

## Stagflationary Effects of a Devaluation in a Monetary Model with Imported Intermediate Goods\*

### Stagflationäre Effekte einer Abwertung in einem monetären Modell mit importierten Rohstoffen

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#### 1. Introduction

The recent experience of exchange rate flexibility has supported the view that countries may not be able to insulate themselves from fluctuations in the world economy on the one hand, and that the trade-off between inflation and unemployment is worse under flexible rates compared to fixed rates on the other hand. The belief that an unmanaged exchange rate could become an independent source of inflationary pressure leads to modern attempts to integrate the theory of exchange rate determination with an analysis of inflation. Along these lines, it appears especially useful to analyse the case of an open economy where final goods prices are based on given labor costs and domestic currency prices of imported intermediate goods. In this setting, there exist two sources of intermediate goods price changes: an exogeneous rise in the world price of intermediates, like an oil price increase, and a currency depreciation. Oil price shocks have been classified as supply shocks which in turn have been defined as a "discrete jump in the price level firms require to be willing to produce a given quantity of GNP". From that definition it seems natural to argue along the lines of a

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Keynesian diagnosis<sup>1)</sup> that, from a rise in the price of imported intermediates, like oil, we will find an inflationary impact upon the domestic price level. With nominal wages rigid at a given level of employment, as import costs are passed on, a fall in real income will take place through a rising price level relative to fixed nominal incomes. This economy-wide real income loss, together with enlarged difficulties in export sales due to the higher domestic price level, triggers a contractionary multiplier process<sup>2)</sup>. Hence, in a Keynesian scenario, the economy in the absence of offsetting macroeconomic policies tends to respond to a supply shock with a stagflationary pattern of adjustment. Dealing with exchange rate changes, in this paper we show that a devaluation has an effect like the supply shock of an oil price increase as soon as we introduce direct cost-push effects of an exchange rate change in an open economy where indispensable raw materials are priced in foreign currency units<sup>3)</sup>. Traditionally, demand-oriented theories of devaluation, including the monetary approach, show stimulating demand effects of a devaluation on the domestic economy. While not denying those well-known effects, our model explains the response of output and price components of GNP upon exchange rate changes as a fine interplay between demand *and* supply forces. With the exchange rate considered as determining part of the cost of production, a devaluation (revaluation) adds to forces pushing up (restraining) the domestic price level. On the other hand, we observe two opposing effects on the demand side. Besides the well-known demand-pull (demand restricting) effects which operate via an improvement (deterioration) in competitiveness of domestic products, the real income effect of a devaluation (revaluation) operates via the domestic demand component similar to a price increase (decrease) for raw materials. Therefore, we can present a simple condition under which a devaluation has the potential to induce an inflationary recession of (gross) production in the domestic economy if the reduction in domestic absorption is not sufficiently counteracted by a strong increase in exports – the foreign component of aggregate demand.

It is worth emphasizing in a model with imported intermediate goods that movements in main economic variables like gross production, value added

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<sup>1)</sup> See papers given at the Kiel Conference on Macroeconomic Policies for Growth and Price Stability – The European Perspective, June 1979, especially the paper by *Kouri* and *Macedo*, Perspectives on the Stagflation of the 1970's. For an account of the different positions of Keynesians and Monetarists in the U. K. after the 1973/74 oil crisis, cf. *Miller* (1976) and *Schmid* (1980 b).

<sup>2)</sup> The assumption of rigid nominal wages has been introduced first by *Findlay* and *Rodriguez* (1977) in explicit contradiction of the full employment assumption in *Schmid* (1976). Theoretical work in the field of open economy macroeconomics with imported intermediates has also been done under varying assumptions by *Herberg* (1976), *Buiter* (1978), *Bruno* and *Sachs* (1979 b), *Dornbusch* (1979), *Herberg* (1979), and *Scarth* (1979). Specifically on competitiveness in a one-good model of world trade under wage rigidities cf. *Schmid* (1981 a, b).

<sup>3)</sup> This assumes the home country being a net importer of intermediate raw materials. For a relaxation of this assumption in case of domestic production of raw materials see *Bruno* and *Sachs* (1979 b) and *Djajic* (1980).

(= national income)<sup>4</sup>), or domestic employment are not necessarily positively correlated. Taking value added, in terms of final goods, as the real component of domestic GNP in an economy with imported intermediates, this paper also investigates GNP effects from a devaluation as opposed to the impact upon gross production. We demonstrate that under the realistic assumption of a low elasticity of substitution between domestic and imported factors of production a devaluation tends to have a contractionary effect on the real component of domestic GNP while raising its price component. We further show that contractionary devaluation effects on gross production and value added do not spill over to domestic employment if the parameters of the model are restricted by a modified Marshall-Lerner condition. It should be recognized in a model where all imports are intermediate goods that it is the elasticity of derived demand for intermediates – an elasticity of factor substitution – which plays the role of the more familiar elasticity of demand for imported final goods. This observation should be taken as a warning against premature policy conclusions. The hunch is that the possibility of expenditure switching in final goods consumption may weaken our contractionary results considerably and may even reestablish the old view on devaluation at least for specific parameter values of a specific economy.

## 2. *The Model*<sup>5</sup>)

We focus first on the supply side of the model. Domestic production,  $x$ , is a linear homogeneous function of domestic labour input,  $\ell$ , and inputs of raw materials,  $n$ .

$$x = x(\ell, n) \quad (1)$$

Given the price of final goods,  $P$ , the nominal wage rate,  $W$ , and the raw materials price,  $P_n$ , all in domestic currency units, factor demand in domestic production is determined by short-run profit maximization

$$Px_\ell(\ell, n) = W; \quad Px_n(\ell, n) = P_n$$

where  $x_\ell \equiv \partial x / \partial \ell$  and  $x_n \equiv \partial x / \partial n$ . We assume the representative production unit to be a price taker in factor markets, i.e., the model is one where the money

<sup>4</sup>) The difference between GDP and GNP is not what matters in our context because it is defined as payments to and from foreign owned primary factors of production. We rather would like to stress the distinction between GDP = GNP (= value added = domestic national income)  $\neq$  gross domestic production (= Bruttoproduktionswert) Note further, that for simplicity domestic value added is derived only from domestic labor instead from labor and capital.

<sup>5</sup>) Notation: Small letters are used for real variables and capital letters, except prices, for nominal variables. Relative change of a variable  $x$  is given as  $\hat{x} = dx/x$ . Sometimes we will write an equation in normal form and will add without further comments its "hat"-form assuming familiarity with the rules of the so-called "hat calculus".

wage rate,  $W$ , is given and labour is in perfectly elastic supply. Hence, the quantity transacted in the labour market is determined by the short side of the market. The same holds true for raw materials markets. World market price for raw materials,  $P_n^*$ , is taken to be fixed in foreign currency units. Given the exchange rate,  $E$ , denoted as the price of foreign currency in domestic currency units, the domestic price of imported inputs is

$$P_n = EP_n^* \quad \text{or} \quad \hat{P}_n = \hat{E} + \hat{P}_n^* \quad (2)$$

At the ruling world market price,  $P_n^*$ , the domestic economy always obtains the quantity of raw materials it has asked for. Price of domestic output,  $P$ , is set by firms in a competitive way at the level of unit costs.

$$P = a_\ell W + a_n P_n \quad \text{with} \quad a_\ell \equiv \ell/x; a_n \equiv n/x \quad (3)$$

As a consequence of linear homogeneous technology, input coefficients  $a_i$  ( $i = \ell, n$ ) are functions of the relative factor price,  $W/P_n$ , alone.

$$a_\ell = a_\ell(W/P_n); \quad a_n = a_n(W/P_n)$$

Making use of the well-known condition of cost minimization, differentiation of (3) gives the percentage change of the output price as the average of changes in factor prices.

$$\hat{P} = \theta_\ell \hat{W} + \theta_n \hat{P}_n \quad (4)$$

In (4), symbols  $\theta_\ell \equiv (W/P)a_\ell$ ,  $\theta_n \equiv (P_n/P)a_n$  represent shares of domestic or imported factors of production, respectively, in the value of domestic production. As is well known those shares sum up to unity.

$$\theta_\ell + \theta_n = 1$$

As is further known these shares appear as partial elasticities of production if we differentiate (1)

$$\hat{x} = \theta_\ell \hat{\ell} + \theta_n \hat{n} \quad (5)$$

Introducing the factor intensity  $v \equiv n/\ell$ , we can rewrite the change in output (5) in two equivalent ways.

$$\hat{x} = -\theta_\ell \hat{v} + \hat{n} \quad \text{or} \quad \hat{x} = \theta_n \hat{v} + \hat{\ell} \quad (6)$$

Knowing that the definition of the elasticity of factor substitution relates changes in factor intensity to changes in relative factor price,

$$\hat{v} = \hat{a}_n - \hat{a}_\ell = -\sigma(\hat{P}_n - \hat{W}) \quad \sigma > 0 \quad (7)$$

we combine (6) and (7) to find a useful relation.

$$\hat{x} = \theta_\ell \sigma (\hat{P}_n - \hat{W}) + \hat{n} \quad (8)$$

Note that, fixing the relative factor price ratio, (8) exhibits constant returns to scale if we let output depend on factor use. (4) and (8) fully determine price output responses of the production side of our economy which has to be brought into line with the consumption side later. Therefore, we turn now to income, spending, and the role of money.

It is of strategic importance in the macroeconomic analysis of imported intermediates to distinguish the value of gross production and domestic value added (GNP). Nominal gross national product is less than the total value of gross domestic production by the value of a country's bill of raw materials imports. Denote  $P_x$  as the value of domestic production at let  $Y$  represent the value of gross national product. We then have the following relation<sup>6)</sup>

$$Y = P_x - P_{n,n} \quad (10)$$

Recalling the terms of production given above, we can say more about GNP and the value of production. We know that the value of production is exhausted by the sum of factor payments. Therefore, we can identify the share of GNP in the value of output as the cost share of the domestic factor of production in the value of domestic output<sup>7)</sup>.

$$Y/P_x \equiv \theta_\ell = 1 - \theta_n \quad \text{with} \quad \theta_n \equiv P_{n,n}/P_x$$

Using these shares, we can derive from (10) another useful relation showing the relative change of GNP in value terms as a function of relative changes in all other variables.

$$\hat{Y} = \frac{1}{\theta_\ell} (\hat{P} + \hat{x}) - \frac{\theta_n}{\theta_\ell} (\hat{P}_n + \hat{n})$$

For later use, we are interested in real GNP,  $y \equiv Y/P$ , which we measure, deflating (10) by the price level,  $P$ , as

$$\hat{y} = \frac{1}{\theta_\ell} \hat{x} - \frac{\theta_n}{\theta_\ell} (\hat{P}_n - \hat{P} + \hat{n}) \quad (11)$$

We characterize the consuming sector by imposing a budget constraint on the representative consumer.

<sup>6)</sup> If we assume, as *Bruno and Sachs* (1979 b) do, that the domestic country would produce a quantity,  $h$ , of raw materials itself, then it is the value of net imports of the intermediate good which determines the difference between output and GNP. To see this, note that value added in the two industries of the economy is  $P_x - P_{n,n}$  and  $P_{n,h}$  respectively. Total value added is the sum of sectoral value added  $Y = P_x - P_{n,n}(n-h)$ .

<sup>7)</sup> Within the context of the world model developed in *Schmid* (1976), domestic GNP measures value added contributed by the domestic country to value of world production.

$$Y = C + H \quad \text{with} \quad H \geq 0 \quad (12)$$

$$C = P_c \quad (c = \text{physical consumption})$$

According to (12), consumption expenditures<sup>8</sup>) may deviate from national income by positive or negative amounts of hoarding,  $H$ . Routinely, authors of the monetary approach explain consumption behaviour in terms of a hoarding function. Hoarding appears as a linear stock adjustment process where actual cash balances,  $M$ , are adjusted continually to desired money holdings,  $L$ , which in turn are assumed to be a linear function of nominal income.

$$\dot{M} = H = \lambda[kY - M] \quad \lambda, k = \text{const} > 0 \quad (13)$$

Using (13) in (12) and assuming  $0 < \lambda k < 1$ , nominal expenditures appear quite normally as a linear function of nominal income.

$$C = (1 - \lambda k)Y + \lambda M \quad (14)$$

First, note the importance of the long-run stock equilibrium for the expenditure function (14). If  $kY = M$  stock equilibrium prevails and consumers spend all their income. If  $kY \neq M$  consumers spend more or less than their income, using hoarding or dishoarding to reduce disequilibrium in the stocks of money holdings. Secondly, note the property of linear homogeneity of the expenditure function in  $Y$  and  $M$ . To explore this property a bit further, let us define the following expenditure elasticities with respect to nominal income and actual cash balances evaluated at a point of long-run stock equilibrium.

$$\frac{\partial C}{\partial Y} \frac{Y}{C} \equiv \alpha = (1 - \lambda k); \quad \frac{\partial C}{\partial M} \frac{M}{C} \equiv \varrho = \lambda k \quad (15)$$

We can enjoy this new notation in differentiating (14) at a point of long-run stock equilibrium to get

$$\hat{C} = \alpha \hat{Y} + \varrho \hat{M} \quad (16)$$

In (16), linear homogeneity imposes the following useful condition upon our spending parameters

$$\alpha + \varrho = 1$$

Knowing what happens to nominal expenditures sometimes is not enough if we have to deal with an economy where prices and quantities are independent

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<sup>8</sup>) We suppress investment expenditure, thereby using consumption expenditures and absorption as synonymous expressions.

variables. We therefore deflate (14) by the domestic price level to get

$$c = (1 - \lambda k)y + \lambda m \quad (17)$$

$$y = Y/P, \quad c = C/P, \quad m = M/P$$

The differentiated form of (17) is now

$$\hat{c} = \alpha \hat{y} + \rho \hat{m} \quad (18)$$

The real expenditure function (18) indicates differences in real consumption behaviour not obvious from the nominal expenditure function:

- i) A uniform increase of price level and nominal cash balances holding real income constant raises nominal expenditures by the same percentage rate while real consumption demand remains constant<sup>9)</sup>.
- ii) A uniform increase of real income and nominal cash balances holding price level constant raises nominal expenditures by the same percentage rate. This time, however, real consumption demand has increased.

It remains to complete the exposition of our model by specifying how equilibrium is reached at the market for final products and to explain the fundamental equivalence between trade balance and hoarding even in the present context of a vertically trading open economy. For a final goods market equilibrium, domestic supply and demand from domestic and foreign residents must equalize.

$$x = c + c^* \quad (19)$$

In (19) we have  $c^*$  representing foreign demand for domestic final products. Foreign demand for exports is assumed to be a decreasing function of the price of domestic goods in terms of foreign currency units.

$$c^* = c^*(P/E) \quad (20)$$

Negative and positive changes in export demand arise in this specification from a change in domestic price for exports and from exchange rate changes. That can be seen by introducing the elasticity of export demand,  $\eta$ . We find<sup>10)</sup>

$$\hat{c}^* = \eta(\hat{P} - \hat{E}) - 1 \leq \eta \equiv \frac{dc^*}{dP^*} \frac{P^*}{c^*} \leq 0 \quad (21)$$

<sup>9)</sup> As a corollary, if we hold nominal cash balances constant and increase nominal income and price level by the same rate real income stays constant. However, real consumption declines because of a negative real balance effect working via the parameter  $\rho$ . Note that nominal expenditures increase in that case at a lower rate than the increase in nominal income.

<sup>10)</sup> Implicit in our specification of the export demand function we have the assumption  $-1 \leq \eta \leq 0$ . In a world with only one final product the rest of the world either produces the same good or it specializes in the production of the intermediate good. In both cases foreign export demand is closely related to the difference between income and expenditures in the "foreign" country and their dependence on the foreign price level.

The interesting feature of our specification (21) is that in a crude way it models the idea of competitiveness of domestic exports in a perfect world market for final goods as the interplay of two factors, i.e., offering domestic exports at rising domestic prices hurts export sales while an increase in the exchange rate helps selling.

In an open economy with a vertical trading pattern, the trade balance,  $B$ , contrasts exports of final products with imports of raw materials.

$$B = P_c^* - P_n n \quad (22)$$

To show the correspondence between the trade balance and domestic hoarding we multiply equilibrium condition (19) by price level,  $P$ . That gives the statement that revenues to the domestic country from selling to domestic and foreign residents equal the value of domestic production which in turn is exhausted by payments to domestic and foreign factors of production. Therefore, when we subtract payments for imported raw materials from both sides we get

$$P_x - P_n n = P_c + P_c^* - P_n n \quad (23)$$

The left side of (23) we recognize as domestic income, hence (23) can be rewritten in a well-known form

$$Y = C + EX + IM \quad \text{with} \quad EX \equiv P_c^*, \quad IM \equiv P_n n \quad (24)$$

Using the budget constraint (12) in (24), we end up with the relation between trade balance and hoarding we looked for.

$$B = H \quad (25)$$

(25) illustrates a distinctive common feature of the monetary approach and the absorption approach: As long as domestic absorption is in accordance with domestic income, trade balance must be zero. This we must keep in mind while differentiating (19) in the initial state of balanced trade to get another highly useful relation.

$$\hat{x} = \theta_c \hat{c} + \theta_n \hat{c}^* \quad (26)$$

Application of the traditional absorption approach to a vertically trading open economy underlines the lack of distinction most monetary trade models exhibit with respect to value of domestic production and value of national product (= value of national income). It is exactly that difference which matters. Hence, domestic absorption has to be compared to domestic value added, not value of production, if we make statements concerning the domestic trade balance. The simple message is that a country lives beyond its means as soon as its absorption exceeds the value added that country contributes in the process of making final products out of raw materials in a two-tier world-production

process. As a consequence of its absorption behaviour, such a country runs a trade deficit. The equivalence of hoarding and the trade balance can be used to explain the change in the trade balance by changes in hoarding. We find from (25) with (15)

$$dB = \lambda M[\hat{y} + \hat{P} - \hat{M}] \quad (27)$$

With fixed exchange rates, this means that, as long as we have an unbalanced trade account, we have an inflow or outflow of money which is used to adjust actual to desired money balances. Only a balanced trade account halts the process of redistribution of money supply between trading countries and we refer to such a state as a long-run stock equilibrium without analysing it further.

The equations given so far can be condensed to a model in which we can explain changes of three endogenous variables ( $\hat{x}$ ,  $\hat{P}$ ,  $dB$ ) taking into account changes in four exogenous variables ( $\hat{P}_n^*$ ,  $\hat{E}$ ,  $\hat{W}$ ,  $\hat{M}$ ).

Following this design of analysis, we deal first with the final goods market. Using (18) and (21) in (26), we find

$$\hat{x} = \theta_\ell[\alpha\hat{y} + \rho\hat{m}] + \theta_n[\eta(\hat{P} - \hat{E})] \quad (28)$$

Repeating (11) for ready use,

$$\hat{y} = \frac{1}{\theta_\ell} \hat{x} - \frac{\theta_n}{\theta_\ell} [\hat{P}_n - \hat{P} + \hat{n}]$$

we observe as a bracketed term the change in real domestic expenditures for imported raw materials, i.e., the "real oil bill". Substituting for  $\hat{n}$  from (8), we catch the "direct" change of domestic real income if we raise prices of raw materials and domestic labour *holding constant domestic production*.

$$\hat{y} = \frac{1}{\theta_\ell} \hat{x} - \frac{\theta_n}{\theta_\ell} [\theta_\ell(1 - \sigma) \hat{P}_n - \theta_\ell(1 - \sigma) \hat{W} + \hat{x}] \quad (29)$$

$$\hat{y} = \hat{x} - \theta_n(1 - \sigma) (\hat{P}_n - \hat{W}) \quad (30)$$

Note that we have evaluated the real income squeeze by incorporating cost-push effects on the domestic price level induced by factor price increases from (4). Assuming realistic values of  $0 \leq \sigma < 1$ , we can identify a negative real income effect of an increase in raw materials prices and a positive income effect of a rising wage rate. Using (30) in (28), we have the first equation of our final system of equations.

$$\begin{aligned} (\rho\theta_\ell + \theta_n)\hat{x} + (\rho\theta_\ell - \eta\theta_n)\hat{P} &= \\ = -\alpha\theta_\ell\theta_n(1 - \sigma)\hat{P}_n + \alpha\theta_\ell\theta_n(1 - \sigma)\hat{W} - \eta\theta_n\hat{E} + \rho\theta_\ell\hat{M} & \quad (31) \end{aligned}$$

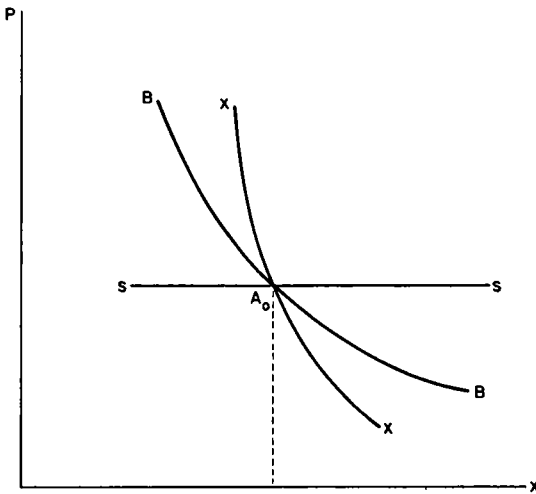


Figure 1

The falling  $xx$  line in Figure 1 depicts goods market equilibrium in  $x, P$  space. The negative slope of the  $xx$  line indicates restrictive demand effects exerted by domestic price level increases operating via both a negative real balance effect and a reduction in exports. The demand shortage triggers a receding production level to establish a new goods market equilibrium. The recession of production feeds on itself via a contractionary multiplier process towards the lower level of production. The coefficient of  $\hat{x}$  in (31) shows the inverse of the output multiplier in an open resource-importing economy.  $\theta_n$  represents the leakage corresponding to the raw materials bill and  $\varrho\theta_\ell$  represents the marginal propensity not to spend with respect to gross production. Therefore, the elasticity of the  $xx$  line is negative, appearing larger or equal to unity in absolute value as long as  $-1 \leq \eta \leq 0$ .

$$\hat{P}/\hat{x} \Big|_{xx} = -\frac{\varrho\theta_\ell + \theta_n}{\varrho\theta_\ell - \eta\theta_n} < 0$$

On the right hand side of (31), we track down the tax-like effect of a raw materials price increase if and only if  $0 \leq \sigma < 1$ . Note that an increase in the nominal wage rate correspondingly works in the contrary, producing a demand stimulus if  $0 \leq \sigma < 1$ <sup>11</sup>). The impact of a devaluation can now be shown to be

<sup>11</sup>) A reader used to thinking that stagflation is the standard result from a nominal wage increase exceeding productivity progress (cf. Schmid (1980 a)) may find this surprising. He is invited to reflect upon the fact that, if resource exporters can impose a real income loss upon resource consumers, then in the case of low substitution-possibilities, resource importing countries must be able to regain some of the *direct income loss* by raising the price of domestic factors of production. Because of this positive effect on domestic real income a nominal wage increase in the present model may even stimulate domestic output while raising the domestic price level if the positive real income effect is sufficiently strong (cf. Schmid, (1980 b)).

subjected to conflicting forces if we consider (2) in (31). We find

$$-[\alpha\theta_\ell\theta_n(1-\sigma) + \eta\theta_n]\hat{E} \geq 0 \quad (32)$$

On the one hand, we realize the stimulating impact a devaluation has in the export market, while, on the other hand, a rising exchange rate influences a resource-importing open economy in the same way we just mentioned in connection with a rising price of raw materials.

Next we have portrayed a horizontal ss curve in Figure 1. This curve delineates cost determinedness of the final product price. Simultaneously, it can be looked at as a macroeconomic supply function, if we vary the output level, holding factor prices constant, with a linear homogenous technology. The properties of the ss curve can be realized by combining (4) and (2) to get

$$\hat{P} = \theta_n(\hat{P}_n^* + \hat{E}) + \theta_\ell\hat{W} \quad (33)$$

Obviously, the price elasticity of output is infinity at the cost-determined price level. Increases in factor prices shift the ss curve upwards, the percentage change being given by the cost share of the factor of production whose price has risen.

Finally, Figure 1 shows the BB curve as a falling line. This locus is determined by combinations of price and output levels compatible with trade balance equilibrium. Using (11) in (27), we get

$$dB = \lambda M \left[ \frac{1}{\theta_\ell} \hat{x} - \frac{\theta_n}{\theta_\ell} (\hat{P}_n - \hat{P} + \hat{n}) + \hat{P} - \hat{M} \right]$$

Substitution of  $\hat{n}$  from (8) results in

$$dB = \lambda M [\hat{x} + \hat{P} - \theta_n(1-\sigma)\hat{P}_n + \theta_n(1-\sigma)\hat{W} - \hat{M}] \quad (34)$$

where the elasticity of the BB curve can be seen as

$$\left. \frac{\hat{P}}{\hat{x}} \right|_{BB} = -1$$

Given the domestic money supply and factor prices as in (34), we need an inverse relationship between real income and price level if the trade balance is to be preserved. This is necessary because an isolated increase of each of these variables produces excess demand for cash balances by increasing demand or decreasing supply of real cash balances, respectively. Hence, points to the right or above the BB curve represent a trade balance surplus. Similarly, we can argue that increases in the money supply and raw materials price and a declining wage rate are related to excess cash balances if  $0 \leq \sigma < 1$ . Given  $x$ ,  $P$ , this results in trade balance deficits because the BB curve shifts to the right.

The model we were looking for is given now as equations (31), (33), and (34). By rewriting these in a compact matrix version, we realize its ability to determine  $\hat{x}$ ,  $\hat{P}$ , dB.

$$\begin{bmatrix} [\varrho\theta_\ell + \theta_n] & [\varrho\theta_\ell - \eta\theta_n] & 0 \\ 0 & 1 & 0 \\ 1 & 1 & -(1/\lambda M) \end{bmatrix} \begin{bmatrix} \hat{x} \\ \hat{P} \\ \text{dB} \end{bmatrix} \quad (35)$$

$$= \begin{bmatrix} -\alpha\theta_\ell\theta_n(1-\sigma) & \alpha\theta_\ell\theta_n(1-\sigma) \\ \theta_n & \theta_\ell \\ \theta_n(1-\sigma) & -\theta_n(1-\sigma) \end{bmatrix} \begin{bmatrix} \hat{P}_n^* \\ \hat{W} \end{bmatrix} + \begin{bmatrix} -[\alpha\theta_\ell\theta_n(1-\sigma) + \eta\theta_n] & \varrho\theta_\ell \\ \theta_n & 0 \\ \theta_n(1-\sigma) & 1 \end{bmatrix} \begin{bmatrix} \hat{E} \\ \hat{M} \end{bmatrix}$$

The determinant of (35) is

$$D = -\frac{1}{\lambda M} \Delta < 0$$

$$\Delta = \varrho\theta_\ell + \theta_n > 0$$

### 3. Devaluation and Domestic Production

The theory of devaluation has widely neglected the import content of exports. As a consequence, Keynesian open economy models, as well as monetary approach models, tend to overestimate the output response of a devaluation. The present model gives an unbiased view of exchange rate effects showing a simultaneous impact of a currency depreciation on the demand side as well as on the supply side of an open economy. This view reduces the expansionary effects the traditional theory claims with regard to a devaluation while at the same time it stresses a particularly strong form of direct interaction between the domestic price level and exchange rate changes. In order to discuss this view in a moment in more detail, it is useful to calculate from (35) the effects of a currency depreciation on a number of relevant variables.

$$\hat{x}/\hat{E} = -\frac{\theta_n[\theta_\ell(\eta - \sigma + 1) + \sigma\varrho\theta_\ell]}{\Delta} \cong 0 \quad (36)$$

$$\hat{P}/\hat{E} = \theta_n > 0 \quad (37)$$

Using (36) in the factor demand functions given by (8) and (6) with regard to (7) yields

$$\hat{n}/\hat{E} = -\frac{\theta_\ell[\theta_n(\eta - \sigma + 1) + \sigma(\varrho + \theta_n)]}{\Delta} \quad (38)$$

$$= -\frac{\theta_\ell[\theta_n(1 + \eta) + \sigma\varrho]}{\Delta} < 0 \quad (39)$$

$$\hat{r}/\hat{E} = -\frac{\theta_n[\theta_\ell(\eta - \sigma + 1) - \sigma\theta_n]}{\Delta} > 0 \quad \text{if } (\eta - \sigma + 1) < 0 \quad (40)$$

Overlooking results (36)–(40), we realize a common term  $(\eta - \sigma + 1)$  which appears in nearly all our results. We point out next the importance of this expression in connection with the so-called “primary reactions” of the trade balance. We repeat the definition of the trade balance.

$$B = P^*c - P_n n \quad (22)$$

Differentiation of (22), in a state of initially balanced trade yields, with respect to (21), (8), (4) and (2)

$$dB = -Pc^*[\theta_\ell(\eta - \sigma + 1)\hat{E} + \hat{x}]. \quad (41)$$

Holding production constant, we can say that we find a “normal” reaction of the trade balance if the following condition holds.

$$(\eta - \sigma + 1) < 0 \quad (42)$$

Recalling  $\sigma$  as our elasticity of import demand, we look upon (42) as a modified Marshall-Lerner condition, the validity of which we always assumed as we evaluated the signs of our results (36)–(40). We can express the total impact of a devaluation upon the domestic trade balance if we insert (36) in (41).

$$dB/\hat{E} = \frac{-Y\varrho\theta_n[\theta_\ell(\eta - \sigma + 1) - \sigma\theta_n]}{\Delta} > 0 \quad (43)$$

Comparison of (43) with (40) indicates the strong connection in trends of both the trade balance and the employment variable.

In a resource-importing country, a devaluation acts like a supply shock by raising production costs. However, this is not the whole story. On the demand side two opposing effects manifest themselves in the coefficient of  $\hat{E}$  in (35)<sup>12</sup>.

$$-[\theta_n\eta + \alpha\theta_\ell\theta_n(1 - \sigma)] \geq 0 \quad (44)$$

<sup>12</sup> This coefficient yields demand effects for a given price level except that we took into consideration price level increases when we evaluated the direct real income effect.

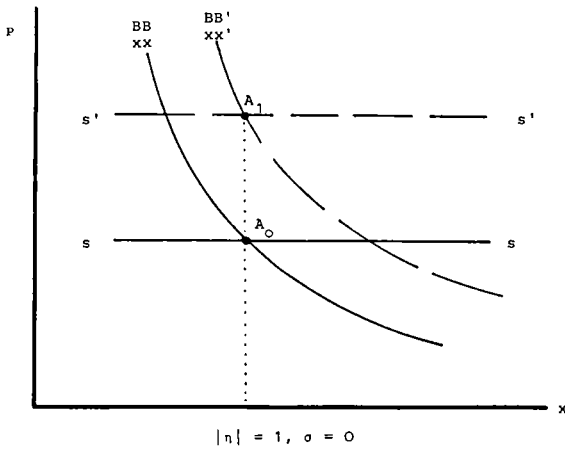


Figure 2

The first term shows the well-known export stimulating effect because a devaluation improves competitiveness of domestic exports. The second term characterizes the fall of demand for domestic goods induced by the direct real income loss which accrues to domestic residents if  $0 \leq \sigma < 1$  in just the same way it results from a higher foreign currency price of raw materials. To fix ideas and to understand better the total result of interacting forces it is worthwhile to consider a theoretical border line case:  $|\eta| = 1, \sigma = 0$ . Despite the general indeterminacy of (44), in this special case we find a clear-cut increase in total demand, given the price level. This appears as a rightward shift of the  $xx$  curve in Figure 2<sup>13</sup>). Further, we observe the cost effect of a devaluation pushing upwards the  $ss$  curve in Figure 2. This demonstrates two more dampening factors in total demand for domestic goods, namely a negative real balance effect in goods demand of domestic residents and a negative effect in export sales because of rising domestic prices. Figure 2 presents a situation where the loss in demand of domestic residents is exactly compensated by a (net) increase in demand of foreign residents. Thus domestic output and factor demand remain constant. Domestic income and absorption also remain constant in nominal terms ensuring that the trade balance stays balanced. As export value has increased by the percentage of the exchange rate change if  $|\eta| = 1$ , import value must have risen via a price increase by the same percentage.

$$\hat{x}/\hat{E} = 0; \quad \hat{P}/\hat{E} = \theta_n; \quad \ell/\hat{E} = \hat{n}/\hat{E} = 0$$

These findings are summed up in a new equilibrium point  $A_1$  in Figure 2. However, as soon as  $\sigma$  approaches higher values, the direct real income effect is

<sup>13</sup>) Note that the  $xx$  and  $BB$  curves coincide if  $|\eta| = 1$ . We further can see from (35) that  $xx$  and  $BB$  curves shift to the right by the same percentage rate if  $\sigma = 0$ .

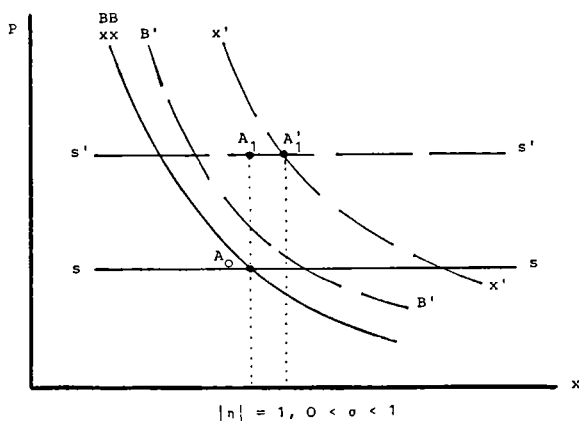


Figure 3

weakened, therefore the demand loss from domestic residents falls short of the demand increase resulting from export gains. Now a devaluation unambiguously raises domestic output and employment. These findings show up in Figure 3 if  $|\eta| = 1$  and  $0 < \sigma < 1$ . Points of a new equilibrium as  $A_1$  must be located to the right of  $A_0$  if  $0 < \sigma < 1$ . Note that the  $BB$  curve is shifted to the right the less the increase in  $\sigma$ ; hence, for a growing  $\sigma$  trade balance surpluses become larger.

It appears that the implications of a reduction in  $|\eta|$ , the export elasticity, are uncertain. On the one hand, export aid by devaluation is diminished the lower the absolute values of the elasticity of export demand. From (44) we can conclude if  $|\eta|$  falls below some critical value, the (net) demand effect of a devaluation will become negative even when the price level is given<sup>14</sup>). On the other hand, the cost-push effect of a rising exchange rate on the price of domestic goods hurts exports less, the more inelastic is the export demand of the domestic country. This effect shows up as a greater steepness of the  $xx$  curve. In total, a reduction of  $|\eta|$  causes a decline of the expansive power normally attributed to devaluation by raising the export component of total demand for domestic goods. Corresponding to each value of  $0 \leq \sigma < 1$ , there exists a critical value of  $|\eta|$  below which export support is weakened so far that it is unable to exceed demand losses on the part of domestic residents. In such an event a devaluation brings stagflation to the devaluing country. The exact condition for that unusual result is given in (36). We have

$$\hat{x}/\hat{E} \geq 0 \quad \text{if} \quad \sigma(1 - \rho) - (1 + \eta) \geq 0 \quad (45)$$

Formula (39) shows another most interesting result by proving that the recession of domestic production takes place without affecting domestic employment

<sup>14</sup>) That value for  $|\eta|$  is sufficient for a stagflationary adjustment, because the  $xx$  curve shifts to the left when the domestic country devaluates.

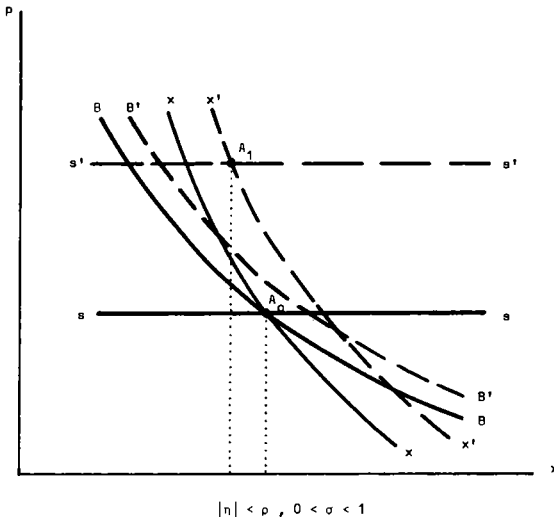


Figure 4

as long as we are prepared to assume a normal reaction of the trade balance after a devaluation<sup>15</sup>). In this case, (43) tells us that the *total effect* of a devaluation on the trade balance is unambiguously positive. Figure 4 sums up such a course of events demonstrating stagflation and a trade surplus as a result of domestic devaluation. A sufficient condition for the stagflationary result is  $|\eta| < \rho$  if  $0 < \sigma < 1$ . In general we can say the occurrence of stagflation is assisted by a small elasticity of substitution between domestic and imported factors of production and a small elasticity of export demand.

#### 4. Devaluation and Value Added

Because of the importance of GNP analysis in traditional open economy macroeconomics we next reformulate our model in a way which emphasizes this traditional format of macroeconomic analysis<sup>16</sup>). We hope that this pays off later when we shall discuss GNP effects of a devaluation in more detail. It will turn out that the import content of exports substantially modifies the traditional argument about the GNP impact of these disturbances.

<sup>15</sup>) Note that  $|\eta| < 1$  is a sufficient condition for stagflation if  $\sigma = 0$ . However, this parameter constellation violates condition (42) for a "normal" trade balance reaction.

<sup>16</sup>) *Findlay-Rodriguez* (1977) have studied mainly GNP effects. The attentive reader should be aware that they speak somewhat confusingly about "output" when they refer to GNP, i.e., "(net) output". Gross production effects have been studied within their model in *Scarth* (1979).

More in line with traditional macro analysis, we set up the goods market equilibrium condition (24) in a way which yields real GNP deflated by the final goods price level.

$$y = c + c^* - (P_n/P)n \quad (46)$$

Assuming balanced trade initially, we can differentiate (46) to obtain

$$\hat{y} = \hat{c} + \frac{\theta_n}{1 - \theta_n} [\hat{c}^* - (\hat{P}_n - \hat{P} + \hat{n})] \quad (47)$$

Factor demand for intermediate goods is

$$\hat{n} = -\theta_e \sigma (\hat{P}_n - \hat{W}) + \hat{x} \quad (8)$$

To evaluate the real oil bill  $(P_n/P)n$  substitute the factor demand function (8) in (47), and then additionally take into account the cost-push effects from increased factor prices on the domestic price level,  $\hat{P} = \theta_n \hat{P}_n$  and  $\hat{P} = \theta_e \hat{W}$ . If we further use (18) and (21) in (47) we obtain the goods market equation

$$\begin{aligned} & [\theta_e \varrho + \theta_n] \hat{y} + [\theta_e \varrho - \theta_n \eta] \hat{P} = \\ & = \theta_e \varrho \hat{M} - [\theta_n (1 - \sigma + \eta)] \hat{E} - \theta_n (1 - \sigma) \hat{P}_n^* + \theta_n (1 - \sigma) \hat{W} \end{aligned} \quad (48)$$

Figure 5 depicts the goods market equilibrium condition in  $P, y$  space as the line  $yy$ . This line is downwards sloping because we can generate an excess supply of goods by either increasing the price level or by expanding real GNP. The former expresses a demand contraction from a negative real balance effect and from diminishing export sales, while the latter follows if we realize that an increase in GNP raises goods demand by the marginal propensity to spend while goods supply must increase by a factor  $1/(1 - \theta_n) > 1$ . Note that these considerations assume given real factor prices in terms of final goods. On the other hand, we observe a shift of the  $yy$  line to the right or to the left from an increase in the real wage or the real oil price, respectively<sup>17</sup>). These shifts are symmetric and their magnitude depends upon  $\sigma$ , the elasticity of factor substitution. Finally we observe conflicting goods market effects of an exchange rate change. If factor imports are priced in foreign currency units a devaluation raises the real factor price of intermediates in the same way as does an exogenous increase in the foreign currency price of intermediates and this accounts for a fall in aggregate demand via a real income loss. On the other hand, given the final goods price level, a devaluation invites foreign demand if  $0 < |\eta| \leq 1$ . As in Section 3 we

<sup>17</sup>) Note that in (48) increases in nominal factor prices,  $\hat{W}, \hat{P}_n^*$ , actually measure changes in real factor prices because we have already allowed for cost push induced price level increases.

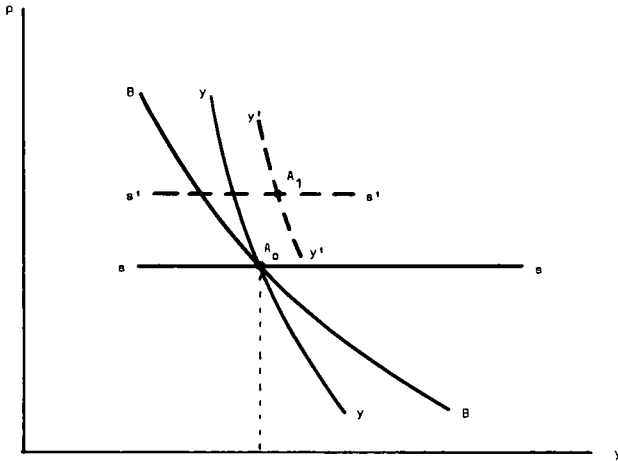


Figure 5

assume that the latter export demand effect dominates the former tax-like real income loss, i.e.,  $(1 - \sigma + \eta) \leq 0$ . This condition is analogous to the well-known Marshall-Lerner condition although we have certainly a different model because the direct response to a devaluation is one of a demand for a factor of production. The elasticity of import demand is the elasticity of substitution away from imported intermediates, the real factor price ( $P_n/P$ ) of which rises, given the level of production<sup>18</sup>).

The BB line of Figure 5 portrays trade equilibrium. This line must have a negative slope because, with a given money supply, real income and the price level must react in opposite directions to keep money stocks in equilibrium. From (27) we have

$$dB = \lambda M(\hat{y} + \hat{P} - \hat{M}) \quad (27)$$

Equation (27) shows that the BB line is unit-elastic, and therefore, with  $0 \leq |\eta| \leq 1$ , the yy line is always steeper or has the same slope as the BB line. Finally Figure 5 exhibits the determination of the price level from the cost side.

$$\hat{P} = \theta_n(\hat{P}_n^* + \hat{E}) + \theta_c \hat{W} \quad (33)$$

Equations (48), (27), and (33) represent the open economy model with imports of intermediates in a more traditional format by bringing out the real and price components of GNP.

<sup>18</sup> As we already know, the total effect upon derived demand for intermediates must also allow for a scale effect from an ambiguous change in gross production (see (36)). This total effect has been shown to be unambiguously negative (see (38)).

Solving for  $\hat{y}$  from (48) and (33), we obtain

$$\hat{y}/\hat{E} = \theta_n \frac{\Delta' - \Delta}{\Delta} = - \frac{\theta_n[(1 - \sigma) + \theta_e(\rho + \eta)]}{\Delta} \geq 0 \tag{49}$$

$$\Delta' = \sigma - \theta_e(1 + \eta) \quad 0 < \Delta' < 1$$

The ambiguous effect of a depreciation on domestic value added can be demonstrated using Figure 5 where fulfilment of our modified Marshall-Lerner condition secures a rightward shift of the  $yy$  line. The shift is larger the lower is  $\sigma$  and the greater is  $|\eta|$ . The shift to the right may or may not be enough to permit higher GNP at an increased price level the latter being a necessary consequence of the direct cost-push effect of a devaluation assuming a constant nominal wage rate. We also observe that a devaluation improves the trade balance unambiguously if  $(1 - \sigma + \eta) < 0$ . As we have pointed out in equation (40) this condition also guarantees a rise in domestic employment in response to a depreciation.

According to (49), the GNP effect of a devaluation is ambiguous for an economy with imports of intermediates priced in foreign currency units. Closer inspection of (49) reveals a critical condition for a successful depreciation with respect to GNP.

$$\hat{y}/\hat{E} \geq 0 \quad \text{if} \quad \sigma - \theta_e(1 + \eta) \geq \Delta \tag{50}$$

A more detailed discussion of the economic meaning of (50) is facilitated greatly by a representation of (50) in the parameter space of Figure 6. First, note

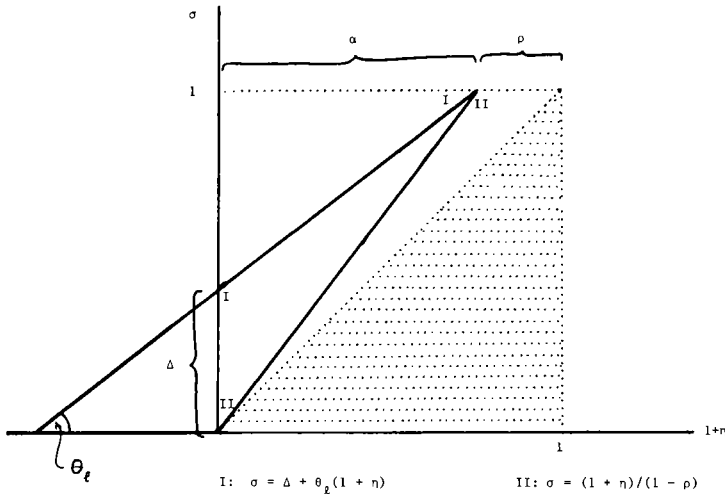


Figure 6

that condition (50) is represented by the straight line I I in  $[\sigma, (1 + \eta)]$  space. Second, it is clear that, given the oil share of an economy and its propensity to spend, location of line II is fixed and its position is within the admissible (non-dashed) range defined by our modified Marshall-Lerner condition. Line I I, according to (50), divides the parameter space in two sections characterized by a positive or negative GNP response to a devaluation. It is now important to notice that our model not only shows the combined appearance of a simultaneous rise or fall in production and GNP but also opens the possibility of a negative GNP response to a domestic depreciation despite an apparently rising domestic production. To understand this, consider (45), the condition for a positive or negative output effect from a devaluation. Note that this condition has been depicted in Figure 6 as line II II. The main point to realize is that, given the oil share,  $\theta_n$ , and the propensity to spend,  $1 - \varrho$ , the position of line I I relative to line II II is completely determined. These lines must have a common intersection point at  $|\eta| = \varrho$  with line I I lying above line II II. This holds because  $\Delta > 0$ . To explain the economics of different output and GNP effects resulting from a domestic devaluation we next discuss two extreme cases.

Assume first an unrealistically high value of the elasticity of substitution, i.e.,  $\sigma = 1$ , and assume further  $|\eta| = \varrho$ . The real income loss from higher factor prices in domestic currency does not lower domestic real income in this case and the demand stimulating forces of the devaluation are exactly offset by the corresponding demand contractionary forces because foreign demand completely replaces falling domestic demand. Therefore, domestic production and GNP remain unchanged. Assume on the contrary a low elasticity of substitution, i.e.,  $\sigma = 0$ , and a relatively high elasticity of export demand  $|\eta| = 1$ . The higher export elasticity now makes depreciation a more powerful instrument in stimulating export sales, hence again foreign demand is capable of offsetting the fall in domestic demand, which now also includes a negative effect from real income losses imposed by the devaluation. Therefore, production remains unchanged while domestic GNP falls. From these two extreme cases it follows that, with a relatively small elasticity of substitution, there exists the possibility of an export elasticity large enough to stimulate production but insufficient to stimulate GNP. Figure 6 also demonstrates that only with a given minimal size of  $\sigma > \Delta$ , increasing the export elasticity is helpful in avoiding a situation of rising production and falling GNP following a currency depreciation.

Recently, analysts have argued that a currency depreciation in oil importing OECD countries may act like a raw materials price shock<sup>19</sup>). Our model broadly supports this view and moreover allows us to spell out exactly when a depreciation will be completely equivalent to a raw materials price shock. From (35) and using the definition of domestic GNP,  $y = W\ell/P$ , we can determine an unambiguously negative effect of an increase in the foreign currency price of intermediate goods on GNP.

<sup>19</sup>) See *Kouri-Macedo* (1979), p. 41.

$$\begin{aligned}\hat{y}/\hat{P}_n^* &= -\frac{\theta_n[(1-\sigma) + (\rho\theta_\ell - \eta\theta_\ell)]}{\Delta} = - \\ &= -\frac{\theta_n[\Delta - (\Delta' + \eta)]}{\Delta} < 0\end{aligned}\quad (51)$$

Using (49), we decompose the GNP effect of an oil price shock (51) in the following way

$$\hat{y}/\hat{P}_n^* = \hat{y}/\hat{E} + \frac{\theta_n\eta}{\Delta} < 0 \quad (52)$$

From (52) we notice the importance of the elasticity of export demand. If export demand is totally inelastic a devaluation is indeed a supply shock. More realistically, however, an oil price shock tends to affect GNP in a more adverse way than a devaluation. The reason is simply the usual stimulating demand effect a devaluation exerts upon foreign demand for final goods.

### *Conclusion*

This paper has studied an important role for imported intermediate goods in the theory of devaluation. From a theoretical point of view there exists a variety of possible response patterns for domestic production and value added including their movement in opposite directions. However, with a low elasticity of substitution the most likely result is a reduction in GNP along with increasing or decreasing gross production. A modified Marshall-Lerner condition has been derived under which, despite falling production, creation of employment via positive substitution effects always dominates adverse effects from falling output. This outcome for employment is strengthened in a world not only with intra-sectoral factor substitution but inter-sectoral commodity substitution (Dornbusch (1979)), because consumers will shift expenditures towards goods less intensive in imported intermediates, i.e., more intensive in domestic factors of production. Another point worth emphasizing is the setting of a fixed nominal wage, i.e., falling real wage. Assuming in contrary a fixed real wage because of a scheme of nominal wage adjustment, the devaluation induced positive effects on competitiveness would totally disappear leaving the foreign component of demand for domestic goods unchanged. On the other hand real wage resistance avoids the direct real income loss. Hence, only the expenditure reducing real balance effect is left in the domestic demand component. Thus a devaluation under real wage rigidity turns out to be unambiguously contractionary and at best to be neutral if nominal wage and exchange rate changes are accommodated by an increasing money supply.

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*Zusammenfassung*

Dieser Aufsatz untersucht eine Wechselkursabwertung in einer ressourcenimportierenden OECD-Wirtschaft bei nominaler Lohnträgheit. Wenn man den Gehalt an importierten

Produktionsfaktoren in den Exporten eines Landes explizit berücksichtigt, wird eine Währungsabwertung in ihren Wirkungen einer Rohstoffpreiserhöhung sehr ähnlich. Als Folge davon besteht eine Tendenz zur negativen Output- und Realeinkommensentwicklung, die umso stärker ausfällt, je geringer die Möglichkeiten sind, zwischen heimischen und aus dem Ausland bezogene Produktionsfaktoren zu substituieren. Wir finden außerdem einen unmittelbaren Kostendruckeffekt auf das inländische Preisniveau, da der Währungspreis in diesem Modell zum Kostenbestandteil wird.

### *Summary*

This paper investigates currency depreciation in a raw materials importing OECD economy under nominal wage rigidity. When an import content of exports is explicitly taken into account a devaluation becomes similar to a raw materials price shock. In consequence, domestic production and GNP (value added) tend to react negatively the lower the elasticity of substitution between domestically and foreign owned factors of production. Moreover, when considering the exchange rate as a determinant of the cost of production, a devaluation adds directly to forces pushing up the domestic price level.

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