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DEVALUATION: KEYNESIAN TRADE MODELS AND THE MONETARY APPROACH

The Role of Nominal and Real Wage Rigidity*

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Labor market assumptions provide the crucial ingredients by which we distinguish between a Keynesian and a classical monetary trade model (monetary approach). Domestic and foreign goods are perfect substitutes and the law of one price holds. This minimal model should be appreciated as an income-cum-price specie flow mechanism although the long-run equilibrating process is not discussed in any detail. The paper stresses the interplay between demand pull and cost-push factors as a result of exchange rate changes.

1. Introduction

During the second half of the 70s open economy macroeconomics and general equilibrium theory at times seem to have exactly exchanged their positions on significant points of interest. Applied to the monetary theory of international trade, both approaches ignored the reality of international adjustment problems associated with trade imbalance, inflation, and unemployment. The orthodox monetary approach talked about 'inflation' in a full-employment framework while general equilibrium theorists increasingly deserting standard Walrasian equilibrium analysis, talked about unemployment equilibria under quantity rationing in a fixed price setting. This article links several important components of international trade and payments theory: a direct effect of money (wealth) on the demand for goods at unchanged income and prices, the relation between income and spending,

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the determination of aggregate output and employment by aggregate demand, and the determination of the price level of an open economy in international goods market simultaneously influenced by wage–price processes originating in individual national economies.

We present our synthesis model by adopting a one-good version of the well-known Dornbusch (1973) two-country fixed-exchange rate model. We allow for a varying output supply based on a variable — possibly different — degree of national nominal wage rigidity. In this minimal model of trade and payments under sticky wages, devaluation works through cost related output effects as well as through the standard wealth related absorption effects popularized by the orthodox monetary approach. The spirit of the model is close to recent work by Noman and Jones (1979), Dornbusch (1980, ch. 8), Dixit and Norman (1980, ch. 8), Branson and Rotemberg (1980) and Schmid (1980a). An extension of the present model to a possibly useful analysis of oil shocks under wage rigidity has been presented in Schmid (1980b, c). Katseli-Papaefstratiou (1980) has studied an asymmetric oil shock in the Noman–Jones model, a symmetric oil shock has been analyzed in Dornbusch (1980, ch. 5).

2. The model

2.1. *Building blocks*[1]

We begin with a specification of the supply side. Both countries produce different amounts y, y^* of the same unique good which exists in our world economy. Applying country specific ordinary neoclassical linear homogeneous technologies to given supplies of factor resources in each country we can describe national physical production,

$$y=F(l;\bar{K}), \qquad y^*=F^*(l^*;\bar{K}^*). \tag{1}$$

We explain short-run supply for given national capital stocks in each country assuming a marginal cost–pricing rule in the productive sector. This permits a simple statement of price–output response.[2] Let P, P^* be price levels for the same unique good in national currency units, W, W^* the nominal wage rates, and R, R^* the rental rates, each in national currency units. Then with a linear homogeneous technology, national price covers national unit-factor costs,

$$P=a_lW+a_kR, \qquad a_l\equiv l/y, \quad a_k\equiv K/y. \tag{2}$$

[1]In the exposition of the model we freely draw upon the author's article in Schmid (1980a).
[2]To save space we explain price–output response only for the domestic country.

Under a linear homogeneous technology, unit labor and unit capital requirements a_i $(i=l,k)$ are known to be functions of the relative factor–price ratio (W/R). Making use of the condition for cost minimization we can differentiate (2) to get

$$\hat{P}=\theta_l\hat{W}+\theta_k\hat{R}.^3 \tag{3}$$

In (3) we find factor shares $\theta_l\equiv(W/P)a_l$, $\theta_k\equiv(R/P)a_k$ which sum to unity.

From differentiating the marginal cost condition assumed to hold for labor — the only variable factor of production — we obtain a well-known equation between price level, output, nominal wage rate, and the capital stock

$$\hat{y}=-(\theta_l/\theta_k)\sigma[\hat{W}-\hat{P}]+\hat{K}, \tag{4}$$

where σ is the elasticity of factor substitution.

We refer to the relation between price level and output derived from (4) as the short-run aggregate supply function,[4]

$$y=y(P;\,W,K). \tag{5}$$

Note that this function is upward sloping and conditional upon the fixed capital stock and the level of nominal wage rate. Eq. (5) should not be read as simply saying P causes y. Rather it can be considered as a price-setting equation under a marginal cost–price rule. This becomes apparent when we note from (3) that $\hat{P}$ is not an independent variable in (4) if we have an isolated change in W. Note further the zero-homogeneity in W and P of the aggregate supply function (5). That means if price level and nominal wage rate have changed by the same percentage, output remains constant because the rental rate implicitly has changed by the same percentage.

Our discussion of the supply side can be summarized by a useful definition of the elasticity of output with respect to real product wage,

$$\frac{\mathrm{d}y}{\mathrm{d}(W/P)}\,\frac{(W/P)}{y}=-\varepsilon<0 \quad \text{with} \quad \varepsilon\equiv(\theta_l/\theta_k)\sigma>0.$$

[3]A $\hat{}$ over a variable stands for percentage change: $\hat{x}=\mathrm{d}x/x$.

[4]The reader may find a geometric exposition of this standard supply side in Branson and Rotemberg (1980). The algebraic presentation is simply a one-sector variant of the specific factors model of production developed by R. Jones. Corresponding to the short-run supply function, we have a derived demand for labor equation $\hat{l}=\gamma(\hat{W}-\hat{P})$ with $\gamma\equiv-(\sigma/\theta_k)$. See Caves and Jones (1977, pp. 430–434).

Using this definition in (4) we find a simple formulation for price-output response,

$$\hat{y}=\varepsilon(\hat{P}-\hat{W}). \tag{6}$$

Similarly we can derive a supply function for the foreign country,

$$\hat{y}^*=\varepsilon^*(\hat{P}^*-\hat{W}^*). \tag{7}$$

Next we turn to a description of the consumption sector. We postulate real expenditures (=real absorption) expressed in terms of final goods as a function of real income and real cash balances,

$$c=c(y,m), \qquad c_y, c_m>0, \tag{8}$$

with

$$m=M/P \quad \text{and} \quad c=C/P,$$

and we make use of a differentiated form of (8),

$$\hat{c}=\alpha\hat{y}+\rho[\hat{M}-\hat{P}] \quad \text{with} \quad \alpha+\rho=1, \quad 0<\alpha,\rho<1. \tag{9}$$

In (9) we have imposed on $c(\cdot)$ the property of linear homogeneity in y and m. The function is sufficiently general[5] to allow for demand effects from real income changes as well as real cash balances. The following statements may explain the expenditure behavior in more detail:

(1) A uniform increase of the final goods price level and nominal cash balances, holding real income constant, raises nominal expenditures by the same percentage rate. Real absorption, however, does not change.
(2) A uniform increase of the price level and nominal income does not affect real income but decreases real balances. Therefore real expenditures fall due to a real balance effect expressed by ρ.
(3) A uniform increase of real income and nominal cash balances, holding the price level constant, raises nominal expenditures by the same percentage because real expenditures have risen.

[5]Routinely, many authors of the monetary approach suppress the spending decision and concentrate on a specification of either money demand and money supply function only [see Laidler (1975, chs. 7, 9)] or a hoarding function [see Dornbusch (1973), and also Brunner (1976)]. For reasons of exposition we prefer to emphasize an expenditure function where expenditures are equal to income minus an adjustment for excess balances. Desired cash balances are related to income via a constant income velocity, $v=1/k$. Dornbusch and Mussa (1975) and Helpman (1979) have derived conditions for expenditure behavior with constant consumption and income velocities of money from an intertemporal framework.

Similarly for the foreign country we have a real expenditure function

$$\hat{c}^* = \alpha^* \hat{y}^* + \rho^* [\hat{M}^* + \hat{E} - \hat{P}], \qquad \alpha^* + \rho^* = 1, \quad 0 < \alpha^*, \rho^* < 1. \tag{10}$$

We complete the exposition of the model by specifying goods market clearing at a uniform world market price for final goods. In goods market equilibrium, national excess demands must be cleared in the world market,

$$(c - y) + (c^* - y^*) = 0. \tag{11}$$

It is in line with the literature to assume, furthermore, that the 'law of one price' holds in the world market for a homogeneous good. This gives us

$$P = EP^*. \tag{12}$$

Here E denotes the price of a foreign currency unit in terms of domestic currency units. Using (11) and (12) allows us to explain the fundamental equivalence between the trade balance and hoarding, and to present an alternative specification of goods market equilibrium.

The alternate way to express goods market equilibrium is to say that world spending for final goods must equal world income,[6]

$$C - Y + E(C^* - Y^*) = 0. \tag{13}$$

The budget constraint determines hoarding, H and H^*, as the difference between income and spending, hence we find from (13)

$$H + EH^* = 0. \tag{14}$$

Notice that in a one-good world, trade in physical terms always is a 'one-way street'. A country is exclusively either an exporter or an importer of final goods. Assuming the first possibility we define a surplus of the domestic trade balance,

$$B = -P(c - y) > 0. \tag{15}$$

According to the budget constraint over- or underspending is equivalent to dishoarding or hoarding, respectively. Hence we can state

$$B = H. \tag{16}$$

[6]Nominal terms in (13) are obtained by multiplying (11) with the domestic price level, i.e., $Y = Py$, $Y^* = P^* y^*$, $C = Pc$, $C^* = P^* c^*$.

The simple message the monetary approach has retained from the absorption approach is: A country having a trade deficit lives beyond its means because it overspends, and can only do so by running down its cash balances. Therefore trade in a one-good world actually is trade between goods and money (as a store of value).

Eqs. (14) and (16) show clearly that goods market equilibrium is possible with or without trade balance equilibrium. If we further assume that the nominal wage is rigid above the market clearing level, it also follows that goods market equilibrium is possible without labor market clearing. Following Corden (1978) and others we refer to a model as 'Keynesian' if employment and real income are determined by the short side of the labor market, i.e., if we have rationing of labor supply in both countries.[7]

2.2. *The model and its geometry*

After a few substitutions the model basically consists of two equations in the two variables P, B. Eq. (17) represents goods market equilibrium, and (18) specifies the trade balance,

$$[c(y, M/P)-y]+[c^*(y^*, EM^*/P)-y^*]=0, \tag{17}$$

$$B=-P[c(y, M/P)-y], \tag{18}$$

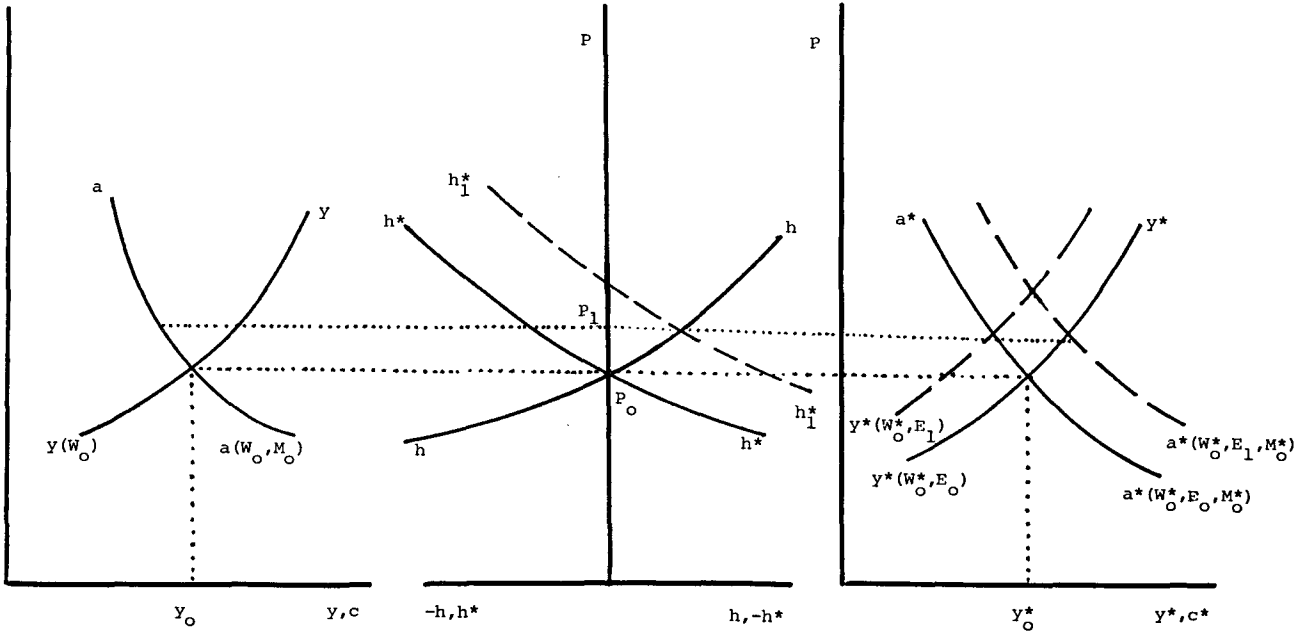
with

$$y=y(P; W, K) \quad \text{and} \quad y^*=Y^*(P/E; W^*, K^*).$$

To facilitate understanding of the short-run adjustment mechanism in a world with sticky wages, we first discuss a geometric exposition of our model.[8] In fig. 1 the left-hand diagram shows domestic short-run aggregate supply as an upward sloping yy curve. It should be recalled that this curve has domestic nominal wage level, W_0, as a parameter. Further we define a downward sloping aa curve for real domestic absorption as a negative function of the domestic price level. The aa curve depicts the following

[7]Note the asymmetry w.r.t. price stickiness. The world goods market clears instantaneously via a flexible final goods price without rationing but national labor markets do not clear at sticky nominal wage rates. Modern equilibrium theory concerned with general quantity rationing reserves the label 'Keynesian' for a regime where consumers and producers are rationed simultaneously. Dixit (1978) and Dixit and Norman (1980, ch. 8.3) discuss trade with Keynesian unemployment when all prices are sticky.

[8]The reader should compare the geometry of fig. 1 with the early exposition of the Humean equilibrating mechanism in Samuelson (1971, p. 164). The present model assumes nominal wage rigidity while Samuelson has endogenous labor supply, labor market clearing and a two-sector model with specific factors. The geometry of fig. 1 explicitly takes into account 'the direct effect of money supply on demand-at-unchanged prices' [see Samuelson (1980)].


a
y
$y(W_o)$
$a(W_o,M_o)$
y_o
y,c
P
h_1^*
h*
h
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-h,h*
h,-h*
P
a*
y*
$y^*(W_o^*,E_1)$
$y^*(W_o^*,E_o)$
$a^*(W_o^*,E_1,M_o^*)$
$a^*(W_o^*,E_o,M_o^*)$
y_o^*
y*,c*

Fig. 1

function for domestic real absorption:

$$c=c(y(P, W_0), M_0/P). \tag{19}$$

Note that domestic nominal wage and money supply are parameters of the *aa* curve. More important we find from (19) the following ambiguity with respect to the price elasticity of absorption:

$$\hat{c}/\hat{P}\big|_{aa}=[\alpha\varepsilon-\rho]\gtreqless 0. \tag{20}$$

Given the price–output response elasticity, ε, a price level increase tends to increase absorption via increased real income and discourage absorption via a negative real balance effect. According to (20) the larger ρ is the more negative the net effect of a price level increase may become.[9] However, for small values of ρ, the real income effect dominates the real balance effect and real absorption increases with a rising price level. The right-hand diagram in fig. 1 similarly portrays curves for the foreign country. Besides foreign money supply and wage level, the exchange rate is also a parameter of *both* curves. The a^*a^* curve depicts the foreign (real) absorption function,

$$c^*=c^*(y^*(P/E, W^*), (E/P)M^*). \tag{21}$$

Differentiating (21) we find

$$\hat{c}^*/\hat{P}\big|_{a^*a^*}=[\alpha^*\varepsilon^*-\rho^*]\gtrless 0, \tag{22}$$

and

$$\hat{c}^*/\hat{E}\big|_{a^*a^*}=\hat{c}^*/\hat{P}\big|_{a^*a^*}. \tag{23}$$

Eq. (22) is analogous to what we had for the domestic economy. Eq. (23), however, is more interesting, because it shows that, on direct impact (i.e., holding constant the domestic price level), a devaluation of the domestic currency has an ambiguous effect on foreign real absorption. This property is also related to the slope of the foreign a^*a^* curve. An important tenet of the monetary approach always has been the 'windfall gain' which holders of foreign currency enjoy in terms of purchasing power when the domestic currency is devalued. Obviously, however, if real output is held constant, the orthodox monetary approach neglects a negative real income effect in the

[9]Note that $\varepsilon=0$ suppresses the real income effect and emphasizes the real balance effect which figures prominently in most early expositions of the monetary approach. If $\rho=0$, the *aa* and *yy* curves coincide. Furthermore, the ambiguity of absorption disappears if we focus on hoarding or 'net absorption', i.e., excess goods demand in a one-good model. The elasticity of excess demand is $\hat{c}/\hat{P}\big|_{yy}-\hat{c}/\hat{P}\big|_{aa}=\rho(1+\varepsilon)>0$.

foreign country. This effect is present if we account for competitiveness in a world market where producers sell goods manufactured under cost conditions dominated by fixed national wage levels.

A devaluation of the domestic currency lowers foreign currency prices of domestic goods. In an effort to stay competitive, foreign producers must lower the price of their goods exactly by a margin given by the exchange rate change. Downward wage stickiness in the foreign country prevents any possible adjustment in a neoclassical productive sector other than by a reduction in foreign output and employment together with a falling rental rate for the fixed foreign capital stock. The resulting real income loss in the foreign country cuts down foreign real absorption and condition (22) rules whether the net effect of a devaluation of the domestic currency upon foreign real absorption is positive or negative. The devaluation induced competitiveness price losses of the foreign productive sector show up as a leftward shift of the foreign supply curve y^*y^*. According to (23) a devaluation of the domestic currency shifts the a^*a^* curve to the right if and only if that line is downward sloping, i.e., if ρ^* is relatively large given ε^*.

The middle diagram in fig. 1 shows real domestic (foreign) hoarding on the positive (negative) abscissa, The domestic (foreign) real hoarding function is portrayed in fig. 1 as the positively (negatively) sloped hh (h^*h^*) curve. Given our assumptions, the positiveness (negativeness) of the slope of these two lines does not depend upon the positive or negative slopes of the underlying aa and a^*a^* curves.[10] A long-run equilibrium of the model is shown by the intersection point, P_0, of the hh and h^*h^* line on the ordinate. Intersections to the right of the ordinate depict a domestic trade surplus.

3. Devaluation under rigid nominal wages

The results for a devaluation of the domestic currency with nominal wage rigidity in both countries follow from differentiation of (17) and (18),

$$\hat{P}/\hat{E}=\frac{\xi^*\rho^*(1+\varepsilon^*)}{\Lambda}>0, \qquad \hat{P}^*/\hat{E}=-\frac{\xi\rho(1+\varepsilon)}{\Lambda}<0,$$

$$\hat{y}/\hat{E}=\frac{\varepsilon\xi^*\rho^*(1+\varepsilon^*)}{\Lambda}>0, \qquad \hat{y}^*/\hat{E}=-\frac{\varepsilon^*\xi\rho(1+\varepsilon)}{\Lambda}<0, \tag{24}$$

$$\mathrm{d}B/\hat{E}=\bar{Y}\frac{\xi\rho(1+\varepsilon)\xi^*\rho^*(1+\varepsilon^*)}{\Lambda}>0,$$

$$\hat{\bar{y}}/\hat{E}=\xi\xi^*\frac{\varepsilon\rho^*(1+\varepsilon^*)-\varepsilon^*\rho(1+\varepsilon)}{\Lambda}\gtrless 0,$$

[10]This follows from $\hat{c}\,\hat{P}_{|a^*a^*}-\hat{c}\,\hat{P}_{|y^*y^*}=-\rho^*(1+\varepsilon^*)<0$ and footnote 9.

where

$$\Delta = \xi\rho(1+\varepsilon)+\xi^*\rho^*(1+\varepsilon^*)>0,$$

$$\xi = y/\bar{y}, \quad \xi^* = y^*/\bar{y} \quad \text{with} \quad \bar{y} = y+y^*,$$

$$\bar{Y} = Py + EP^*y^* = P\bar{y}.$$

Devaluation affects output, prices, and employment in both countries in a way known as the 'beggar-my-neighbor' policy. The trade balance of the devaluing country unambiguously improves and world output may increase or decrease.

We can discuss devaluation in more detail using the geometric apparatus in fig. 1. The adjustment process is dominated by two basic effects: (i) a windfall gain of increased purchasing power accruing to holders of foreign cash balances, and (ii) a competitive downward adjustment in sales prices of foreign produced goods. With nominal wages rigid in the foreign country, the latter effect causes a slump in foreign output and employment which is visualized in fig. 1 as a shift of the y^*y^* line to the left. On the consumption side the drop in real income may or may not be large enough to match the consumer's willingness to increase absorption due to their devaluation-related wealth increase. The special case where the wealth effect dominates the real income effect is shown in fig. 1 where the a^*a^* curve shifts to the right as a consequence of the devaluation. Obviously a devaluation of the domestic currency has created excess demand for goods in the foreign country at the ruling domestic currency price for goods, P_0.[11] However, in an open economy the foreign excess demand spills over to the world market raising the world market price denominated in domestic currency units. The price level increase induces the domestic economy to satisfy the foreign claims for more goods on two counts. First, domestic production is enlarged, and second, domestic absorption is crowded out if the negative real balance effect of the rising price level dominates the positive real income effect (as shown in fig. 1). More technically, a devaluation shifts the h^*h^* line to $h_1^*h_1^*$ thereby increasing the domestic price level from P_0 to P_1. Notice that this price level increase weakens somewhat the necessity of competitive price cuts in the foreign economy and subsequent output reductions, which foreign producers had to execute in the beginning.

4. Aggregate demand and supply analysis

Our exposition so far has been concerned only peripherally with the allocation of short-run effects on output and prices following an exchange

[11]Note that initially the foreign price level was adjusted downwards by the devaluation percentage rate.

rate shock. In this section we will introduce aggregate demand and supply analysis of devaluation. This alternate exposition of our model allows us to focus on the role of real wage resistance.

The basic idea of all aggregate demand and supply analysis is simply to bring out the price level and output as separate variables. Therefore we rewrite (17) as follows:

$$y=c(y, M/P)+[c^*(y^*, EM^*/P)-y^*] \tag{25}$$

with

$$y^*=y^*(P/E; W^*, \bar{K}^*).$$

This is the equation of an aggregate demand curve relating to the domestic economy. Note that (25) is a function in y, P space if we solve out y^* using the foreign short-run supply curve. Differentiation of (25) yields

$$[\xi\rho+\xi^*\rho^*(1+\varepsilon^*)]\hat{P}+\xi\rho\hat{y}=\xi\rho\hat{M}+\xi^*\rho^*\hat{M}^*+\xi^*\rho^*(1+\varepsilon^*)\hat{E}$$
$$+\xi^*\rho^*\varepsilon^*\hat{W}^*. \tag{26}$$

The aggregate demand curve is shown in fig. 2 as $y^d y^d$. This line must fall if $0<\rho<1$ because at a given price level an increase in y creates excess supply. This can be choked off only by a falling domestic price level, which encourages aggregate demand via a domestic wealth effect and stimulating foreign demand for domestic exports. The aggregate demand curve shifts when one of its parameters M, M^*, W^*, E is changed. Next we notice in fig. 2 the upward sloping $y^s y^s$ curve. That curve is the image of the domestic country's short-run output behavior, or, as shown below, its aggregate supply curve,

$$y=y(P; W, \bar{K}). \tag{27}$$

The price elasticity of this curve is $\hat{P}/\hat{y}=1/\varepsilon>0$, out of reasons we have discussed above. Finally, fig. 2 presents a falling BB line. That line depicts equilibrium of the domestic trade balance,

$$B=P[y-c(y, M/P)]. \tag{28}$$

The trade balance equilibrium line must be downward sloping because an output increase creates a trade surplus if $0<\rho<1$. Therefore a falling price level must stimulate domestic absorption if we wish the domestic trade balance to stay in equilibrium. Closer inspection of (28) reveals that the price

elasticity of the BB curve is $P/\hat{y}=-1$. This follows from the linear homogeneity property of our absorption function. Comparison of the elasticities of the BB and $y^d y^d$ lines shows a steeper slope for the BB line as long as a fall in the domestic price level successfully attracts foreign demand for domestic goods.

$$\hat{P}/\hat{y}\big|_{y^d y^d} = -\frac{\xi\rho}{\xi\rho+\xi^*\rho^*(1+\varepsilon^*)} > -1 = \hat{P}/\hat{y}\big|_{BB}.$$

A long-run equilibrium of the domestic economy is shown in fig. 2 at point A_0 where all three lines have a common intersection point.

4.1. *Money supply change*

An increase in M shifts both the BB and the $y^d y^d$ line to the right by exactly the same amount. In a one-good model holding the price level constant, obviously the same output increase which keeps the goods market

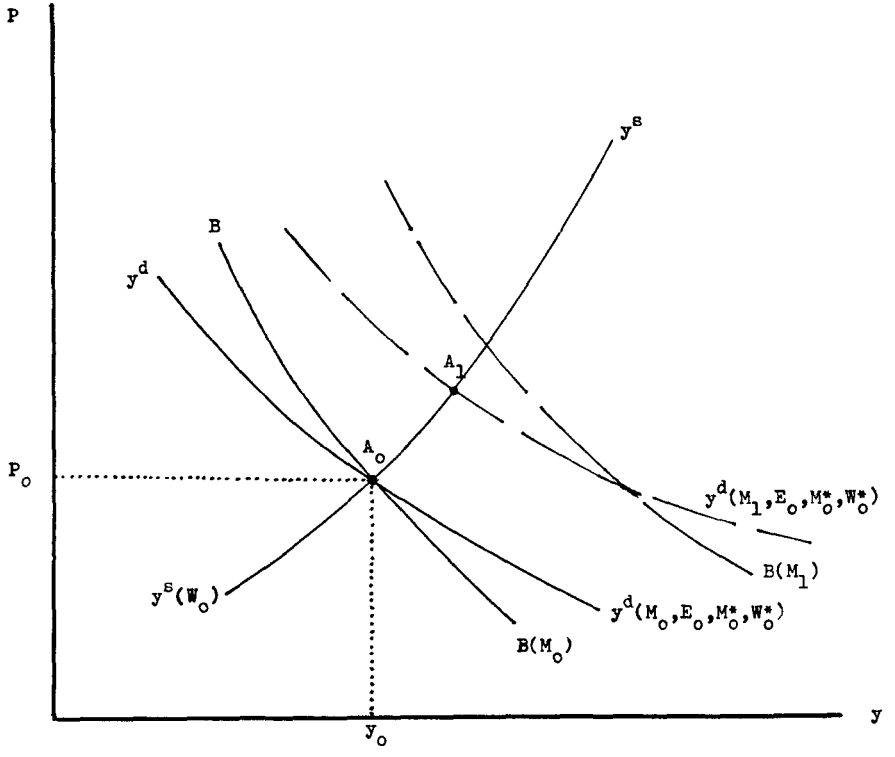

Fig. 2

in equilibrium after a money supply rise can balance the trade account. In consequence, a domestic supply increase with rigid nominal wages increases the price level and employment (see the dashed lines in fig. 2). It also creates a domestic deficit because domestic residents overspend.

4.2. Devaluation

Using fig. 3 allows us to visualize the impact of an exchange rate change under nominal wage rigidity in both countries in an alternate manner. We have argued above that a devaluation will create excess demand for final goods in the foreign country on two grounds: (i) competitive price adjustments reduce foreign output and real income, and (ii) a real wealth effect enlarges foreign absorption. The resulting foreign excess demand appears as a rightward shift of $y_0^d y_0^d$ towards $y_1^d y_1^d$. The new equilibrium point A_1 shows an increased price level together with reduced unemployment and a surplus of the domestic current account.

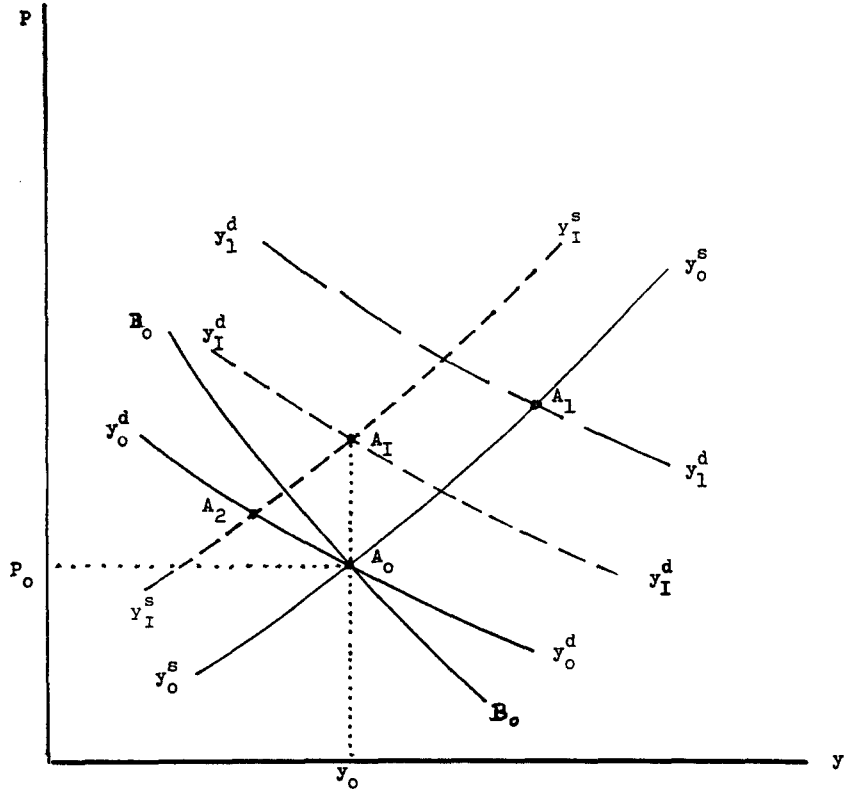

Fig. 3

4.3. Nominal wage push

Prior to our discussion of the effects of devaluation under real wage rigidity, it will be worthwhile to briefly examine the impact of a domestic wage push in our model.[12] It is helpful to use fig. 3 to summarize the main results: A domestic wage push shifts our $y_0^s y_0^s$ curve upwards. The new equilibrium point A_2 indicates higher unemployment, a higher price level, and a domestic trade deficit. From appendix equation (A.1) it follows that a domestic wage push will increase foreign output.[13] In short, the basic reason for these results is domestic excess spending after a wage push, because domestic absorption falls less than domestic output at a given domestic price level. The domestic excess demand for goods is met by the foreign country at the higher domestic currency price level. Similarly a policy of domestic wage restraint ($\hat{W}<0$) can be shown from (A.1) to be a 'beggar-my-neighbor' policy under a regime of fixed exchange rates. It exports domestic unemployment to the foreign country because at a given domestic currency price level with $0<\alpha<1$, the increase in domestic absorption falls short of the increase in domestic production. The domestic excess supply places downward pressure on world market price and, at falling world market prices, foreign producers cut down their production if foreign nominal wages are sticky while simultaneously foreign consumers spend their excess cash balances. Hence at a lower domestic currency price level the domestic excess supply can be sold to the foreign country. Comparing the outcomes of a policy of money supply increase and a policy of wage restraint it is important to note that both policies *increase* domestic real income. However, the supply side policy creates trade surpluses while the demand side policy creates deficits. Hence in our model the nexus between domestic income and the trade balance is more sophisticated than in the traditional income expenditure model.

5. International adjustment to a devaluation with rigid real wages

So far in our analysis of devaluation we have assumed nominal wage rigidity in both countries. Under nominal wage rigidity foreign producers reduced their production levels when they were forced to cut sales prices of their products in an effort to stay competitive after the domestic devaluation. We get a very different adjustment if we instead assume a downward adjustment of foreign nominal wages. If labor in the foreign country could be persuaded to be 'price responsive' with nominal wage claims, i.e., adjust

[12]Elsewhere in Schmid (1980a), the author has analyzed nominal wage shocks in the present framework in much greater detail. Mussa (1979) has an informal discussion of wage shocks in a two-good, two-country model.

[13]It can be shown that the domestic rental rate is reduced while the foreign rental rate has increased.

nominal wages in a downward direction, then this policy of foreign wage restraint would hinder domestic producers from having a competitive edge over foreign producers. Foreign producers could sustain the current level of production and employment. This would wipe out the contractionary real income effect. However, it would not eliminate a buildup of foreign excess demand because we have left the real balance effect of domestic devaluation upon foreign currency owners. Hence, as before, we will find world market pressure originating from the foreign country which raises the price level for goods measured in domestic currency units. As before, this tends to stimulate domestic production at given domestic wages. Assuming, however, that *domestic* suppliers of labor resist a decline in domestic real wage and therefore claim higher nominal wages, domestic output will not adjust to the price level change and, in order to match the foreign excess demand, the adjustment mechanism must rely solely on a crowding out effect upon domestic absorption. It is a domestic real balance effect which does the job. We next want to give a more formal expression to the described scenario, and later we shall show that the assumption of real wage resistance, i.e., complete up- and downward movement of nominal wages irrespective of the unemployment situation or the assumption of a classical labor market in both countries exactly produces the Dornbusch (1973) version of the monetary approach.

To fix ideas we introduce the following rules for the working of the labor market:

(i) It is assumed that nominal wage increases are tied to the expected price level increase by an indexing scheme expressed in the following way:

$$\hat{W}=\phi\hat{P}^e, \quad \hat{P}^e \gtrless 0, \qquad 0 \leqq \phi \leqq 1. \tag{29}$$

If $\phi=1$, we speak of a fully symmetric indexation scheme.

(ii) We assume that expectations are rational in the sense that labor expects a price level increase which is the outcome of the actual economic adjustment process,

$$\hat{P}^e=\hat{P}. \tag{30}$$

Using (i) and (ii) in (6), (7) we find an expression which relates output–price response to the degree of wage indexation, ϕ, ϕ^*,

$$\hat{y}=\varepsilon(1-\phi)\hat{P}, \qquad 0 \leqq \phi \leqq 1. \tag{31}$$

Similarly we find for the foreign country

$$\hat{y}^* = \varepsilon^*(1-\phi^*)[\hat{P}-\hat{E}], \quad 0 \leqq \phi^* \leqq 1. \tag{32}$$

As we expect with perfect indexation ($\phi = \phi^* = 1$) output is price inelastic in both countries. This is the case of complete real wage resistance. Nominal wage rigidity ($\phi = \phi^* = 0$) yields a price–output response the reader can recall from section 3.

5.1. *The algebra of devaluation with indexed wages*

We replace our short-run supply functions (6), (7) by (31), (32). This gives us the following modified exchange rate impact in an indexed world economy which is derived in appendix equation (A.2):

$$\begin{aligned}
\hat{P}/\hat{E} &= \frac{\xi^*\rho^*[1+\varepsilon^*(1-\phi^*)]}{\Delta_I} > 0, \\
\hat{P}^*/\hat{E} &= -\frac{\xi\rho[1+\varepsilon(1-\phi)]}{\Delta_I} > 0, \\
\hat{y}/\hat{E} &= \frac{\varepsilon(1-\phi)\xi^*\rho^*[1+\varepsilon^*(1-\phi^*)]}{\Delta_I}, \\
\hat{y}^*/\hat{E} &= -\frac{\varepsilon^*(1-\phi^*)\xi\rho[1+\varepsilon(1-\phi)]}{\Delta_I}, \\
\mathrm{d}B/\hat{E} &= \bar{Y}\,\frac{\xi\rho[1+\varepsilon(1-\phi)]\xi^*\rho^*[1+\varepsilon^*(1-\phi^*)]}{\Delta_I} > 0, \\
\hat{\hat{y}} &= \xi\xi^*\,\frac{\varepsilon(1-\phi)\rho^*[1+\varepsilon^*(1-\phi^*)] - \varepsilon^*(1-\phi^*)\rho[1+\varepsilon(1-\phi)]}{\Delta_I}.
\end{aligned} \tag{33}$$

The first point to note from (33) is that with nominal wage rigidity we can reproduce our former results given in (24). With a fully symmetric indexation scheme in both countries we find from (33) that a devaluation has normal price and trade balance effects but does not affect production and employment, respectively. In fact it can be shown that setting $\phi = \phi^* = 1$ in (33) yields exactly the results for a devaluation as obtained by Dornbusch (1973). We can demonstrate Dornbusch's theory of devaluation by means of fig. 3. We have argued above that a devaluation under nominal wage rigidity

raises the price level denominated in domestic currency and lowers the foreign currency price. We may now see from system (A.1) that the concomitant domestic nominal wage adjustment shifts the domestic supply curve $y^s y^s$ upwards towards $y_I^s y_I^s$ and reduces the original devaluation induced shift of the $y^d y^d$ curve from $y_1^d y_1^d$ to a $y_I^d y_I^d$ position. This dampening effect of course stems from downward adjustment of foreign nominal wages enforced by the fully symmetric indexation rule. While the new equilibrium point A_I shows clearly that devaluation has not affected domestic output and employment, it is not clear from fig. 3 whether the domestic price level as a *result of indexation* has increased or decreased.[14]

5.2. *International adjustment to a devaluation — Synopsis of different approaches*

We will now compare the adjustment of our world economy with and without real wage resistance in a more comprehensive way.

To simplify matters we here consider only the special case where a devaluation does not affect world output because both countries are completely identical ($\varepsilon=\varepsilon^*$, $\rho=\rho^*$, and $\xi=\xi^*$). Note first from (33) that under nominal wage rigidity the international division of the burden of price adjustment is now symmetric, and that domestic production exactly matches the fall in foreign production. This observation assures us that the 'square' world economy depicted in fig. 4 does not change size, hence the adjustment mechanism is confined to the 'interior' of the world economy. In the initial state point Q in fig. 4 is a point of trade equilibrium where income and absorption lines coincide. The switch in world production towards the domestic country shifts the income line to the right towards $Y_1 Y_1$. Assuming $0<\alpha=\alpha^*<1$, domestic absorption grows less than domestic production while foreign absorption declines less than foreign production, leaving the world with a trade deficit. In fig. 4 this must appear as a rightward shift of the absorption line towards $A_1 A_1$ which always falls short of the shift of income line $Y_1 Y_1$. Note that this adjustment mechanism relies on price and income effects and that the distribution of world absorption has been in favor of the country which produces more. This is not necessary, however, if we are prepared to assume that price and (real) income effects offset each other in the absorption functions of both countries ($\alpha\varepsilon=\rho$). This pegs the distribution

[14]Comparison of price formula (24) to (33), assuming $\phi=\phi^*=1$, reveals that a symmetric indexation scheme brings no additional price effects if and only if price output responsiveness in both economies is equal, i.e., $\varepsilon=\varepsilon^*$. We can conclude that indexation tends to strengthen (dampen) the domestic price increase caused by a domestic devaluation if price-output responsiveness of the domestic productive sector is greater than the one in the foreign country, i.e., $\varepsilon>\varepsilon^*$. In any case indexation dampens the trade surplus for the domestic country following a domestic devaluation.

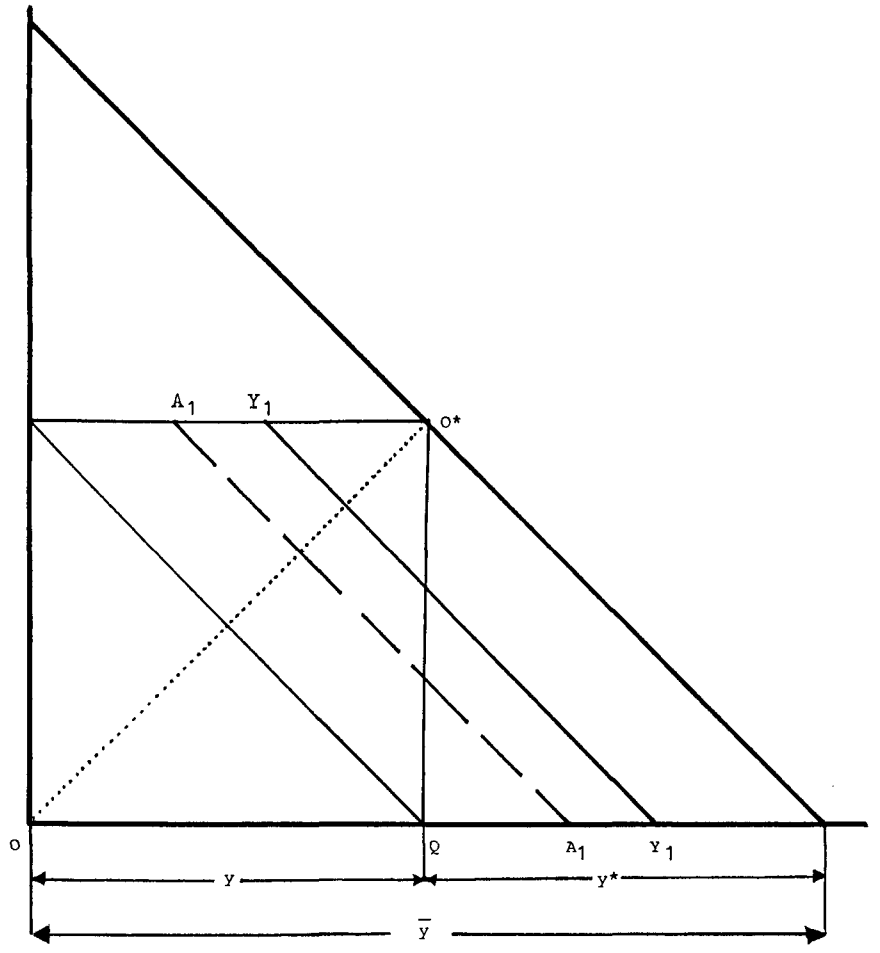

Fig. 4

of world absorption while the distribution of world production is switched towards the devaluing country. Now the absorption line stays put and the domestic trade surplus is equal to the domestic production increase.[15] It is clear now that by assuming $\alpha\varepsilon < \rho$ we can emphasize the real balance effect in both countries. That is, we witness an increase in the domestic trade surplus resulting from decreased domestic and increased foreign absorption, despite a

[15]As the reader may verify from (33) we can obtain the same effect under the weaker assumption of different price–output responsiveness across countries ($\varepsilon \neq \varepsilon^*$) retaining, however, the assumption of equal size and matching real balance and income effects in both countries ($\alpha\varepsilon = \rho$ and $\alpha^*\varepsilon^* = \rho^*$).

corresponding increase in domestic production and decrease in foreign production, i.e., the absorption line would shift to the left. The reader will observe that our combination of the income expenditure approach with the quantity theory gives us exactly the full range of adjustment possibilities early writers of so-called absorption theory always claimed a devaluation may have. It is also clear now that fixing real income in the adjustment mechanism, either on the ground of implicitly assuming a classical labor market [Dornbusch (1973)] or by assuming a fully symmetric wage indexation scheme, restricts the international adjustment mechanism to the demand side and we get the familiar 'crowding out story' the orthodox monetary approach has popularized. This could be represented in fig. 4 by noting that under real wage resistance in both countries the income line stays put while the absorption line shifts to the left. That gives us again a domestic surplus, however, this time totally at the expense of domestic real absorption.

6. Devaluation as a policy tool

This final section discusses the effectiveness of a devaluation in influencing domestic employment, the trade balance, and the price level within the context of other domestic and foreign economic policy variables.

We would like to derive the following two statements on 'super-neutrality' of a domestic exchange rate change by which we mean neutrality with respect to real output, the price level, and the trade balance:

(a) If domestic nominal wages are indexed (upwards) in an excess supply labor market or move upwards in a classical labor market under full employment, then a domestic devaluation is 'weak superneutral' under domestic monetary accommodation. The domestic economy suffers from a devaluation induced inflationary wage–price spiral, but there are no employment and trade balance effects.

(b) If foreign wages are downward price responsive, i.e., scaled down according to foreign price level reductions, independent of foreign unemployment in an excess (supply) labor market, or move automatically downwards in a classical labor market, then a domestic devaluation is 'superneutral' under a policy of foreign non-accommodation (money supply restraint). The foreign economy goes through a deflationary wage–price spiral induced by the domestic devaluation.

The reader can easily obtain a formal proof by applying the condition $\hat{M} = \hat{W} = \hat{E} > 0$ to (A.1) in the appendix to obtain (a), and $\hat{M}^* = \hat{W}^* = -\hat{E} > 0$ to

obtain (b). We use fig. 5 to explain the economics in a wage space.[16] The diagram depicts two specific nominal wage rates, W_s, W_s^*, at which national labor markets and the final goods market clear. Hence we can legitimately claim point S to be a point of worldwide Walrasian equilibrium for a given exchange rate and given national money supplies. Points within the $OW_sSW_s^*$ area represent rationing of labor *demand* in the foreign and domestic economy while we have rationing of labor *supply*, i.e., unemployment, within

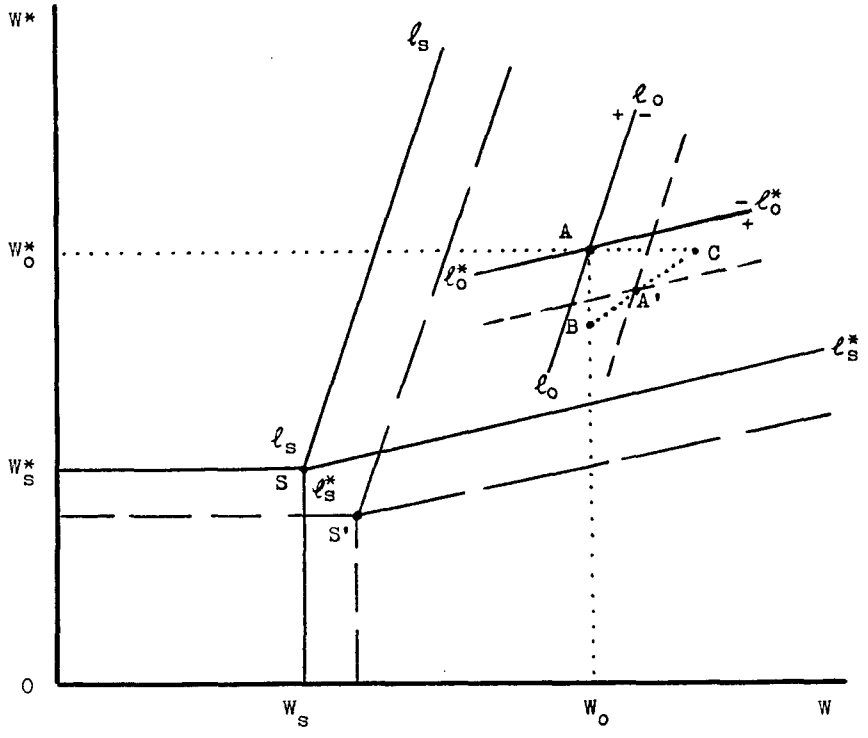

Fig. 5

the cone $l_sSl_s^*$ for the home (foreign) country if $W > W_s$ ($W^* > W_s^*$). The cone is spanned by the l_sl_s and $l_s^*l_s^*$ loci. Along the l_sl_s ($l_s^*l_s^*$) locus we have simultaneously labor market clearing in the home (foreign) country and clearing of the word final goods market.

[16]A similar diagram can be found in Dornbusch (1980, ch. 8, p. 148) and Dixit and Norman (1980, ch. 8.2). Note that the Dornbusch diagram has been designed for a fully employed world economy with a continuum of goods. The Dixit–Norman diagram does not explain the case of worldwide unemployment and the Dornbusch diagram shows wages in a common currency.

Focusing on $l_s^* l_s^*$ first we can easily derive the required relation between the two nominal wage rates from differentiation of the goods market equilibrium condition (17),

$$-\xi\rho\varepsilon\hat{W}-\xi^*\rho^*\varepsilon^*\hat{W}^*+\Delta\hat{P}=\xi^*\rho^*(1+\varepsilon)\hat{E}+\xi\rho\hat{M}+\xi^*\rho^*\hat{M}^*.$$

Notice that the condition for maintaining foreign labor market equilibrium under a changing domestic wage rate simply amounts to using $\hat{W}^*=\hat{P}$ in the goods market equation. We obtain the elasticity of the $l_s^* l_s^*$ locus,

$$\hat{W}^*/\hat{W}\big|_{l_s^* l_s^*}=\frac{\xi\rho\varepsilon}{\xi\rho(1+\varepsilon)+\xi^*\rho^*}<1.$$

Similarly we derive the elasticity of the $l_s l_s$ locus representing alternative domestic wage rates which simultaneously clear the domestic labor market and goods market for $W^*>W_s^*$,

$$\hat{W}^*/\hat{W}\big|_{l_s l_s}=\frac{\xi\rho+\xi^*\rho^*(1+\varepsilon^*)}{\xi^*\rho^*\varepsilon^*}>1.$$

It follows from the construction of the $l_s l_s$ and $l_s^* l_s^*$ lines that we must obtain a whole family of lines within the cone $l_s S l_s^*$ where each single ll or l^*l^* line indicates a given amount of unemployment in the domestic or foreign economy, respectively. Hence we can represent a point of *worldwide* unemployment by picking point A within the cone. Point A is determined by the constant employment lines $l_0 l_0$ and $l_0^* l_0^*$.[17] We also have an upward sloping balanced trade line (not shown) which passes through point A if trade is in equilibrium. The elasticity of that line is $\hat{W}^*/\hat{W}=[(1+\varepsilon^*)\varepsilon]/[(1+\varepsilon)\varepsilon^*]$, i.e., it is determined by supply side parameters only.

If we start with point A representing a situation of worldwide unemployment and balanced trade we can shock the system by a devaluation. We leave it to the reader to convince himself that a devaluation must shift both the ll and l^*l^* line to the right showing at point A' in fig. 5 a lower foreign nominal wage rate and a higher domestic wage rate if employment is to be constant in both countries.[18] It follows immediately that by fixing wages at point A a domestic devaluation becomes a policy which causes higher domestic employment and higher foreign unemployment.

An increase either in domestic or foreign money supply would shift the ll and l^*l^* curves, moving point A on a straight line through the origin, in a

[17]Note first constant employment is equivalent to constant unemployment. Note further that the goods market equilibrium is not shown explicitly in fig. 5 but it must run through point A as a negatively sloped line.

[18]Note that devaluation also shifts the cone $l_s S l_s^*$ in a southeastern direction.

northeast direction[19] which would account for rising wages and final goods price level.

It is easy now to illustrate the validity of statement (a). Assume the domestic devaluation is associated with an increase in the domestic money supply which drives the system from A' to C. An accompanying increase in the domestic wage rate by AC demonstrates employment neutrality of this concerted action which has become a familiar story to explain neutrality of a devaluation.[20] It is obvious a devaluation on the basis of this argument can be made effective as soon as domestic policy makers use policy variables under their own control in a more efficient way. However, statement (b) indicates that there is a second possibility to render a devaluation totally ineffective, that being an offsetting policy strategy in the foreign country which, of course, is beyond control of domestic authorities. The argument is as follows: Taking as given that a domestic devaluation works firstly via a wealth effect upon holders of foreign cash balances and secondly via competitive price concessions on the part of foreign producers, these effects can be counteracted by appropriate foreign policy measures. A policy of monetary restraint exerted by the foreign monetary authority would take away the windfall wealth effect, and a policy of nominal wage restraint on the part of foreign trade unions would restore competitiveness of foreign products without any detrimental effect on foreign employment. In technical language, the reduction of the foreign money supply drives point A' down to B, where we also obtain employment neutrality if the foreign country restrains wages by AB. Following this strategy the foreign country successfully undermined the domestic attempt to gain employment at the expense of foreign unemployment. The only lasting effect of this foreign concerted action is a fall in foreign wages and prices equal to the percentage increase of the exchange rate.

7. Concluding remarks

With nominal wage rigidity a devaluation has a simultaneous demand *and* supply side effect. The real balance and the independent real output effect work in the same direction confirming the traditional trade balance impact of a devaluation. Consequently, to neutralize the original exchange rate effect

[19]Note that a redistribution of world money (gold) stock towards one or the other country may either rise or bring down the final goods price level depending upon $\rho^* v^* \gtrless \rho v$ where v, v^* are income velocities of money. The famous Humean equilibrating mechanism works via such a redistribution of the world gold stock. Our exposition shows clearly that this mechanism is working perfectly under the law of one price with wages and final goods price level going up or down simultaneously in both countries. Theoretically it also works with constant wages and price level or with constant wages but changing final goods price level. Samuelson (1980) recently stresses this well-known fact.

[20]If we brought the trade line into the picture it could be shown that the net shift from devaluation *and* money supply change moves this line such that it passes through point C. The diagram can also be used to discuss a flexible exchange rate system.

on the current account, we need a concerted action of demand *and* supply management. We have shown how real income can be stimulated from the demand side as well as from the supply side. The two policies, however, induce different outcomes for the trade account. The model allowed for two national currencies and one international medium of exchange which is held by monetary authorities as an external reserve. Putting the same emphasis on wage stickiness, Henderson (1974) has analyzed a two-country portfolio balance approach. In his model the public also holds nationally issued paper assets which are perfect substitutes. In this extended framework trade in goods *and* assets can be modelled, and exchange rate expectations have an important role to play in a flexible rate system.

Appendix

Differentiation of (25), (27) and (28) yields the following system:

$$\begin{bmatrix} \varepsilon & -1 & 0 \\ \xi\rho+\xi^*\rho^*(1+\varepsilon^*) & \xi\rho & 0 \\ \xi\rho & \xi\rho & -(1/\bar{Y}) \end{bmatrix} \begin{bmatrix} \hat{P} \\ \hat{y} \\ \mathrm{d}B \end{bmatrix}$$
$$= \begin{bmatrix} 0 & 0 \\ \xi\rho & \xi^*\rho^* \\ \xi\rho & 0 \end{bmatrix} \begin{bmatrix} \hat{M} \\ \hat{M}^* \end{bmatrix} + \begin{bmatrix} \varepsilon & 0 & 0 \\ 0 & \xi^*\rho^*\varepsilon^* & \xi^*\rho^*(1+\varepsilon^*) \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \hat{W} \\ \hat{W}^* \\ \hat{E} \end{bmatrix}, \tag{A.1}$$
$$|D| = -(1/\bar{Y})\,\Delta < 0 \quad \text{with} \quad \Delta = \xi\rho(1+\varepsilon)+\xi^*\rho^*(1+\varepsilon^*) > 0.$$

The importance of (A.1) derives from its apparent capability to capture algebraically the shifts of each line in fig. 2 due to changes in exogenous variables. It is interesting to note that the variables E, M^* and W^* influence the system exclusively via the goods market equilibrium line $y^d y^d$ while W affects only the $y^s y^s$ line.

Replacing our short-run supply functions (6), (7) by (31), (32) yields the following system for an indexed world economy:

$$\begin{bmatrix} \varepsilon(1-\phi) & -1 & 0 \\ \xi\rho+\xi^*\rho^*[1+\varepsilon^*(1-\phi^*)] & \xi\rho & 0 \\ \xi\rho & \xi\rho & -(1/\bar{Y}) \end{bmatrix} \begin{bmatrix} \hat{P} \\ \hat{y} \\ \mathrm{d}B \end{bmatrix}$$
$$= \begin{bmatrix} 0 & 0 & 0 \\ \xi\rho & \xi^*\rho^* & \xi^*\rho^*[1+\varepsilon^*(1-\phi^*)] \\ \xi\rho & 0 & 0 \end{bmatrix} \begin{bmatrix} \hat{M} \\ \hat{M}^* \\ \hat{E} \end{bmatrix}, \tag{A.2}$$
$$\Delta_1 = \xi\rho[1+\varepsilon(1-\phi)]+\xi^*\rho^*[1+\varepsilon^*(1-\phi^*)].$$

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