DOI: 10.20378/irb-91738

Journal of International Economics 6 (1976) 347–361. © North-Holland Publishing Company

A MODEL OF TRADE IN MONEY, GOODS AND FACTORS

Michael SCHMID*

University of Chicago and University of Mannheim, Mannheim, West Germany

Received July 1975 revised version received May 1976

The 'Oil Crisis' provides the challenge to analyze effects of a resource shortage in a minimal monetary model of a vertically trading world economy. The one-asset monetary approach to balance of payments theory is employed to demonstrate that in a model with one final good and two inputs the elasticity of substitution between the domestic factor of production and an imported raw material plays the key role in determining the reaction of the balance of payments (= balance of trade).

1. Introduction

In this paper the economic implications of a rise in price of a natural resource produced by one group of countries and used as an indispensable factor of production in another group of countries is investigated utilizing a minimal theoretical structure. In particular, we assume the world consists of two trading partners who are engaged in a vertical trade pattern with world production of final goods performed in a two-tier production process. The group of 'foreign countries' is the sole producer of the natural resource which is sold as a raw material to the group of 'domestic countries.' However, in what follows we do not intend to consider individual countries in each group. Therefore we introduce the simplifying notions of 'foreign country' and 'domestic country' respectively. By adding domestic labor resources the home country operates as a processing plant and manufactures a final good which is both domestically consumed and exchanged with the foreign country in payment for the imported raw material. In this simple structure each country specializes in the production of their exportables.[1] The postulated rise in resource price is caused by an exogenous reduction in the production of the natural resource. Within the framework of a simple monetary model of trade in final and intermediate goods, the effects of this real disturbance are explored. Emphasis is placed on the level

*I gratefully acknowledge encouragement and help from Rudiger Dornbusch. I benefited also from Horst Herberg's comments on a first draft, and I followed in some points the recommendations of an anonymous referee. This work was made possible by a scholarship from Deutsche Forschungsgemeinschaft.

[1]See Khang (1969) for a discussion of growth in a barter model of the described structure.

and distribution of nominal world income, the balance of payments (= balance of trade) and the relative and absolute prices of both goods and factors.

The model proposed here is related to a framework suggested by Dornbusch (1973). The special problems attacked in the present paper involve an extension of the 'real part' of his model. This development entails well-known theoretical techniques from the one-sector theory of income distribution which are now becoming useful in generating clear-cut results concerning the impact of resource shortages in an international context. Section 2 of the paper develops an extended version of Dornbusch's framework allowing trade between final and intermediate goods. The equilibrium of the system is discussed in section 3 and in section 4 a detailed discussion of resource shortage effects is presented. In section 5 we consider the effects of a resource shortage on the domestic labor market. While in the first parts of the paper a perfectly flexible nominal wage rate is assumed, the final section explores the effects of the resource shortage on the employment of the domestic factor of production if the wage rate is fixed.

Among the main conclusions of the paper are the following. The elasticity of substitution between domestic and imported factors of production plays the key role in determining the balance of payments effects of a resource shortage. Further, the impact of such a shortage on the final goods price is shown to be ambiguous. Assuming a fixed nominal wage rate, the effects on domestic employment depend also on the elasticity of substitution.

2. A monetary model of a vertically trading world economy

First we focus on a description of the real part of the model. Production of final goods, X, in the home country is represented by a neoclassical production function,

$$X = F(N, L), \tag{1}$$

where N and L denote factor inputs of the natural resource and domestic labor respectively. We assume that $F(\cdot)$ is a well-behaved linear homogeneous function with the ordinary properties. Foreign output, X^*,[2] is exogenously determined and unresponsive to its price, P_N^*. Since foreign output is used exclusively as an input in the domestic production process, we have

$$X^* = N.$$

Hence, we rewrite our production function (1) as

$$X = F(X^*, L). \tag{2}$$

[2]Variables of the foreign country will always appear as starred symbols and indicate measurement in foreign currency units if they refer to nominal values.

Given the price of final goods, P, the nominal wage rate, W, adjusts via a competitive labor market to insure full employment of the domestic labor supply $\bar{L}$. Therefore

$$W = PF_L(X^*, \bar{L}), \tag{3}$$

where $F_L = \partial X/\partial L$. Assuming a fixed exchange rate, e (the price of foreign currency in terms of home currency units), we have the domestic price of the natural resource

$$P_N = eP_N^*. \tag{4}$$

The domestic price of the natural resource is given by

$$P_N = PF_N(X^*, \bar{L}). \tag{5}$$

Eq. (5) can be interpreted as an equilibrium condition for the market for natural resources and can be used to determine the relative resource price $q \equiv P_N/P$, which is the terms of trade of the foreign country. To make this point more clear we distinguish for a moment demand, N, and supply, X^*, of the natural resource. We have derived in the Appendix the following factor demand function in 'hat' form,[3]

$$\hat{N} - \hat{L} = -(\sigma/\theta_L)(\hat{P}_N - \hat{P}), \tag{6}$$

where σ is the elasticity of substitution between domestic and imported factors of production. Hence for an equilibrium in the resource market the following equation must hold if we recall that domestic labor is always fully employed,

$$\hat{X}^* = -(\sigma/\theta_L)(\hat{P}_N - \hat{P}). \tag{7}$$

Next, we consider income, spending and the role of money. Nominal income of the home country, Y, is defined as nominal value added,

$$Y \equiv PF(X^*, \bar{L}) - P_N X^*. \tag{8}$$

Nominal income of the foreign country, Y^*, is given by

$$Y^* \equiv P_N^* X^*.$$

The vertical structure of the world production process implies the following

[3]In deriving (6) we used rules of the well known 'hat calculus.' A 'hat' denotes percentage change of a variable X, i.e. $\hat{X} = dX/X$.

identity between world income, $\bar{Y}$, and the value of domestic production, PX,

$$\bar{Y} \equiv PX.$$

Therefore national incomes can be viewed as the share of domestic factor costs in the value of world production, $\theta_L \equiv WL/PX$, and the share of imported factor costs in value of world production, $\theta_N \equiv P_N X^*/PX$, respectively. In other words, these shares give us world income distribution:

$$\theta_L \equiv Y/\bar{Y}, \qquad \theta_N \equiv eY^*/\bar{Y}. \tag{9}$$

Using (9) we can derive from (8) a useful relation for the change in domestic nominal income as a function of changes in all the dependent variables,

$$\hat{Y} = \frac{1}{\theta_L}(\hat{P}+\hat{X}) - \frac{\theta_N}{\theta_L}(\hat{P}_N+\hat{X}^*). \tag{10}$$

We turn now to the national budget constraints and the national hoarding and consumption functions. It is assumed that national expenditure may deviate from national income by positive or negative amounts of national hoarding,

$$PD = Y-H, \qquad P^*D^* = Y^*-H^*. \tag{11}$$

In (11) D and D^* represent real consumption demand and H and H^* denote hoarding. P^* is the foreign currency price of final goods. To specify hoarding functions we introduce the following linear stock adjustment mechanism of actual money balances M and M^* to desired money balances, which, in turn, are assumed to be linear functions of national incomes,[4]

$$H = \pi(kY-M), \qquad H^* = \pi^*(k^*Y^*-M^*), \tag{12}$$

where π and π^* are the domestic and foreign rates of stock adjustment. Using (12) in (11) we can express consumer behavior in terms of expenditure functions:

$$PD = (1-\pi k)Y+\pi M,$$

$$P^*D^* = (1-\pi^*k^*)Y^*+\pi^*M^*. \tag{13}$$

The short-run marginal propensities to spend $(1-\pi k)$ and $(1-\pi^*k^*)$, are assumed to lie between zero and one. However, it is important to note that if

[4]For earlier use of the specified hoarding functions see Dornbusch (1973). In a recent article Dornbusch–Mussa (1975) justify the hoarding function of the text on the basis of an intertemporal maximization model.

$kY \neq M$, consumers spend more or less than their income, the dishoarding or hoarding being used to reduce the money market (stock) disequilibrium. In the long run (i.e. if stock equilibrium prevails) all income is spent.

Finally we give the equilibrium conditions for the world market for final goods,

$$D + D^* = X, \tag{14}$$

and because in this market a homogeneous good is traded, price arbitrage confirms the law of a uniform price for the final good,

$$P = eP^*. \tag{15}$$

From the preceding equations we note that goods market equilibrium implies

$$H = (PX - P_N X^*) - PD = PD^* - P_N X^*. \tag{16}$$

Eq. (16) illustrates a distinctive feature of the monetary approach to balance of payments theory. It is well known that in simple one-asset versions of this kind of model, hoarding is the mirror image of an unbalanced trade account. That means that as long as we observe a trade surplus (deficit) we have an inflow (outflow) of money and we observe accumulation (decumulation) of cash balances,

$$\dot{M} = H = PD^* - P_N X^*. \tag{17}$$

Only a balanced trade account halts the process of world money stock redistribution, and we refer to such a state of simultaneous stock and flow equilibrium as long-run equilibrium.

3. Equilibrium of the model

The model is shown in fig. 1 in Y, Y^* space. Along the $\overline{MM}$ schedule we have world monetary stock equilibrium as described by (18) - a long-run property of the system,

$$kY + k^* e Y^* = \overline{M}. \tag{18}$$

Monetary stock equilibrium obtains when the level and distribution of world nominal income and money are such that in each country the demand for money equals the supply of money. The schedule is drawn from a given nominal quantity of money in the world $\overline{M}$. Initial long-run equilibrium obtains at point A^0, where nominal incomes are Y_0 and Y_0^* with an associated distribution of monies $M_0 = kY_0$ and $M_0^* = k^* Y^*$.

Next we explain the $\bar{H}\bar{H}$ line which describes short-run equilibrium in the final goods market. Along that schedule eq. (14) is satisfied. That yields, with respect to (13),

$$PX = Y - \pi(kY - M) + e[Y^* - \pi^*(k^* Y^* - M^*)]. \tag{19}$$

Eq. (19) suggests that the $\bar{H}\bar{H}$ line can be interpreted as a locus along which world income equals world spending, that is to say, world hoarding, $\bar{H}$, must be zero,

$$\bar{H} = H + eH^* = 0. \tag{20}$$

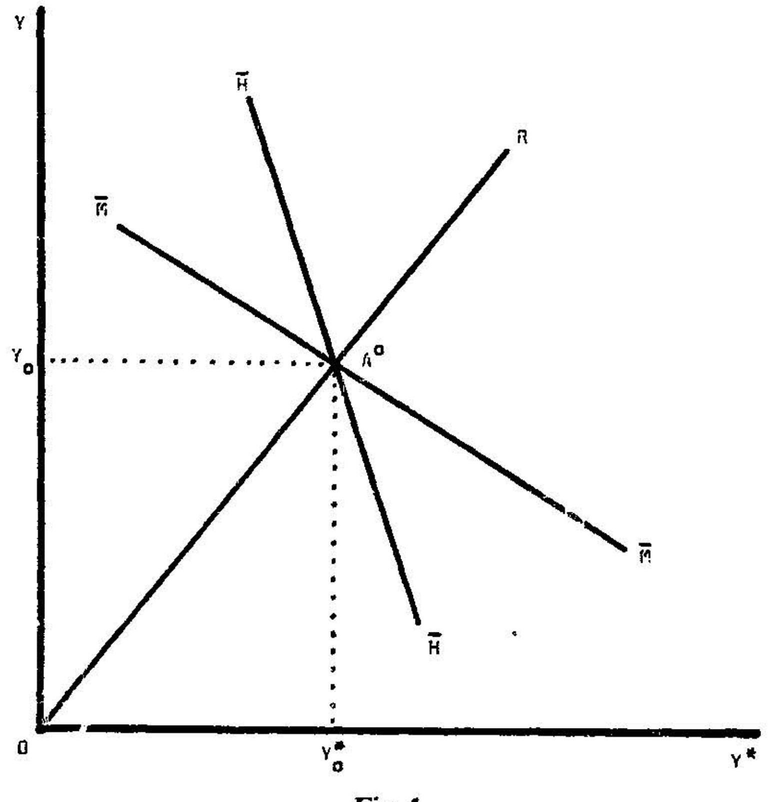

Fig. 1

The latter is readily shown by rewriting (19) using (12) to yield

$$\pi(kY - M) + e[\pi^*(k^* Y^* - M^*)] = 0. \tag{21}$$

The $\bar{H}\bar{H}$ schedule is drawn for the initial distribution of the world money stock and is for that reason negatively sloped. An increase in foreign income relative to foreign money holdings raises foreign hoarding, thus creating a world excess supply of goods. A reduction in domestic income is required to induce domestic dishoarding and thus increased spending to maintain the equality of world income and spending. It is obvious that the $\bar{H}\bar{H}$ line passes through A^0, because stock equilibrium at the initial distribution of world money supply necessarily implies that the terms $(kY_0 - M_0)$ and $(k^*Y_0^* - M_0)$ are zero. Thus the income levels Y_0 and Y_0^* corresponding to point A^0 must lie on the $\overline{HH}$ schedule since they satisfy eq. (21).

Further, we know that both the $\overline{MM}$ and $\overline{HH}$ lines are negatively sloped. In absolute terms the $\overline{HH}$ line is steeper (less steep) if $\pi^* > \pi$ $(\pi^* < \pi)$. Moreover, if both countries have the same marginal propensity to spend, the $\overline{HH}$ line has a slope of 45 degrees.

Thus far we have emphasized the monetary aspects of the model. Now we turn to a consideration of the role of real factors in determining world income distribution. In fig. 1 we have drawn a third line labeled OR which is a ray from the origin through point A^0. The slope of the ray indicates world income distribution for a given supply of factors of production. It is well known from the one-sector model of the theory of income distribution that factor supplies determine income distribution between factors of production. The following known relations[5] between changes in factor quantities and changes in factor shares in the value of production are derived in the Appendix,

$$\widehat{(Y/\bar{Y})} = \hat{\theta}_L = -(1-1/\sigma)\theta_N\hat{X}^*,$$
$$\widehat{(eY^*/\bar{Y})} = \hat{\theta}_N = (1-1/\sigma)\theta_L\hat{X}^*. \tag{22}$$

These expressions show that world income distribution, this is to say the position of the OR ray, is influenced by a change in the natural resource only if the elasticity of substitution differs from unity.

It remains to demonstrate that point A^0 in fig. 1 is actually a point of stock and flow equilibrium for the world economy. Given initial levels of factor supplies, the position of the OR ray is determined. This ray's intersection with the $\overline{MM}$ line determines nominal incomes Y and Y^* and hence the initial distribution of the given world money stock $\bar{M}$ for a given and fixed exchange rate. We have already shown that a stock equilibrium at that initial distribution of the world money stock causes the $\overline{HH}$ line to pass through point A^0. Therefore we have a unique equilibrium which we subject in the next section to a real shock in the form of a supply change of the natural resource.

4. Effects of a shortage in supply of imported resources

Assume we have a reduction in the production of the natural resource. The effects of this resource shortage depend crucially on what happens to world income distribution. We discuss first the case of $\sigma = 1$, in which world income distribution is unaffected by factor supply changes. In this case the OR ray in

[5]See, for example, Johnson (1971, pp. 87–89).

fig. 1 does not shift, and hence point A^0 represents both the old and new equilibrium points. This fact suggests that world nominal income as well as national incomes remain constant. World production of final goods, however, has fallen by

$$\hat{X} = \theta_N \hat{X}^*. \tag{23}$$

Unchanged nominal world income and lower world production necessitate an offsetting price increase for the final good. The constancy of foreign income implies an increase in the resource price, P_N, which is exactly proportional to the reduction in physical resource supply. The final goods price increase must be less than the resource price increase because the marginal product of the natural resource, and therefore its relative price, has risen.

For the case in which $\sigma \neq 1$, our story changes dramatically. Only the more realistic case of insignificant substitution possibilities between the domestic and the imported factors of production ($0 < \sigma < 1$) is considered in what follows. Further, the foreign country is assumed to have the smaller marginal propensity to spend ($\pi^* k^* > \pi k$). Note from (22) that, in the case of $0 < \sigma < 1$, the relative share of a factor increases as its supply decreases. This is shown in fig. 2 as a clockwise movement of the OR ray to OR', establishing a new intersection of the original $\overline{HH}$ schedule and OR' at point A^1. Notice that at A^1 world income has fallen. This result is intuitively appealing since world income has been redistributed in favor of the small spender. The result can be formally verified by the explicit introduction of world income distribution into (21). We find

$$[\pi k \theta_L + \pi^* k^* \theta_N] Y = \pi M + e\pi^* M^*. \tag{24}$$

The right-hand side of (24) is a constant and the bracketed term on the left-hand side is the world's marginal propensity to hoard, which is a weighted sum of the national propensities to hoard. From (24) the relationship between changes in world income and changes in the distribution of world income can be derived,

$$\hat{Y}/\hat{\theta}_L = \frac{(\pi^* k^* - \pi k)\theta_L}{(\pi k \theta_L + \pi^* k^* \theta_N)} \gtrless 0. \tag{25}$$

National incomes change unambiguously as a function of changes in world income distribution,

$$\begin{aligned} \hat{Y}/\hat{\theta}_L &= \frac{\pi^* k^*}{\pi k \theta_L + \pi^* k^* \theta_N} > 0, \\ \hat{Y}^*/\hat{\theta}_L &= \frac{\theta_L}{\theta_N}\left[\frac{-\pi k}{\pi k \theta_L + \pi^* k^* \theta_N}\right] < 0. \end{aligned} \tag{26}$$

Therefore a reduction in the supply of natural resources induces for $0 < \sigma < 1$ a redistribution of world income towards the foreign country ($\hat{\theta}_L < 0$). This leads to an increase in foreign nominal income and to a decrease in domestic nominal income according to (26). However given the actual money supplies in each country, this causes excess money supply in the home country and excess money demand in the foreign country. Therefore at point A^1 there is hoarding in the foreign country and dishoarding in the home country. From the identity of hoarding and the trade balance we conclude that the foreign country must run a trade balance surplus in order to adjust actual to desired money balances.

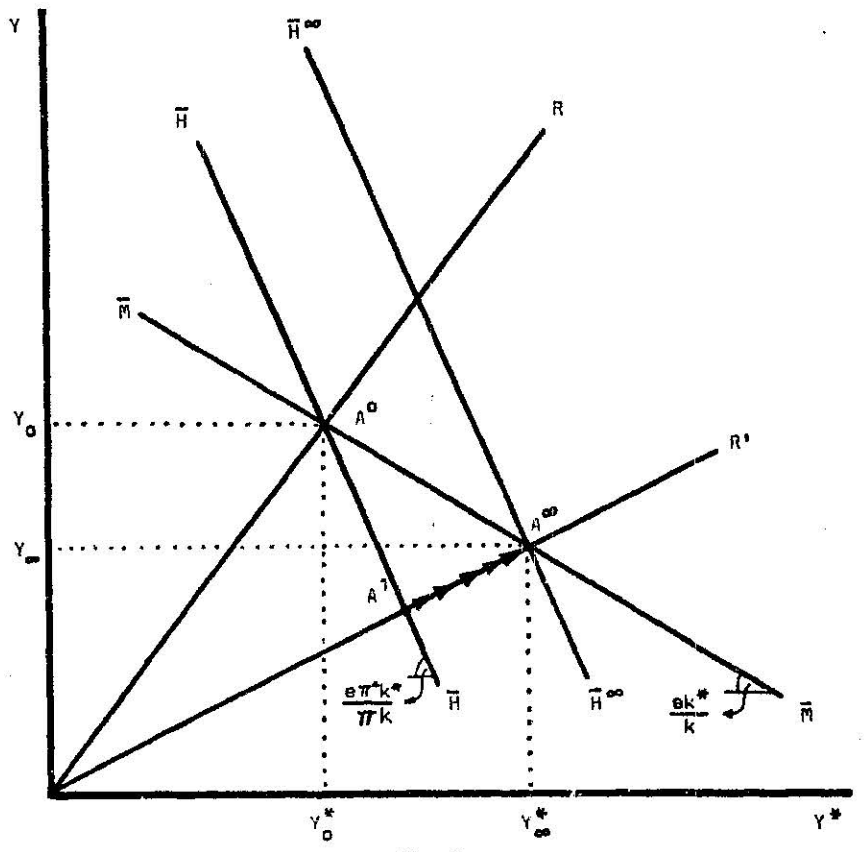

Fig. 2

Of course a domestic trade surplus is produced if the resource shortage changes world income distribution in favor of the domestic country. Hence, the main message is the following: the balance of payments effects of a resource shortage are completely determined by the elasticity of substitution between domestic and imported factors of production. For the case in which σ is equal to one, there are no balance of payments effects at all. For a low elasticity of substitution ($0 < \sigma < 1$) we end up with a domestic deficit, and a domestic surplus is created when $\sigma > 1$.

The foregoing discussion covers only short-run effects. Over time the trade balance deficit for the home country produces a redistribution of the world money stock toward the foreign country and that process continues as long as there is a trade balance disequilibrium. In terms of fig. 2, redistribution of the world money stock toward the foreign country causes a parallel rightward shift of the $\overline{HH}$ line if the $\overline{HH}$ line is steeper than the $\overline{MM}$ line, i.e. $\pi^* > \pi$. The opposite is true if the slope of $\overline{HH}$ is absolutely smaller than the slope of $\overline{MM}$. Now the redistribution of the world money stocks would produce a leftwards shift in $\overline{HH}$. Therefore, for $\pi^* > \pi$ the long-run equilibrating mechanism insures that, following a shortage of the natural resource, prices will increase while world income distribution is unchanged, i.e. point A^1 moves along the OR' ray until it reaches the intersection of the shifted $\overline{HH}$ line and the $\overline{MM}$ locus at point A^∞. At point A^∞ the new distribution of the world money stock is such that supply and demand for money balances are equal in both countries at the prevailing levels of national income Y_∞ and Y^*_∞.

We now turn to a closer examination of the short-run impact on absolute prices when $\sigma \neq 1$. We know that for $0 < \sigma < 1$ the resource price must rise unambiguously. It is also clear that the domestic nominal wage rate must fall because domestic income is reduced along with an unchanged domestic labor force. However, the value of world production can increase or decrease according to the condition $\pi^*k^* \lesseqgtr \pi k$. Since real production of final goods has definitely fallen, $\pi^*k^* < \pi k$ is a sufficient condition for an increase in the final goods price. In that case the change in world income distribution is in favor of the bigger spender. Hence the final goods price is subject to two forces which reinforce each other in creating excess demand in the final goods market: first, the decrease in production of final goods caused by the resource shortage (supply effect), and secondly, the increase in final goods demand caused by the change in world income distribution following the resource shortage (distribution effect). However, in discussions of the oil crisis[6] the opposite assumption of $\pi^*k^* > \pi k$ is usually made. Under this assumption the distribution effect counteracts the supply effect in generating excess demand in the final goods market, creating the possibility of the former effect dominating the latter and leaving the world economy with a decrease in the final goods price. In order to investigate further this possibility we could solve the model for its equilibrium prices.

However a more revealing strategy which fits in our discussion of the interplay between the supply and redistribution effects consists in the following argument: the change in world income equals the sum of changes in price and quantity of final goods,

$$\hat{Y} = \hat{P} + \hat{X}.$$

The reduction in final goods production is known from (23) and the change in world income, as a function of the change in world income distribution, is given by (25). Hence we get the following expression for $\hat{P}$,

[6]See, for instance, the discussion of Mussa (1974).

$$\hat{P} = -\theta_N \hat{X}^* + \frac{(\pi^* k^* - \pi k)\theta_N}{\pi k \theta_L + \pi^* k^* \theta_N} \hat{\theta}_L. \tag{27}$$

We recall that eq. (22) relates the change in world income distribution to the resource supply change. Hence we obtain

$$\hat{P} = -\theta_N \hat{X}^* - \frac{(\pi^* k^* - \pi k)\theta_L (1 - 1/\sigma)\theta_N}{\pi k \theta_L + \pi^* k^* \theta_N} \hat{X}^*. \tag{28}$$

We can see from (28) that if world income distribution is not affected ($\sigma = 1$) or if world income distribution is affected but the national marginal propensities to spend are not different, the distribution effect of a resource shortage cancels and an increase in final goods price results only from the supply effect. If world income distribution changes in favor of the country with the greater propensity to spend, $\pi^* k^* - \pi k < 0$, we observe again an unambiguous increase in final goods price because supply and distribution effects work in the same direction. The ambiguity in the direction of change of $\hat{P}$ occurs only if $0 < \sigma < 1$ and $\pi^* k^* - \pi k > 0$. This can be seen by rewriting (28) as

$$\hat{P} = -\frac{\theta_N [\pi^* k^* + (\pi k - \pi^* k^*)\theta_L/\sigma]}{\Delta} \hat{X}^*, \tag{29}$$

$$\Delta \equiv \pi k \theta_L + \pi^* k^* \theta_N.$$

From (29) and (7) we obtain the change in resource price,

$$\hat{P}_N = -\frac{\pi k \theta_L + \pi^* k^* \theta_N \sigma}{\sigma \Delta} \hat{X}^*. \tag{30}$$

This shows that the relative change in resource price is greater or smaller than the relative change in resource supply as σ is smaller or greater than unity. In the case in which σ equals unity the formulas (29)–(30) confirm our more intuitive discussion of the absolute price changes at the beginning of this section,

$$\hat{P} = -\theta_N \hat{X}^*, \qquad \hat{P}_N = -\hat{X}^*.$$

Using eqs. (29) and (30) we can easily calculate the relative changes in world nominal income and national nominal incomes:

$$\hat{\bar{Y}} = \hat{P} + \hat{X} = \frac{(\sigma - 1)(\pi k - \pi^* k^*)\theta_L \theta_N}{\sigma \Delta} \hat{X}^*,$$

$$\hat{Y}^* = \hat{P}_N + \hat{X}^* = \frac{(\sigma - 1)\pi k \theta_L}{\sigma \Delta} \hat{X}^*, \tag{31}$$

$$\hat{Y} = \frac{\hat{\bar{Y}} - \theta_N \hat{Y}^*}{\theta_L} = -\frac{(\sigma - 1)\pi^* k^* \theta_N}{\sigma \Delta} \hat{X}^*.$$

Eqs. (31) confirm the constancy of all income terms[7] in the case in which σ equals unity. We realize further that if the marginal propensities to spend are not different for both countries the income redistribution effect disappears and we get, independently of the size of σ, the same result for the increase in final goods price and world nominal income as we might get by ruling out the income distribution effect through the assumption $\sigma = 1$. A small elasticity of substitution $0 < \sigma < 1$ leads to an unambiguous decline in domestic income and a rise in foreign income. This again indicates the strategic importance of σ for the explanation of balance of payments effects of a resource shortage. Knowing that the short-run balance of payments position is determined through hoarding we can compute expressions for the balance of payments by substituting (31) into (12),

$$\mathrm{d}B \equiv \mathrm{d}H = -\pi M \cdot \frac{(\sigma-1)\pi^* k^* \theta_N}{\sigma \Delta} \hat{X}^*,$$

$$\mathrm{d}B^* \equiv \mathrm{d}H^* = \pi^* M^* \frac{(\sigma-1)\pi k \theta_L}{\sigma \Delta} \hat{X}^*. \tag{32}$$

5. Effects of a resource shortage on the domestic labor market

In this section we look closer at the effects on the market for the domestic factor of production. First we are interested in knowing what happens to the domestic nominal wage rate if we assume a perfectly flexible wage rate.

We can express factor intensity changes as a function of real wage rate changes,

$$\hat{N} - \hat{L} = (\sigma/\theta_N)(\hat{W} - \hat{P}). \tag{33}$$

Assuming full employment and equilibrium in the market for the imported factor of production, we can express the change in the nominal wage rate as a function of changes in P and X^*,

$$\hat{W} = \hat{P} + (\theta_N/\sigma)\hat{X}^*.$$

Substituting for $\hat{P}$ from (29) the effects of a resource variation on nominal wage rate are given by

$$\hat{W} = -\frac{(\sigma-1)\pi^* k^* \theta_N}{\sigma \Delta} \hat{X}^*.$$

[7] We show in section 5 below that for $\sigma = 1$ the increase in P exactly offsets the decrease in marginal product of the domestic factor of production so that the nominal wage rate and, given the domestic labor supply, hence, domestic nominal income remain constant.

Comparing this equation with (31) it can be seen that $\hat{W}$ is equivalent to the change in domestic income because the domestic factor supply is constant. Further we note if $\sigma = 1$, variations in X^* do not affect the domestic wage rate.

Finally we turn to the case of a *fixed nominal wage rate*. Fixing the money wage rate deprives us of one degree of freedom and we must therefore in the following distinguish between actual employment L and full employment $\bar{L}$. With a fixed nominal wage rate the final goods price itself becomes a function of the resource supply given a certain input of domestic factors of production. This can be seen from (33) with $\hat{W} = 0$,

$$\hat{P} = -(\theta_N/\sigma)(\hat{X}^* - \hat{L}). \tag{34}$$

Using (34) and (29) we can determine the employment change as a function of $\hat{X}^*$. This is given by

$$\hat{L} = -\frac{(\sigma-1)\pi^* k^*}{\Delta} \hat{X}^*. \tag{35}$$

From (35) a decrease in the supply of imported resources decreases employment in the case of a fixed nominal wage rate only if the elasticity of substitution is smaller than one. Hence, it is quite conceivable that for $\sigma > 1$ we have over-employment of the domestic factor.

6. Conclusions and qualifications

We have restricted our analysis to a discussion of a particular *real shock* in a very simple monetary model of a vertically trading world economy.

The main theme of our analysis was that with $\sigma < 1$ an increase in the relative price of imported factors of production like oil imposes a real income loss upon countries which are net importers of these factors: the value added by such countries shrinks. We have seen that with fixed exchange rates downward adjustment in real spending dictated by the income loss can be smoothed by spending out of previously accumulated wealth (cash balances). The model shows that in the transient period 'overspending' is accompanied by a redistribution of cash balances in favour of natural resource producers, but in the long run real consumption must fall. With flexible wages and prices this adjustment takes place without unemployment, but necessary reductions in nominal wages are difficult to achieve. Hence following the analysis at the end of section 5, with fixed nominal wages unemployment will occur.

It would be worthwhile to reconsider the analysis of this paper along the lines of the so-called 'portfolio approach to balance of payments.' This gives oil-importing countries the possibility of 'paying for food and fuel' by borrowing from natural resource producers. In the case of flexible exchange rates a simple model would emerge in which current account deficits could be financed by a capital account surplus generated by sales of domestic securities to foreigners.

Appendix

Linear homogeneity of (1) allows the introduction of the following function,

$$x = f(m), \quad \text{with } x = X/L, \qquad m = N/L, \qquad q = P_N/P. \tag{A.1}$$

Hence we can rewrite (5) as

$$q = f_m(m), \qquad f_m = \frac{\partial F}{\partial N} = F_N. \tag{A.2}$$

Introducing relative changes in (A.2), we have

$$\hat{q} = \frac{mf_{mm}}{f_m}\hat{m}. \tag{A.3}$$

In terms of the function (A.1), the elasticity of substitution between domestic labor and imported materials is defined as

$$\sigma = \frac{-f_m(f-mf_m)}{mff_{mm}} > 0. \tag{A.4}$$

Introducing σ in (A.3), we get

$$\hat{q} = -(\theta_L/\sigma)\hat{m}, \quad \text{with } \theta_L = \frac{f-mf_m}{f}. \tag{A.5}$$

Using the definitions of m and q, we end up with the factor demand function

$$\hat{N} - \hat{L} = -(\sigma/\theta_L)(\hat{P}_N - \hat{P}). \tag{A.6}$$

Next, we evaluate the change in factor shares. From the definition of Q_N, we get

$$\hat{\theta}_N = \widehat{(P_N X^*)/(PX)} = \hat{P}_N - \hat{P} + \hat{X}^* - \hat{X}. \tag{A.7}$$

From (23) and (A.6) we can substitute in (A.7) and find that

$$\hat{\theta}_N = (1-1/\sigma)\theta_L \hat{X}^*. \tag{A.8}$$

Because $\theta_L + \theta_N = 1$, the following relation must hold,

$$\hat{\theta}_L = -\frac{\theta_N}{\theta_L}\hat{\theta}_N.$$

If we insert this in (A.8), we have

$$\hat{\theta}_L = -(1-1/\sigma)\theta_N\hat{X}^*. \tag{A.9}$$

(A.8) and (A.9) yield eq. (22) of the text.

References

Dornbusch, R., 1973, Devaluation, money and nontraded goods, American Economic Review 63, no. 3, 871–880.

Dornbusch, R. and M. Mussa, 1975, Consumption, real balances and the hoarding function, International Economic Review 16.

Johnson, H.G., 1971, The two sector model of general equilibrium (Allen and Unwin, London).

Khang, Ch., 1969, A neoclassical growth model of vertically related international trade, Osaka Economic Papers 17, 21–29.

Mussa, M., 1974, Oil relative prices and macroeconomic policy in an open economy, Paper presented at the Geneva Conference on Oil and the International Monetary and Financial System, November.