruno and Sachs (1979), the wage equation is specified so that the real economy is neutral with respect to the steady-state rate of inflation. In Sachs (1979), statistical tests fail to reject the hypothesis of long-run neutrality in the wage equation for the seven large OECD economies.

results from short-term contracts, negotiated at branch levels, in the context of the 'Concerted Action' policy. Similarly, institutional detail can help us to explain the sharp deceleration in real wages after 1975 in countries such as the U.K., where income policies contributed, along with high unemployment, to the real-wage deceleration.

Branson and Rotemberg have shown us why the issue of wage determination is important. I look forward to further empirical application of their model.

References

Artus, Jacques, 1977, Measures of potential output in manufacturing for eight industrial countries, 1955–1978, IMF Staff Papers XXIV, March, 1–35.

Bruno, Michael and Jeffrey Sachs, 1979, Supply versus demand approaches to the problem of stagflation (presented at the 1979 Kiel Conference on Macroeconomic Performance in the 1970's), Weltwirtschaftliches Archiv, forthcoming.

Fischer, Stanley, 1977, Long-term contracts, rational expectations, and the optimal money supply rule, Journal of Political Economy 85, no. 1.

Giersch, Herbert, 1979, Aspects of growth, structural change, and employment — A Schumpeterian perspective (presented at the 1979 Kiel Conference on Macroeconomic Policies for Growth and Stability), Weltwirtschaftliches Archiv, forthcoming.

Sachs, Jeffrey, 1979, Wages, profits, and macroeconomic adjustment in the industrialized economies in the 1970's, Brookings Papers on Economic Activity, forthcoming.

Taylor, John, 1979, Aggregate demand and staggered contracts (Columbia University, New York) in process.

COMMENTS

'International Adjustment with Wage Rigidity' by Branson and Rotemberg

Richard PORTES

Centre d'Economie Quantitative et Comparative, Paris, France
Birkbeck College, University of London, UK

The paper by Branson and Rotemberg is an excellent example of the use of an apparently simple model to throw theoretical light on a complex and controversial policy question, as well as to give guidance for empirical specification. American policy-makers have resented the reluctance of Europe and Japan to adopt expansionary policies since 1974, in part because they have seen no basis for such caution in the face of substantial and growing unemployment throughout the OECD area. Europe and Japan, on the other hand, have resented what they see as American unwillingness to comprehend the obvious, namely that demand expansion would for them raise prices rather than employment and output. Branson and Rotemberg, starting from a suggestion by Giersch, have produced a model which makes sense of these divergent positions, albeit under some fairly strong simplifying assumptions.

The theoretical argument is for the most part quite neat and clear, and it contains a particularly appealing feature, the willingness to apply explicitly the 'minimum condition' from the quantity-rationing models to the labor market. With just a single market in 'disequilibrium', one does get only some of the characteristic responses of this class of models, but they come at a low cost, without much of their complexity. Nevertheless, I think it would be feasible to incorporate some repercussions from the goods market onto the labor market, and I shall return to this below.

In the paper, the labor market is taken as an aggregate (contrast Muellbauer and Winter), and only the case of excess supply is considered as an alternative to equilibrium. The goods market in each country clears through trade as in Dixit's (1978) model of a single small open economy, but here this market clearing comes through price adjustment, whereas in Dixit the domestic wage and price levels are rigid. Thus although he too has 'classical' unemployment, his labor market is unaffected by fiscal policy, which influences only the balance of trade. In both, excess supply in the labor market has only one cause: whether because of rigidity of the money

or of the real wage, the real wage in equilibrium is too high, and the marginal productivity condition determines the demand for labor at a level below supply, with no 'spillover' from the goods market.

Here, however, in the two-good case, the marginal productivity condition which determines unemployment involves a different price index from that faced (or perceived — see below) by workers. Thus a wage which is rigid for workers is not rigid for employers. Workers are assumed to put more weight on foreign prices than employers do. While neither of the two economies is 'small', the stress is on their 'openness', the precise extent of which indeed determines the model's properties. The fundamental equation is (22), which very neatly expresses the effects of the differences between the price indices and allows an exceedingly simple incorporation of the 'disequilibrium' features of the model through eqs. (20^N) and (20^R).

I found one confusing point in the specification, in regard to the workers' price index. Initially, in the discussion of the demand for output and eq. (15), this price index is treated as a measured CPI, i.e., as a weighted average of the domestic and foreign prices. In the subsequent discussion of the supply of labor, however, following eq. (20^N), money illusion is represented by reference to the properties of a *perceived* CPI. Moreover, one is tempted to confuse nominal-wage rigidity with money illusion, although it is only their *effects* on the role of this price index which may be represented similarly.

The properties of the model are summarized in table 3, which is somewhat less complicated than it appears. Case 1 (Giersch) is a special case of case 4, and as the text points out, relatively little money-wage rigidity will give an unambiguously positive response of domestic demand expansion on foreign output, so we need not worry much about the special case. The three remaining cases all suppose rigid real wages and differ *only* in the relative sensitivity of workers and firms to domestic and foreign price changes.

In fact, it seems to me that the model suggests testing directly not merely wage rigidity, but perhaps more importantly, these differences in responses to domestic and foreign price changes. This turns out to be the key to the behavior of the model, and it is not immediately obvious for countries like Japan and the U.K. (say) whether the Argy–Salop, the 'classical', or the 'Hong Kong' case would be empirically appropriate.

Finally, it might not be overly complex (especially if one were to focus on just a couple of the cases in table 3) to extend the model to allow the possibility that the goods market might not clear, at least in one of the two countries. We would then have 'Keynesian' as well as 'classical' unemployment [see Malinvaud (1977)]. An economy with the former would normally have a trade surplus, though not enough to absorb all the excess supply of goods. An economy with the latter would normally have a trade deficit, though not so great as to satisfy all the excess demand for goods.

Evidently in this sense the non-clearing goods market in a large open economy is more plausible for the Keynesian than for the classical case.

If the domestic economy is in Keynesian unemployment, expansionary fiscal policy raises wages, prices, employment and output, while reducing net exports. Then if the foreign economy were also in Keynesian unemployment, it would experience expansion all around as well. But if unemployment abroad were classical in character, though its price level and net exports would rise, the effect on output (and hence on employment and goods market conditions) would differ according to the stickiness of money or real wages. It would be very interesting to see how this argument might be modified by the assumption that households and firms face (or perceive) different price indices.

References

Dixit, A., 1978, The balance of trade in a model of temporary equilibrium with rationing, Review of Economic Studies, Oct.

Malinvaud, E., 1977, The theory of unemployment reconsidered (Blackwell, Oxford).