Seminar Paper No. 258

DOES DEVALUATION IMPROVE THE CURRENT ACCOUNT?

by

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University of Stockholm

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ABSTRACT

This paper incorporates the link between devaluation, foreign interest payments, and the current account into a fairly general macroeconomic model in which exchange rate changes influence aggregate demand through exports, imports, and expenditures as well as aggregate supply via the cost of imported factors of production. On the basis of available statistical estimates of the behavioral and structural parameters of the model, an attempt is made to assess the empirical importance of this link among others in a group of highly indebted industrial and developing countries. By and large, the empirical results indicate that high foreign debt and interest payments tend to reduce the short-to-medium-run effect of devaluation on national income, especially in the LDCs, but make little difference to its generally positive effect on the current account.

DOES DEVALUATION IMPROVE THE CURRENT ACCOUNT?

1. Introduction

The considerable weakness of the external payments position of many industrial and developing countries over the last decade has directed renewed attention among academic economists and policy makers to the effects of exchange rate changes on the balance of trade and payments. Devaluation for balance of payments purposes has long been a controversial instrument of economic policy. Some economists have argued that devaluation can be counterproductive because exports and imports are relatively insensitive to price and exchange rate changes, especially in developing and semi-industrialized countries (Cooper 1971a, 1971b; Krugman and Taylor 1978). Emphasizing the importance of the supply side, other writers have called attention to the possibility that devaluation may affect growth performance and the external position adversely in many industrial and less developed countries, at least in the short to medium term, because of their dependence on imported oil and other foreign inputs into production (Taylor 1981; Schmid 1982). A less pessimistic conclusion was reached by Gylfason and Schmid (1983) who developed a simple macroeconomic model of the effects of devaluation on income, expenditure, and the trade balance, and presented empirical evidence that indicated that the sensitivity of exports and imports (including oil and other inputs) to relative price changes is generally sufficient for devaluation to have the intended positive effect on the external payments position as well as on output in the short to medium run. 1/

This paper reexamines the relationship between devaluation and the current account in economies that export final goods and import both final and intermediate goods. In particular, the paper examines the question whether--and if so, to what extent-- the decision of a country in balance of payments difficulties to devalue its currency or to seek other means of external adjustment should depend on the country's indebtedness abroad. This question arises from the fact that a devaluation automatically increases the domestic currency debt servicing burden of external loans denominated in foreign currency, and thus tends to reduce national income and spending with the result that the current account of the balance of payments deteriorates through this channel, other things being equal. In policy debate, the efficacy of devaluation for balance of payments purposes is frequently questioned for this reason -- not because of its direct negative effect through the burden of interest payments on the current account in domestic currency (because, after all, it is the current account in foreign currency that matters), but rather because the increased interest burden tends to absorb resources that otherwise could be used for current production and spending.

The main purpose of this paper is twofold. First, it is intended to incorporate the above-mentioned link between devaluation, interest payments, and the current account into a fairly general macroeconomic framework in which exchange rate changes influence aggregate demand through exports, imports, and expenditures as well as aggregate supply via the cost of imported oil and other inputs into production. Second, an attempt is made to assess the empirical importance of this link among others in a selected group of industrial and developing countries whose external debts are high by international standards. The general

research strategy adopted here is similar to that of Gylfason and Schmid (1983) who used the same type of macroeconomic model to analyze the effects of devaluation on aggregate demand and supply in economies that import intermediate goods, and to make a quantitative assessment of the relative strengths of the demand and supply effects in ten industrial and developing countries on the basis of available statistical estimates of the parameters of the theoretical model.

The present paper is organized as follows. Section 2 presents the theoretical framework, and shows how the effect of devaluation on the current account depends on various behavioral and structural parameters of the model, including the ratio of foreign interest payments or of the stock of net foreign debt to GNP. Section 3 presents statistical estimates of all these parameters for fifteen highly indebted industrial countries and LDCs, and uses these estimates to quantify the relative importance of the various channels through which devaluation changes the current account in the short to medium term in these countries. By and large, the empirical results show that high foreign debt and interest payments tend to reduce the short-to-medium-term effect of devaluation on GNP, especially in the LDCs, but make little difference to its effect on the current account which responds favorably and fairly strongly to devaluation everywhere except in Brazil (where the effect is negative but tiny). Section 4 summarizes our principal findings.

2. Devaluation and the Current Account: A Theoretical Framework

It is convenient to begin by defining gross domestic product y' as the sum of domestic expenditure e and exports x minus imports of final goods z and of factors $(E/P)n$, all measured in units of domestic output except, in keeping with national income accounts, e and z are measured in units of domestic expenditure and of imports, respectively:

$$(1) \quad y' = e + x - z - (E/P)n.$$

Here E is the exchange rate which is exogenous and equals, by assumption, the domestic currency price of imported inputs and of final goods, P is the price of domestic output, and n is the volume of imported oil and other foreign factors of production.

Gross national product y equals, by definition:

$$(2) \quad y = y' - (E/P)r^*D^*$$

where $(E/P)r^*D^*$ represents interest payments on the foreign debt D^* which is denominated in foreign currency; r^* is the real world rate of interest which equals the nominal rate as long as the domestic rate of inflation is matched by the same proportional rate of depreciation of the domestic currency vis-à-vis foreign currencies. From the point of view of domestic residents, interest payments to foreigners constitute a withdrawal from the domestic income stream.

The trade balance in domestic currency equals, by definition, the difference between GDP and expenditure:

$$(3) \quad b' = y' - e$$

and the current account balance, also in domestic currency, is defined as

$$(4) \quad b = y - e.$$

Domestic expenditure is a linearly homogeneous function of GNP measured in units of domestic absorption and of real assets less net foreign debt: $e = e[yP/\Pi, (M + A - \tau ED^*)/\Pi]$, and may be expressed in proportional rates of change as follows for given M , A , and D^* :

$$(5) \quad \hat{e} = \alpha(\hat{y} + \hat{P} - \hat{\Pi}) - (1-\alpha)(\tau\phi\hat{E} + \hat{\Pi}).$$

Here α is the short-run income elasticity of expenditure ($0 < \alpha < 1$); P is the GNP deflator; $\Pi = P^{1-\psi}E^\psi$ is the expenditure deflator where ψ is the share of final goods imports in expenditure ($0 < \psi < 1$); M is the money supply and A is other financial and

real assets both of which we hold fixed throughout the analysis;^{2/} ϕ is the share of foreign debt ED^* in total net wealth $M+A-\tau ED^*$; and τ is the fraction of foreign debt that is regarded by domestic firms and households as a financial liability. For example, in some developing countries where the foreign debts of the private sector are relatively minor, the parameter τ may be interpreted as an indicator of the extent to which the private sector anticipates the future tax burden required to service the foreign debts of the public sector. In this section we assume for simplicity that $\tau = 1$, but we shall consider other possibilities when we turn to the empirical analysis in the next section. Current interest payments on the public sector's share of the foreign debt are financed by lump-sum taxes so that real disposable income y is independent of the division of the foreign debt between the public sector and the private sector.

We assume that the current account is initially in deficit equivalent to a fraction ω of exports so that $e = (1 + \omega x/y)y \equiv \rho y$ initially.^{3/} Then a change in the current account balance can be expressed as a fraction of GNP as follows:

$$(6) \quad db/y = (1-\alpha\rho)\hat{y} + \rho(1-\alpha-\psi)\hat{P} + \rho[(1-\alpha)\phi + \psi]\hat{E}.$$

Equation (6) implies that for given GNP and prices devaluation improves the current account via the expenditure-reducing effect through both real wealth and the reduced purchasing power of the given GNP expressed in domestic output units (the terms of trade or Harberger-Laursen-Metzler effect).^{4/} Further, the equation shows that in order to have a meaningful theory of the current account it is necessary also have a theory of national income and price level determination. In particular, the current account and GNP can move in the same direction or in opposite directions in response to devaluation, depending on the direction and magnitude of the effects of the devaluation on GNP and prices (compare Frenkel, Gylfason, and Helliwell 1980).

On the basis of equation (6) the effect of a devaluation on the current account can now be written as

$$(7) \quad (db/y)/\hat{E} = (1-\alpha\rho)\hat{y}/\hat{E} + \rho(1-\alpha)\hat{P}/\hat{E} + \rho\psi(1-\hat{P}/\hat{E}) + \rho(1-\alpha)\phi.$$

This equation expresses the effect of devaluation on the current account as the sum of four components:

- (i) an income effect $(1-\alpha\rho)\hat{y}/\hat{E}$ (i.e., the effect of devaluation on income less expenditure);
- (ii) a wealth effect $\rho(1-\alpha)\hat{P}/\hat{E}$ (i.e., the effect of devaluation on expenditure through real wealth);

- (iii) a terms of trade effect $\rho\psi(1-\hat{P}/\hat{E})$ (i.e., the effect of devaluation on expenditure through the dependence of real income in units of domestic absorption on the terms of trade); and
- (iv) a debt effect $\rho(1-\alpha)\phi$ (i.e., the effect of devaluation on expenditure through the dependence of net wealth on the external debt position).

According to equation (7), a sufficient condition for devaluation to have a positive effect on the current account is that the income effect be nonnegative and $\hat{P}/\hat{E}$ lie between 0 and 1. If $\hat{P}/\hat{E}$ is positive (as it must be except in extreme cases), a devaluation will fail to improve the current account only if it has a sufficiently negative income effect to outweigh the wealth effect (which is positive as long as $\hat{P}/\hat{E} > 0$), the terms of trade effect (which is positive as long as the devaluation worsens the terms of trade so that $\hat{P}/\hat{E} < 1$), and the debt effect (which is always positive).

In order to determine the direction and magnitude of the effect of a devaluation on GNP and prices, we use an extension of the aggregate supply and demand model of national income and price level determination developed by Gylfason and Schmid (1983). The present model differs from the original version in four main respects. First, we now include interest payments on, and the net wealth implications of, foreign debt, and focus the theoretical and empirical analysis on whether high foreign interest payments and debts do materially alter the effects of devaluation on GNP and the current account. Second, we allow for diminishing returns to scale in the two-factor production function (see below) so that the aggregate supply schedule relating output or income to the

price level is positively sloped; implicitly, we hold the "third factor" ("capital") fixed throughout. Third, we postulate that expenditure depends on income expressed in units of domestic absorption rather than of output, thus making explicit the direct link between expenditure and the exchange rate via the dependence of real income, by definition, on the terms of trade. Finally, as said before, we assume an imbalanced current account position from the outset. While all these modifications complicate the analysis considerably, we hope that the more general model and the quantitative application of it to follow provide sufficient additional insights and empirical information to make the incremental complexity worthwhile.

The supply side

The supply side of the economy is described by the following equations:

$$(8) \quad \hat{q} = \theta_{\ell} \hat{\ell} + \theta_n \hat{n} \quad \theta \equiv \theta_{\ell} + \theta_n \leq 1$$

$$(9) \quad \sigma = -(\hat{n} - \hat{\ell}) / (\hat{E} - \hat{W})$$

$$(10) \quad \hat{n} = (1/\theta) \hat{q} - (\theta_{\ell} \sigma / \theta) (\hat{E} - \hat{W})$$

$$(11) \quad y = q - (E/P)n - (E/P)r^*D^*$$

$$(12) \quad \hat{y} = [(1+\mu)/(1-\theta_n)] \hat{q} - [\theta_n(1+\mu)/(1-\theta_n)] (\hat{E} - \hat{P} + \hat{n}) - \mu(\hat{E} - \hat{P})$$

$$(13) \quad \hat{P} = (\theta_{\ell}/\theta) \hat{W} + (\theta_n/\theta) \hat{E} + [(1-\theta)/\theta] \hat{q}$$

$$(14) \quad \hat{y} = [(\theta+\mu)/\theta] \hat{q} - \{[\theta_n(1+\mu)\theta_{\ell}(1-\sigma)]/[(1-\theta_n)\theta] + \mu\theta_{\ell}/\theta\} (\hat{E} - \hat{W})$$

Equation (8) expresses the production function $q = q(\ell, n)$, which relates gross domestic output q to labor and other domestic

inputs ℓ and to imported oil and other foreign inputs n , in terms of proportional rates of change; the production function exhibits decreasing or constant returns to scale as the sum of θ_ℓ and θ_n (the shares of domestic and foreign inputs, respectively, in gross output) is less than or equal to 1. Equation (9) defines the elasticity of substitution σ between the two factors; the price of the imported input E (= exchange rate) and the price of the domestic factor W are both exogenously determined, but we shall introduce endogenous wage adjustment later on. Equation (10) follows from (8) and (9), and shows the derived demand for the foreign factor as a function of output and relative factor prices.

Equation (11) defines real GNP as the difference between gross domestic output and the amount of real factor imports and foreign interest payments. Equation (12) converts (11) to proportional rates of change; μ is the ratio of foreign interest payments to GNP. Equation (13) is the price equation implied by the nonincreasing-returns-to-scale production technology assumed in equation (8), and can be derived in the usual way by first deriving the input demand functions $\ell = \ell(q, W/P)$ and $n = n(q, E/P)$ from the first-order conditions for profit maximization, substituting these into the production function $q = q(\ell, n)$ and solving for P . The resulting equation (13) corresponds to an upward-sloping aggregate supply schedule under decreasing returns to scale; with constant returns to scale ($\theta = 1$), the supply schedule becomes horizontal. Finally, equation (14) is derived from (10), (12), and (13), and shows how devaluation can lower real income obtained from any given level of domestic output and factor prices if the elasticity of substitution between domestic and foreign

inputs is less than or equal to 1 and if net interest payments to the rest of the world are positive ($\mu > 0$).

By combining equations (13) and (14) we can write the supply equation as

$$(15) \quad \hat{P} = b_1 \hat{y} + b_2 \hat{E} + b_3 \hat{W}$$

(+) (+) (+)

where

$$b_1 = (1-\theta)/(\theta+\mu) > 0,$$

$$b_2 = [\theta_n + (1-\theta)(\theta_\ell \sigma - \theta \Lambda)]/\theta,$$

$$b_3 = [\theta_\ell - (1-\theta)(\theta_\ell \sigma - \theta \Lambda)]/\theta,$$

$$\Lambda = \theta_\ell \sigma / (\theta + \mu) - [(1-\sigma)\theta_\ell (\theta_n + \mu)] / [(\theta + \mu)(1-\theta_n)\theta] .$$

Under decreasing returns to scale ($\theta < 1$), the aggregate supply schedule represented by equation (15) has a positive slope b_1 .

Although the signs of b_2 and b_3 , which indicate the responsiveness of the supply schedule to changes in the exchange rate and wages, cannot be determined a priori, they can be shown to be positive for plausible values of the elasticity of substitution σ ; thus $\sigma \leq 1$ is a sufficient but not necessary condition for b_2 and b_3 to be positive.

The demand side

The following equations represent the demand side of the economy:

$$(16) \quad y = e + x - z - (E/P)n - (E/P)r^*D^*$$

$$(17) \quad \hat{y} = \rho \hat{e} + \Gamma \{ [1/(1+\omega)] \hat{x} - (1-\beta-\epsilon) \hat{z} - \beta(\hat{E}-\hat{P}+\hat{n}) - \epsilon(\hat{E}-\hat{P}) \}$$

$$(18) \hat{e} = \alpha(\hat{y} + \hat{P} - \hat{\Pi}) - (1-\alpha)(\phi\hat{E} + \hat{\Pi})$$

$$(19) \hat{x} = \eta(\hat{E} - \hat{P})$$

$$(20) \hat{z} = \hat{e} + (\psi - \delta)(\hat{E} - \hat{P})$$

$$(21) \hat{n} = [1/(\theta + \mu)]\hat{y} - \Lambda(\hat{E} - \hat{W}).$$

Equation (16) follows from the definitions of GNP and GDP stated at the beginning of this section. Equation (17) converts (16) to proportional rates of change, assuming that the current account is initially in deficit so that $e = \rho y$ initially; Γ equals $\lambda + (1+\mu)\theta_n/(1-\theta_n) + \mu$, i.e., the shares of final goods imports, factor imports, and foreign interest payments, respectively, in GNP, while $1-\beta-\epsilon$, β , and ϵ are the shares of these variables, respectively, in total imports (including interest payments). Equation (18) is identical to (5) for $\tau=1$. Equation (19) shows exports as a function solely of the terms of trade; $\eta > 0$ is the absolute value of the price elasticity of export demand. According to equation (20), final goods imports (measured in units of imports) depend on expenditures, with a unitary elasticity for simplicity, as well as on the terms of trade; $\delta > 0$ is the absolute value of the price elasticity of final goods imports in the original import demand equation $\hat{z} = \hat{e} + \hat{\Pi} - \hat{P} - \delta(\hat{E} - \hat{P})$ which is converted to (20) by using $\hat{\Pi} = (1-\psi)\hat{P} + \psi\hat{E}$. Observe that imports of final goods are indirectly affected by net wealth, and hence by the external debt position, through the wealth effect on expenditure. Finally, equation (21) is derived from (10) and (14), and shows the demand for imported inputs as a function of income and relative factor prices.

By substituting from equations (18) to (21) into the income-expenditure equation (17), we obtain the following demand equation:

$$(22) \quad \hat{y} = a_1 \hat{P} + a_2 \hat{E} + a_3 \hat{W}.$$

(-) (?) (?)

The coefficients are complicated functions of all the behavioral and structural parameters of the model:

$$a_1 = - \{ \Gamma \Omega + \rho (1-\alpha-\psi) [1 - \Gamma(1-\beta-\epsilon)] \} / \Delta ,$$

$$\Gamma = \lambda + (1+\mu) \theta_n / (1-\theta_n) + \mu < 1 ,$$

$$\Omega = [1/(1 + \omega)] \eta + (1-\beta-\epsilon)(\delta-\psi) - \beta - \epsilon ,$$

$$\Delta = 1 - \{ [1 - \Gamma(1-\beta-\epsilon)] \alpha \rho - \Gamma \beta / (\theta + \mu) \} > 0 ,$$

$$a_2 = \{ \Gamma \Omega + \Gamma \beta \lambda - \rho [(1-\alpha)\phi + \psi] [1 - \Gamma(1-\beta-\epsilon)] \} / \Delta ,$$

$$a_3 = - \Gamma \beta \lambda / \Delta .$$

Equation (22) represents an aggregate demand schedule whose slope is given by a_1 , which is presumably a negative number provided that the price elasticities of exports and final imports (η and δ , and hence Ω) and the real wealth elasticity of expenditures $(1-\alpha)$ are sufficiently large to outweigh the terms of trade effect (through which a domestic price increase tends to raise expenditure). For convenience, we denote the share of total imports including interest payments in GNP by Γ ; the modified Marshall-Lerner expression by Ω which is a weighted sum of the price elasticities of the

four components of the current account (for given n); and the expenditure multiplier by $1/\Delta$. Observe that $\rho = 1 + \omega\Gamma/(1+\omega)$ and $\psi = \lambda/\rho$. Observe also that in the special case where no inputs are imported ($\theta_n = \beta = 0$), no foreign debt is outstanding ($\mu = \varepsilon = \phi = 0$), and the current account is initially in equilibrium ($\omega=0$, $\rho=1$), these expressions simplify to $\Gamma = \lambda = \psi$, $\Omega = \eta + \delta - \psi$, $1/\Delta = 1/(s+m)$ where $s = 1 - \alpha$ and $m = \alpha\lambda$, $a_1 = -[\lambda(\eta+\delta-1) + (1-\lambda)(1-\alpha)]/(s+m)$, $a_2 = \lambda(\eta+\delta-1)/(s+m)$, and $a_3 = 0$.

The extent to which the demand schedule shifts in response to devaluation or a wage increase is indicated by a_2 and a_3 .

The direction of the effect of devaluation on aggregate demand for given P and W (i.e., the sign of a_2) is ambiguous in principle, and depends on whether the expenditure-switching effects via the price elasticities of exports and final imports (i.e., η and δ and hence Ω) as well as the elasticity of substitution between domestic and foreign inputs (i.e., σ and hence Λ) are strong enough to dominate the expenditure-reducing effects of the devaluation through the debt effect (i.e., $(1-\alpha)\phi$) and the reduced purchasing power of GNP (i.e., through ψ). The elasticity of substitution influences the demand effects of devaluation through the relative price elasticity of demand for the foreign factor which we denote by Λ , compare equation (21). The effect of an increase in wages on GNP for given P and E (i.e., the sign of a_3) is also indeterminate, and depends primarily on whether the elasticity of substitution σ is greater or smaller than the critical value of σ for which Λ equals 0, compare the definition of Λ ; this critical value of σ lies between 0 and 1.

Devaluation, income, prices, and the current account

The solution for GNP and the price level from equations (15) and (22) can now be expressed in matrix form as follows:

$$(23) \begin{bmatrix} \hat{y} \\ \hat{P} \end{bmatrix} = \frac{1}{D} \begin{bmatrix} 1 & a_1 \\ b_1 & 1 \end{bmatrix} \begin{bmatrix} a_2 & a_3 \\ b_2 & b_3 \end{bmatrix} \begin{bmatrix} \hat{E} \\ \hat{W} \end{bmatrix}.$$

The determinant D equals $1 - a_1 b_1 > 0$. For given wages, the effects of devaluation on income and the price level are

$$(24) \left. \frac{\hat{y}}{\hat{E}} \right|_W = \frac{a_2}{D} + \frac{a_1 b_2}{D},$$

(?) (+) (-) (+) (+)

$$(25) \left. \frac{\hat{P}}{\hat{E}} \right|_W = \frac{b_1 a_2}{D} + \frac{b_2}{D}.$$

(+) (?) (+) (+) (+)

The first term on the right-hand side of each equation represents a demand effect as is shown by the distance AB in Figure 1 (where we have assumed that $a_2 > 0$ so that the demand schedule shifts to the right), while the second term reflects the supply effect BC.

It should be emphasized that the above expression for $\hat{y}/\hat{E}$ tends to overstate -- and the expression for $\hat{P}/\hat{E}$, to understate -- the effect of devaluation because wages have been assumed to be held fixed thus far. If wages are adjusted fully to any change in the exchange rate so that $\hat{W} = \hat{E} = \hat{P}$, then devaluation causes GNP to fall, other things being equal. To have a positive effect on GNP, devaluation must lower real wages.

Figure 1. Demand and supply effects of devaluation

While any analysis of the long-run effects of devaluation must emphasize the adjustment of wages, it seems reasonable to allow for some degree of wage inertia in the short to medium term because of overlapping labor contracts (Fischer 1977) or of competing wage claims (Gylfason and Lindbeck 1983). With variable nominal wages, the expressions for $\hat{y}/\hat{E}$ and $\hat{P}/\hat{E}$ based on equations (23)-(25) become more complicated than before:

$$(26) \quad \hat{y}/\hat{E} = \hat{y}/\hat{E} \Big|_W + [(a_3 + a_1 b_3) / D] \hat{W}/\hat{E},$$

(?) (-) (+) (+)

$$(27) \quad \hat{P}/\hat{E} = \hat{P}/\hat{E} \Big|_W + [(b_1 a_3 + b_3) / D] \hat{W}/\hat{E}.$$

(+) (?) (+) (+)

For plausible values of the elasticity of substitution, the direct effect of a wage increase on aggregate demand through changes in outlays on the imported factor will be relatively minor, and a_3 will accordingly be relatively small. Partial wage indexation is therefore most likely to reduce the effect of devaluation on GNP, and to increase its effect on the price level. Specifically, if wages are indexed to the cost of living by the formula

$$(28) \quad \hat{W} = \gamma[(1-\psi)\hat{P} + \psi\hat{E}]$$

where $0 < \gamma \leq 1$ so that

$$(29) \quad \hat{W}/\hat{E} = \gamma(1-\psi)\hat{P}/\hat{E} + \gamma\psi,$$

the magnitude of the effect of devaluation on GNP will vary inversely with the indexation parameter γ , and will decline

to zero before γ reaches unity (for a given supply of money and other nominal assets). Similarly, the effect of devaluation on the domestic price level is positively related to the size of γ . A priori, the effect of wage indexation on the response of the current account to devaluation is ambiguous. In the empirical section to follow we shall attempt to determine the direction and magnitude of this effect.

Having developed the above expressions for the effects of devaluation on GNP and the price level, we are now in a position to evaluate the effect of devaluation on the current account. We do this by substituting equations (24) and (25) (or equations (26) and (27)) into (7), which we repeat here for convenience:

$$(30) \quad (db/y)/\hat{E} = (1-\alpha\rho)\hat{y}/\hat{E} + \rho(1-\alpha)\hat{P}/\hat{E} + \rho\psi(1-\hat{P}/\hat{E}) + \rho(1-\alpha)\phi.$$

If $\hat{y}/\hat{E}$ and $\hat{P}/\hat{E}$ are both positive as shown in Figure 1, then the effect of devaluation on the current account is also positive by equation (30), at least as long as the devaluation causes a deterioration of the terms of trade so that $\hat{P}/\hat{E} < 1$. If, on the other hand, the price elasticities of exports η and of final imports δ and the elasticity of substitution σ are so low, and the wage adjustment parameter γ is so high, that $\hat{y}/\hat{E}$ is negative, the response of the current account to devaluation becomes theoretically ambiguous and hence an empirical matter, to which we turn now.

3. Empirical Evidence

In this section we attempt an empirical assessment of the direction, magnitude, and composition of the effects of devaluation on the current account and on GNP. For this purpose we have gathered statistical estimates of the behavioral and structural parameters of the model presented in the preceding section for 15 highly indebted industrial and developing countries. Our strategy is to substitute these estimates into expressions (24) - (27) and (30) of Section 2 in order to quantify the response of the current account and of GNP to devaluation.

Needless to say, an empirical analysis of the effects of devaluation should, under ideal conditions, be conducted within a dynamic macroeconometric framework. Unfortunately, this is impossible in the present case because econometric models do not exist for a large majority of the countries in our sample. Nevertheless, we hope that the quantitative comparative-statics analysis to follow will shed some light on the relative and absolute importance of the various afore-mentioned channels through which devaluation influences the current account in the short to medium run. Specifically, the empirical simulations are intended to enable us to evaluate the propositions and policy recommendations advanced by Cooper (1971a, 1971b), Krugman and Taylor (1978), and Taylor (1981) within a fairly general short-run macroeconomic framework. By contrast, the conclusions of Krugman and Taylor, for example, were based on a simple macroeconomic model that did not include several of the links between the exchange rate and the current account and GNP emphasized in this paper, and were not confronted with empirical evidence.

Parameter estimates

Table 1 presents estimates of the various behavioral and structural parameters of the model.^{5/}

The estimates of the behavioral parameters are shown in the first four columns of the table. As explained in the appendix, we have collected estimates for the elasticity of substitution σ (column 1), the relative price elasticities of exports η (column 2) and of final goods imports δ (column 3), and the income elasticity of expenditure α (column 4) from various sources. These estimates generally refer to adjustment periods of one to three years. As proxies for σ we use published regression estimates where they are available (Canada, Denmark, Sweden). For the remaining 12 countries we use our own deliberately conservative guesstimates of σ ($= 0.3$ in 10 cases and 0.7 in 2 cases); we shall test the sensitivity of our empirical results to variations in this parameter. With one exception (Kenya), the estimates of η and δ are based on regression estimates of export and import equations reported by various authors, including our own regression estimates in 4 cases (Irish and Portuguese exports and Kenyan and Korean imports). These estimates of η and δ are generally quite high. The average values of η and δ are 1.2 and 1.4 , respectively, for the LDCs in the sample and 0.9 and 1.3 , respectively, for the industrial countries. Of the 30 estimates of η and δ shown in Table 1, 22 are statistically significant at the 0.05 level as indicated by asterisks. As comparable estimates of α are not available for the countries in the present sample, we assume that $\alpha = 0.7$ throughout. We shall test the sensitivity of our results to this choice.

Table 1 Estimates of parameters

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	σ	η	δ	α	θ_n	θ_ℓ	θ	λ	β	μ	ϵ	ϕ	ω
<u>Developing countries</u>													
1. Argentina	.3	.6*	.9	.7	.04	.42	.46	.02	.56	.02	.28	.05	.44
2. Brazil	.3	.4*	1.7*	.7	.05	.39	.44	.03	.42	.04	.33	.10	.50
3. Kenya	.3	1.0	.8*	.7	.16	.32	.48	.09	.64	.014	.05	.12	.72
4. Korea	.3	2.5*	.8*	.7	.19	.32	.51	.09	.63	.05	.12	.10	.21
5. Morocco	.3	.7*	1.0	.7	.11	.36	.47	.09	.50	.04	.16	.15	.81
6. Pakistan	.3	1.8*	0.8*	.7	.10	.37	.47	.08	.58	.0044	.02	.04	.34
7. Philippines	.3	.9	2.7*	.7	.12	.36	.48	.08	.57	.03	.10	.09	.40
8. Turkey	.3	1.4*	2.7	.7	.05	.28	.33	.02	.55	.03	.27	.10	.52
<u>Industrial countries</u>													
9. Canada	.96	.79*	.85*	.7	.13	.54	.67	.08	.60	.03	.11	.04	.06
10. Denmark	.72	.93*	1.63*	.7	.13	.52	.65	.14	.47	.04	.11	.05	.12
11. Finland	.7	1.21	2.28*	.7	.14	.54	.68	.12	.55	.02	.07	.03	.02
12. Ireland	.7	0.50*	1.14*	.7	.25	.47	.72	.30	.51	.04	.05	.06	.20
13. Portugal	.3	0.61*	0.53	.7	.17	.50	.67	.12	.56	.04	.12	.10	.64
14. Spain	.3	.69	.84*	.7	.07	.56	.63	.05	.55	.01	.10	.03	.25
15. Sweden	.96	1.82*	2.07*	.7	.13	.65	.78	.11	.55	.02	.07	.03	.10

Source: See Appendix

Notes: σ = elasticity of substitution between domestic and foreign inputs. η = price elasticity of exports (absolute value). δ = price elasticity of final goods imports (absolute value). α = income elasticity of consumption (= one less real wealth elasticity). θ_n = share of imported inputs in domestic output. θ_ℓ = share of labor in domestic output. $\theta = \theta_n + \theta_\ell$. λ = share of final goods imports in GNP. β = share of inputs in total imports (including interest payments). μ = share of foreign interest payments (net) in GNP. ϵ = share of foreign interest payments (net) in total imports (including interest payments). ϕ = ratio of net foreign debt to net real wealth. ω = ratio of current account deficit to merchandise exports.

The remaining parameter estimates shown in Table 1 were obtained as follows: The shares of imported inputs θ_n (column 5) and of labor θ_ℓ (column 6) in output, and their sum θ (column 7) were computed from national income accounts and import statistics as reported by the IMF, OECD, and UNCTAD. The average values of θ_n and θ_ℓ for the LDCs are 0.10 and 0.35, respectively, and for the industrial countries, 0.15 and 0.54, respectively. The relatively low estimates of θ_ℓ thus leave an unduly high proportion of output to be explained by the "third factor" of production which we implicitly hold fixed throughout. The aggregate supply schedule is consequently steeper than otherwise would be the case. This bias, in turn, increases the likelihood that devaluation causes a reduction of GNP in the simulations to follow. The share of final goods imports λ (column 8) in GNP and of inputs β (column 9) in total imports were also obtained from the above sources. These shares equal, on average, 0.06 and 0.56, respectively, for the LDCs and 0.13 and 0.54, respectively, for the industrial countries, indicating the relatively greater openness of the economies of the industrial countries and a slightly greater dependence of the LDCs on imported intermediate goods relative to total imports.

The next three columns of Table 1 illustrate the role of foreign debt. The share of net foreign interest payments in GNP, μ (column 10), and in total imports, ε (column 11), were computed from IMF and OECD statistics (see Appendix). The value of μ ranges from practically zero in Pakistan to 0.05 in Korea, and equals 0.03 on average in both the LDCs and the industrial countries. The value of ε is lowest also in Pakistan

(0.02) and highest in Brazil (0.33). The average value of ϵ is more than twice as high in the LDCs (0.17) as in the industrial countries (0.08). This difference between the two country groups is to some extent exaggerated because the figures for the industrial countries are from 1981 (with the exception of the Irish data that refer to 1980), while the figures on interest payments for countries 1, 2, 4, 5, and 7 in Table 1 are from 1982 (see Appendix for details). Also, these figures may tend to overstate the importance of interest payments because the figures cover 1981 and 1982 during which nominal interest rates were exceptionally high by historical standards and because no attempt was made to adjust for expected exchange rate or price changes. An indication of the quantitative implications of this bias can be obtained by lowering μ and ϵ gradually to zero because it seems reasonable to suppose that the real interest cost generally lies somewhere between the nominal cost and zero.

Column 12 shows the ratio of net foreign debt to net wealth, ϕ . Due to lack of data on net wealth we assume, on the basis of available estimates for the United States (see, e.g., Gylfason 1981), that the ratio of net wealth to GNP equals 4.5 in the industrial countries and 3 in the LDCs. The importance of this assumption will be tested by varying ϕ .

Finally, column 13 shows the ratio of the current account deficit, including transfers, to merchandise exports, ω , in 1981. The deficit ranges from the equivalent of 2 percent of exports in Finland to 81 percent in Morocco. On average, the deficit/exports ratio is almost 5 times high in the LDCs ($\omega = 0.49$) as in the industrial countries not including Portugal and Spain ($\omega = 0.10$).

Results of simulations

Let us now turn our attention to the empirical results, reported in Table 2. The first and last columns of the table show the effects of 10 percent devaluation on GNP and the current account, respectively, while the intermediate columns divide the total effect on the current account between its four determinants as shown in equation (7) of Section 2. The last column shows that a 10 percent devaluation improves the current account in all 15 countries except Argentina where the effect is negative but very small. Elsewhere the effect of devaluation on the current account is positive, and ranges from 0.2 percent of GNP in Brazil to 3.4 percent of GNP in Sweden, for given wages. The average improvement of the current account is equivalent to 1.2 percent of GNP in the developing countries in the sample and to 2.2 percent of GNP in the industrial countries.

In all the LDCs except Korea and Pakistan the improvement of the current account coincides with a reduction of GNP ranging from relatively minor losses in the Philippines and Turkey to a contraction of 2.4 percent in Morocco (column 1). On the other hand, devaluation tends to stimulate GNP in the industrial countries except in the borderline cases of Portugal and Spain and in Ireland where the negative effect on GNP is tiny. On average, GNP falls by 1 percent in the LDCs and rises by 0.8 percent in the industrial countries.

Why are the GNP responses so different between the two country groups? Let us look first at the supply side. According to the theoretical model of Section 2, devaluation increases the cost of imported inputs and thus causes an unambiguous upward

Table 2

Effects of 10 percent devaluation on GNP and the current account

	Effect on GNP	Effect on the current account				
	(1)	(2)	(3)	(4)	(5)	(6)
	(Changes in percent)	Income effect	Wealth effect	Terms of trade effect	Debt effect	Total effect
		(Changes in percent of GNP)				
<u>Developing countries</u>						
1. Argentina	-1.3	-0.4	-0.0	0.2	0.2	-0.0
2. Brazil	-1.6	-0.4	0.0	0.3	0.3	0.2
3. Kenya	-2.1	-0.4	0.7	0.7	0.4	1.4
4. Korea	0.4	0.1	1.7	0.4	0.3	2.5
5. Morocco	-2.4	-0.5	0.3	0.8	0.5	1.1
6. Pakistan	0.1	0.0	0.9	0.6	0.1	1.6
7. Philippines	-0.3	-0.1	1.0	0.6	0.3	1.8
8. Turkey	-0.7	-0.2	0.4	0.2	0.3	0.7
Average	<u>-1.0</u>	<u>-0.2</u>	<u>0.6</u>	<u>0.5</u>	<u>0.3</u>	<u>1.2</u>
<u>Industrial countries</u>						
9. Canada	0.6	0.2	0.7	0.6	0.1	1.6
10. Denmark	1.6	0.4	1.0	1.0	0.1	2.5
11. Finland	2.9	0.8	1.1	0.8	0.1	2.8
12. Ireland	-0.1	-0.0	1.2	1.9	0.2	3.3
13. Portugal	-3.7	-0.7	0.5	1.0	0.3	1.1
14. Spain	-1.0	-0.3	0.3	0.4	0.1	0.5
15. Sweden	5.4	1.5	1.0	0.8	0.1	3.4
Average	<u>0.8</u>	<u>0.3</u>	<u>0.8</u>	<u>0.9</u>	<u>0.2</u>	<u>2.2</u>

Source: Authors' computations based on equations (24), (25), and (30) and Table 1.

shift of the aggregate supply schedule. This upward shift is greatest in the countries that are most heavily dependent on foreign inputs into production (Kenya, Korea, Ireland). On the demand side, the GNP responses differ qualitatively as well as quantitatively. In one half of the LDCs in the sample (Argentina, Brazil, Kenya, Morocco) as well as in Portugal and Spain, devaluation reduces aggregate demand ($a_2 < 0$). In 3 of these countries (Argentina, Brazil, Portugal) the modified Marshall-Lerner condition is not met ($\Omega < 0$), whereas in the other 3 the increase in net exports of final goods through $\Omega > 0$ and the decrease in intermediate imports through $\Lambda > 0$ (except in Kenya where Λ is negative but very small) are not sufficient to offset the negative debt and terms of trade effects of devaluation through expenditure, compare the term $\rho[(1-\alpha)\phi + \psi][1 - \Gamma(1-\beta-\epsilon)]$ in the expression for a_2 on page 12. The demand and supply effects of devaluation in these 6 countries are summarized in Figure 2a.

In the other 9 countries in the sample, devaluation stimulates aggregate demand ($a_2 > 0$). In 3 of these (Philippines, Turkey, Ireland) the positive demand effect is small and is outweighed by the supply effect, rendering the net effect on GNP negative but quite small (Figure 2b). In the remaining 6 countries (Korea, Pakistan, Canada, Denmark, Finland, Sweden) devaluation has a sufficiently strong positive effect on demand to dominate the negative supply effect so that the net effect on GNP is positive (Figure 2c). These are 6 of the 8 countries in the sample that have the greatest capacity for expenditure switching as reflected by high values of η and δ and hence of Ω ; in the other 2 countries with high η and δ (Philippines and Turkey), the impact of high

(a)

(b)

(c)

Figure 2. Demand and supply effects of devaluation:
 (a) Argentina, Brazil, Kenya, Morocco,
 Portugal, Spain; (b) Philippines, Turkey,
 Ireland; (c) Korea, Pakistan, Canada,
 Denmark, Finland, Sweden.

elasticities is deflated by high initial deficits ω and, in the case of Turkey, also by the small shares of final goods imports in total imports including interest payments ($1-\beta-\epsilon = 0.18$) and of total imports and interest payments in GNP ($\Gamma = 0.10$). Further, the very low estimate for Turkey of the combined share of the variable inputs ($\theta = 0.33$) in output makes the aggregate supply schedule quite steep, thus reducing the positive effect of an increase in aggregate demand on GNP. Compared with the important role played by the price elasticities η and δ through Ω , the elasticity of substitution σ and hence Λ plays a relatively minor role on the demand side of the model, especially in the LDCs. The average values of $\Gamma\beta\Lambda$, which determine the contribution of σ to the demand effect of devaluation, are 0.08 and 0.003 in the industrial and developing countries, respectively, compared with an average of 0.20 for $\Gamma\Omega$ in the industrial countries and of 0.13 for the LDCs. As said before, Ω is positive everywhere except in Argentina, Brazil, and Portugal, and Λ is positive everywhere except in Kenya and Korea. In general, these results indicate sufficient flexibility in commodity and factor substitution over a period of, say, 1 to 3 years for the partial effect of devaluation on the trade balance to be positive for given income and expenditure.

Having accounted for the effects of devaluation on GNP, we are now in a position to examine the decomposition of the total effect on the current account presented in columns 2 to 5 of Table 2. While the breakdown differs between countries, it is of interest to note that of the current account improvement equivalent to 1.2 percent of GNP in the LDCs on average, the wealth effect accounts for 0.6 points on average, the terms of

trade effect for 0.5 points, the debt effect for 0.3 points, and the income effect for -0.2 points. For the industrial countries as a whole, the wealth effect contributes the equivalent of 0.8 percentage points of GNP on average, the terms of trade effect 0.9 points, the debt effect 0.2 points, and the income effect 0.3 points, giving a total average improvement of the current account equivalent to 2.2 percent of GNP. Thus, the expenditure reducing effects of devaluation acting on both real wealth and on real income via the terms of trade make a substantial contribution to the positive effect of devaluation on the current account in both country groups, while the income and debt effects play a relatively minor role in general. The expenditure reduction is facilitated by expenditure switching through both commodity and input substitution that helps increase the price level and lower the terms of trade.

In order to gain better insight into the relative importance of the various channels through which devaluation influences GNP and the current account, we now proceed to test the sensitivity of the results reported above to variations in some of the underlying parameter assumptions. In particular, we shall consider alternative assumptions concerning the treatment of foreign debt and interest payments and of wages.

We begin by examining the importance of the role of foreign debt for the wealth effect of devaluation on expenditure, compare equation (5) on page 5. By setting $\phi = 0$ (or, equivalently, $\tau = 0$) we simulate the case where the foreign debt is incurred by the public sector and financed through tax collection and the private sector does not anticipate the future tax burden implied by the

debt. Because devaluation does not reduce net nominal wealth in this case, GNP expands more or contracts less in response to devaluation than in the general case, but the difference is small. On average, GNP contracts by 0.7 percent in the LDCs with $\phi = 0$ compared with 1.0 percent in the general case of Table 2, and rises by 1.0 percent in the industrial countries compared with 0.8 percent in the general case (Table 3, column 3). The effect of setting $\phi = 0$ is greatest in Morocco and Portugal where the estimated contraction of GNP is reduced by 0.5 percent in each case. This variation also makes little difference for the current account. With $\phi = 0$, the effect of a 10 percent

devaluation on the current account becomes 1.0 and 2.1 percent of GNP in the LDCs and industrial countries, respectively, compared with 1.2 and 2.2 percent, respectively, in the general case (column 4). We conclude from these numbers that our results are in general not very sensitive to variations in ϕ , ceteris paribus.

Next we ask: what is the total contribution of our explicit treatment of foreign interest payments and debt to the results presented in Table 2? In order to quantify this contribution, we set $\mu = \epsilon = \phi = 0$, adjust our estimates of θ_ℓ , θ_n , θ , and β accordingly, and recompute the effect of a 10 percent devaluation on GNP and the current account. By thus removing another channel through which devaluation tends to reduce income and expenditure, we expect to see a further increase in the effect of devaluation on GNP. In this case, GNP falls by 0.4 percent on average in the LDCs and rises by 1.2 percent in the industrial countries, compared with -1.0 and 0.8 percent, respectively, in the general case (Table 3, column 5). Thus, the stock effect (through ϕ) and the flow effect (through μ and ϵ) of foreign indebtedness

Table 3. Effects of 10 percent devaluation on GNP and the current account: Further results

	General case		$\phi = 0$		$\mu = \varepsilon = \phi = 0$		$\gamma = 1$		$\sigma = 0$		$\sigma = 1$		$\alpha = 0.5$	
	GNP (1)	CA (2)	GNP (3)	CA (4)	GNP (5)	CA (6)	GNP (7)	CA (8)	GNP (9)	CA (10)	GNP (11)	CA (12)	GNP (13)	CA (14)
<u>Developing countries</u>														
1. Argentina	-1.3	-0.0	-1.0	-0.0	-0.7	0.1	-1.4	-0.0	-1.5	-0.1	-0.7	0.3	-1.1	-0.0
2. Brazil	-1.6	0.2	-1.2	0.2	-0.5	0.4	-1.8	0.2	-1.9	0.1	-0.9	0.5	-1.5	0.2
3. Kenya	-2.1	1.4	-1.7	1.2	-1.6	1.2	-2.8	1.7	-2.8	1.2	-0.5	1.9	-2.3	1.5
4. Korea	0.4	2.5	0.6	2.3	0.6	2.3	-1.6	2.5	-0.2	2.3	2.0	3.1	-0.3	3.4
5. Morocco	-2.4	1.1	-1.9	0.8	-1.4	1.0	-3.0	1.2	-3.0	0.9	-1.1	1.5	-2.4	1.1
6. Pakistan	0.1	1.6	0.2	1.6	0.2	1.6	-1.5	1.7	-0.4	1.5	1.1	2.0	-0.4	1.9
7. Philippines	-0.3	1.8	-0.1	1.6	0.1	1.6	-1.9	1.9	-0.9	1.6	0.9	2.2	-0.8	2.1
8. Turkey	-0.7	0.7	-0.4	0.6	-0.2	0.6	-1.2	0.8	-0.9	0.6	-0.1	1.0	-0.9	0.8
Average	-1.0	1.2	-0.7	1.0	-0.4	1.1	-1.9	1.3	-1.4	1.0	0.1	1.6	-1.2	1.4
<u>Industrial countries</u>														
9. Canada	0.6	1.6	0.8	1.6	0.9	1.6	-2.4	1.6	-1.8	0.8	0.7	1.7	-0.0	1.9
10. Denmark	1.6	2.5	1.8	2.4	1.8	2.4	-2.0	2.2	0.0	2.0	2.2	2.7	0.8	3.1
11. Finland	2.9	2.8	3.0	2.7	3.0	2.7	-1.8	2.1	1.3	2.3	3.6	3.0	1.8	3.5
12. Ireland	-0.1	3.3	0.0	3.1	0.3	3.2	-2.2	3.0	-2.6	2.7	0.9	3.5	-0.7	3.9
13. Portugal	-3.7	1.1	-3.2	1.0	-2.5	1.1	-4.4	1.7	-4.6	0.9	-1.4	1.7	-3.4	1.0
14. Spain	-1.0	0.5	-0.8	0.5	-0.6	0.6	-2.3	0.7	-1.4	0.4	0.0	0.9	-1.0	0.6
15. Sweden	5.4	3.4	5.5	3.3	5.4	3.3	-2.0	2.2	3.1	2.6	5.5	3.4	3.7	4.2
Average	0.8	2.2	1.0	2.1	1.2	2.1	-2.4	1.9	-0.9	1.7	1.6	2.4	0.2	2.6

Source: Authors' computations based on equations (24), (25), and (30) - and, for columns (7) and (8), on equations (26), (27), and (30) - and Table 1.

each contributes about -0.3 percent on average to the effect of devaluation on GNP in the LDCs, and about -0.2 percent in the industrial countries. The greatest difference is observed for Brazil, Morocco, and Portugal where the removal of foreign interest payments as well as of debt from the model would lead to an underestimation of the contraction of GNP by 1.0 to 1.2 percent. In several other countries (Korea, Pakistan, Denmark, Finland, Sweden) interest payments and debt make little difference to the results; removing these variables from the model biases the effect of 10 percent devaluation on GNP upward by 0.2 percent at most in these countries. Concerning the current account, the removal of interest payments and debt from the model reduces (in 12 cases) or increases (in 3 cases: Argentina, Brazil, Spain) the positive response of the current account to devaluation by 0.2 percent of GNP at most (column 6). Keeping in mind our deliberate exaggeration of the estimates of the shares of interest payments in GNP (μ) and in total imports (ϵ), it seems fair to conclude that the foreign debts of the 15 countries in our sample, including some of the most heavily indebted countries of the world, tend in general to enhance the short-run efficacy of devaluation for balance of payments purposes slightly, at the cost of rendering its effect on GNP somewhat less favorable.

Thus far we have held wages fixed. If wages are adjusted or indexed to the cost of living by the formula (28) on page 15, the effect of devaluation on GNP varies inversely with the indexation parameter γ , while the response of the price level varies directly with γ . The sensitivity of the GNP response to

wage indexation differs considerably between the two country groups. As γ is increased from 0 to 1, the effect of a 10 percent devaluation on GNP declines from -1.0 percent to -1.9 percent on average in the LDCs, and from 0.8 percent to -2.4 percent on average in the industrial countries (Table 3, column 7). The negative effect of increased indexation on the GNP response is more pronounced in the industrial countries because, with higher elasticities of substitution between labor and imported inputs and higher shares of imported inputs in GNP (compare the expression for a_3 on page 12), the induced wage increases have larger negative effects on aggregate demand: the average estimate of a_3 is -0.12 for the industrial countries compared with -0.01 for the LDCs. The more elastic supply response of the industrial countries (where b_1 equals 0.4 on average compared with 1.2 for the LDCs) reinforces the negative demand effect whereas the upward shift of the supply schedule due to the wage increases is of the same magnitude in the two country groups.

The sensitivity of the effect of devaluation on the current account to the degree of wage indexation also differs between the two groups of countries. In all the LDCs as well as in Portugal and Spain it turns out that full wage indexation ($\gamma = 1$) is either neutral or increases the positive response of the current account to devaluation slightly. According to equation (7) on page 6, the influence of indexation on the income effect $(1-\alpha)\hat{y}/\hat{E}$ and on the terms of trade effect $\rho\psi(1 - \hat{P}/\hat{E})$ is either offset or outweighed by its impact on the wealth effect $\rho(1-\alpha)\hat{P}/\hat{E}$ in these countries. In Canada, Denmark, Finland, Ireland, and Sweden, on the other hand, full wage indexation reduces the current account

response to a 10 percent devaluation by an average of 0.5 percent of GNP compared with an average increase of 0.1 percent of GNP for the other 10 countries. It is interesting to note that the above-mentioned group of 5 industrial countries where indexation worsens the current account includes 4 of the countries (all except Ireland) where devaluation has a positive effect on GNP at given wage costs (Table 3, column 1). This is also the group in which the introduction of full indexation reduces the effect of a 10 percent devaluation on GNP the most, or by 4.2 percent on average (compare columns 1 and 8 of Table 3). However, even in these 5 countries full indexation does not prevent

devaluation from improving the current account. A comparison of the 8 developing and 7 industrial countries in the present sample shows that a 10 percent devaluation with full indexation improves the current account by 1.3 and 1.9 percent of GNP, respectively, on average, compared with 1.2 and 2.2 percent, respectively, in the general case with constant wages (Table 3, columns 8 and 2). In sum, devaluation remains an effective instrument for external adjustment in all 15 countries in the sample with or without wage indexation, but full indexation imposes a high cost in terms of lost income and employment in many cases.

It remains to test the sensitivity of our results to variations in the two parameters of the model, σ and α , for which limited empirical evidence is available. If our estimates of σ , which equal 0.3 and 0.7 on average for the LDCs and industrial countries respectively (Table 1), are reduced to 0 throughout, reflecting complete inflexibility in factor substitution,

devaluation has less favorable effects on both GNP and the current account than in the basic case of Table 2. Specifically, a 10 percent devaluation reduces GNP in this case by 1.4 and 0.9 percent on average in the LDCs and industrial countries, respectively, but continues to improve the current account, by 1.0 and 1.7 percent, respectively (Table 3, columns 9 and 10). More optimistically, if we set $\sigma = 1$ throughout as may be more reasonable in a 2 to 3 year perspective, a 10 percent devaluation has more favorable effects everywhere. In this case, GNP rises not only in the industrial countries (by 1.6 percent on average) but also in the LDCs

(by 0.1 percent on average; compare column 11). The current account improves by an average of 1.6 and 2.4 percent of GNP, respectively, in the two country groups (column 12).

Finally, it is of interest to examine the quantitative consequences of lowering our estimate of α , the short-run income elasticity of expenditure. In addition to testing the sensitivity of our results to our estimate $\alpha = 0.7$, this experiment enables us to simulate the effect on expenditure of a devaluation-induced redistribution of income from workers to capitalists, on the assumption that workers have a lower propensity to save than capitalists (Diaz-Alejandro 1963). For example, if we lower α to 0.5 it turns out that a 10 percent devaluation increases GNP in the industrial countries by 0.2 percent on average (1.1 percent if Portugal and Spain are not included), compared with 0.8 percent in the basic case of Table 2, and reduces the GNP of the LDCs by 1.2 percent on average compared with 1.0 percent in the basic case (compare

columns 13 and 1). With $\alpha = 0.5$, the response of the current account to a 10 percent devaluation rises to 1.4 and 2.6 percent of GNP on average in the developing and industrial countries, respectively, compared with 1.2 and 2.2 percent, respectively, in the basic case (compare columns 14 and 2). In general, a reduction of the propensity to spend thus tends to increase the positive effect of devaluation on the current account at the cost, as Diaz-Alejandro (1963) conjectured, of a less favorable effect on GNP, especially in the industrial countries.

4. Conclusion

This paper has analyzed the short-run effects of devaluation on GNP and the current account in economies that are highly dependent on imported inputs and that are also heavily indebted to the rest of the world. The theoretical section demonstrated how the adverse supply side effects of devaluation due to increased cost of imported inputs and to limited substitutability between domestic and foreign factors of production can be offset through expenditure switching on the demand side, thus rendering the net effect of devaluation on GNP uncertain in principle. The ambiguity of the GNP response is reinforced by foreign indebtedness because devaluation increases both the domestic currency value of the stock of debt outstanding and the interest burden, hence contributing to a reduction of expenditure and of aggregate demand. A devaluation-induced increase of GNP was shown to be a sufficient but not necessary condition for devaluation to have the intended positive effect on the current account because the wealth, terms of trade, and debt effects all tend to increase the efficacy of devaluation for balance of payments purposes in the short run.

On the basis of empirical estimates of the behavioral and structural parameters of the theoretical model for 8 developing and 7 industrial countries, all but one (Pakistan) highly indebted by international standards, it was shown that devaluation has a positive effect on the current account in the short to medium run in all the countries in the sample except Argentina (where the effect is negative but tiny). In 6 of the LDCs (all except Korea and Pakistan) as well as in Portugal and Spain,

the improvement of the current account is achieved at the cost of a reduction of GNP. This reduction, however, should be viewed in the light of three factors all of which tend to bias the results in this direction. First, we assumed conservatively that the elasticity of substitution is as low as 0.3 in the LDCs as well as in Portugal and Spain. Second, available national income accounts statistics for these countries attribute too low a share of GDP to labor with the result that the aggregate supply schedule in the present framework is unduly steep. Third, as said above, practically all the countries in the sample carry a heavy debt burden. All these factors increase the probability that devaluation reduces GNP. On the other hand, devaluation generally stimulates GNP in the industrial countries (except Portugal and Spain) because the positive demand effects dominate the negative effects on the supply side.

The empirical results also indicated that foreign debt and interest payments tend to increase the short-run effect of devaluation on the current account at the cost of a less favorable effect on GNP. In general, the positive contribution of the wealth and terms of trade effects of devaluation to the current account is quantitatively much more important than the income and debt effects, especially in the industrial countries. Finally, the empirical simulations showed that devaluation remains an effective tool for balance of payments adjustment even when wages are fully indexed to consumer prices, although the improvement of the external accounts is in this case achieved at a substantial cost in terms of lost income and employment domestically.

In conclusion, we should emphasize some of the limitations of the foregoing analysis. Three points seem to warrant special mention in this context. In the first place, no attempt has been made in this paper to assess the effects of devaluation in the longer run. Specifically, even though our model and its empirical implementation would have enabled us to evaluate the effects of devaluation on profits (defined as GNP less the real wage bill), we abstained from such considerations as they would have taken us too far beyond the scope of the paper. It would seem worthwhile to extend the present framework in the future in order to establish a link between devaluation, profitability, and investment, and to explore the implications of this link for the effects of devaluation on GNP and the current account over time. ^{6/}

Secondly, monetary and fiscal policy variables have been held fixed throughout the analysis, explicitly or implicitly. This simplification was deliberate as we wished to estimate the partial effects of devaluation, other things being equal. Since devaluation is frequently accompanied by restrictive monetary or fiscal measures in practice, it would be interesting to introduce money, credit, government spending, and taxes explicitly into the model, and to attempt to evaluate the relative quantitative contribution of each component of a typical stabilization program to the total effect on GNP and the current account.

The final qualification that we want to mention concerns our deliberate neglect of the ways in which expectations may modify economic behavior, except insofar as we have allowed for the adjustment of wages to exchange rate changes. Among the potentially

important channels of influence that we have thus bypassed in this paper is the effect of devaluation, through expectations, on capital flows and hence, through portfolio readjustment, on the current account and GNP (and interest rates). We made no attempt to incorporate such effects of expectations into our model, both because an empirical implementation of such analysis would be difficult if not impossible at present and also because the relevance of such arguments to developing countries, many of which have rigid controls of capital movements, is not evident.

FOOTNOTES

- * We are indebted to John Cuddington for valuable comments on an earlier version, to William Branson, Jacob Frenkel, Thierry de Montbrial, and Jean Waelbroeck for their suggestions at the seminar in Paris, and to Per Skedinger for assistance with the computations. We remain responsible for any errors.
1. See also Hanson (1983).
 2. We ignore capital gains on the real component of A for simplicity.
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3. See Hirschman (1949).
 4. See Harberger (1950), Laursen and Metzler (1950), and Svensson and Razin (1983).
 5. A detailed description of these estimates is presented in the appendix.
 6. See Kouri (1979) and Risager (1983).

Appendix: Estimates of Parameters

This appendix describes the sources and computations underlying the parameter estimates presented in Table 1 in the main text.

(1) Elasticity of substitution σ . For Canada and Sweden we use Pindyck's (1979, Table 5.8) estimates of σ ($= 0.96$) between labor and energy, based on a factor-share model of ten industrial countries applied to pooled annual time-series cross-section data for 1959-74. Pindyck interprets these as "long-run" estimates. For Denmark we use Griffin and Gregory's (1976, Table 2) estimates of σ ($= 0.72$) between labor and energy, obtained by estimating a translog cost function from pooled data for the manufacturing sector of 9 industrial countries 1955-69. As no estimates of σ are available for the remaining 12 countries, we assume conservatively that σ equals 0.7 in Finland and Ireland and 0.3 in Portugal, Spain, and the developing countries. By comparison, the estimates of Pindyck and Griffin and Gregory lie between 0.8 and 1.0 for all industrial countries considered except Denmark where $\sigma = 0.72$.

(2) Price elasticity of exports η . The sources of the estimates of η are as follows: For Argentina and Brazil, Houthakker and Magee (1969, Table 3); for Korea, Wijnbergen (1982, equation 2); for Morocco, Pakistan, the Philippines, and Turkey, Khan (1974, Table 2); for Canada, Stern, Francis, and Schumacher (1976, Table 2.2); for Denmark and Sweden, Deppler and Ripley (1978, Table 13); for Finland and Spain, Warner and Kreinin (1983, Table 5); for Ireland and Portugal, authors' own regression estimates (available on request); and for Kenya, authors' guess-

timate ($\eta = 1.0$) which lies below the average ($= 1.2$) of the estimates of η for the other developing countries in the sample. Observe also that if the "small country assumption" is taken to apply to Kenya, η should be interpreted as one plus the price elasticity of domestic supply of exports; in this case $\eta = 1.0$ implies no supply response to price changes (see Sohmen 1969, pp. 13-20).

(3) Price elasticity of final goods imports δ . The estimates of δ were obtained from the following sources: For Argentina, Brazil, Morocco, Pakistan, the Philippines, and Turkey, Khan (1974, Table 1); for Kenya and Korea, authors' own regression estimates (available on request); for Canada, Denmark, and Sweden, Deppler and Ripley (1978, Table 13); for Finland, Ireland, and Spain, Warner and Kreinin (1983, Tables 1 and 2); and for Portugal, Houthakker and Magee (1969, Table 3).

(4) Income elasticity of consumption α . For want of comparable estimates of α for the countries in the sample, we use Gylfason's (1981) estimate for the United States, based on a life-cycle model of consumption applied to quarterly data for 1952-78. This estimate ($= 0.7$) refers to an adjustment period of about 2 years, and is similar to the estimate of α implied by the standard empirical Ando-Modigliani expenditure function $e = 0.7y^* + 0.06a^*$ where $y^* = yP/\Pi$ and $a^* = (M + A - ED^*)/\Pi$.

(5) Share of imported inputs in domestic output θ_n . By definition, $\theta_n = E_n/P_q$, and can be rewritten as $(E_n/P_y)/(1 + E_n/P_y + E_r^*D^*/P_y)$ by using equation (11) in the main text. E_n/P_y is defined as the ratio of the sum of imported agricultural raw materials; fuels (for industrial use), ores, and metals; chemicals; and machinery and equipment to GNP in 1979, which is the latest year for which

the import statistics are presently available for all 15 countries. The data on E_n and P_y were obtained from United Nations (1981, Table 4.2) and IMF (1982a), respectively. On the basis of available evidence for the mid-1970s we assume that oil imports for industrial use constitute 40 percent of total oil imports in the industrial countries (except Canada: 30 percent) and 50 percent of the total in the LDCs as well as in Portugal and Spain. The other ingredient necessary for the computation of θ_n --i.e., $E_r^*D^*/P_y$ --is discussed in paragraph (10) below.

(6) Share of labor in domestic output θ_ℓ . This share is defined as W_ℓ/P_q , and can be reexpressed as $(W_\ell/P_{y'})/(1-\theta_n)$ where $y' = q - (E/P)_n$ represents GDP, compare equations (1) and (2) in the text. Using the most recent figures published in United Nations (1980), we approximate the ratio $W_\ell/P_{y'}$ by the share of income from employment to net GDP (net, because there is no consumption of capital in the model). Since no data are available for Morocco, Pakistan, and the Philippines, we assume that θ_ℓ in these countries equals the average share for the LDCs in the sample excluding Turkey as well as Portugal and Spain. To be consistent with the GNP component of the debt figures presented in paragraphs (9) and (10) below, net GDP in the above formula is expressed in market prices as well. As a result, the item "indirect taxes net of subsidies" is implicitly attributed to the "third factor", implying a somewhat steeper aggregate supply schedule than would obtain if GDP were expressed in terms of factor cost.

(7) Combined share of imported inputs and labor in domestic output, $\theta = \theta_n + \theta_\ell$.

(8) Share of final goods imports in GNP λ . We estimate this parameter by the ratio of final goods imports (source: figures from United Nations 1981, Table 4.2, adjusted for oil imports for industrial use as explained in paragraph (5) above) to GNP (source : IMF 1982a).

(9) Share of inputs in total imports (including interest payments) β . This parameter can be expressed as $\beta = (En/Py) / (z/y + En/Py + Er*D^*/Py)$, and can be computed directly from the estimates for En/Py (see paragraph 5), z/y (paragraph 8), and $Er*D^*/Py$ (paragraph 10).

(10) Share of net foreign interest payments in GNP μ . Estimates of the net foreign debt position at the end of 1982 as a proportion of GNP are available for Argentina, Brazil, Korea, Morocco, and the Philippines (OECD 1982a; see paragraph 12 below). We approximate μ for these countries by multiplying each country's debt/GNP ratio (i.e., ED^*/Py) by the average 1982 interest rate on the foreign debt of middle-income countries (Morocco, the Philippines) and newly industrialized countries (Argentina, Brazil, Korea); country-specific data on interest costs are not available for 1982 for these countries. For the remaining 10 countries we estimate μ directly by the ratio of net interest payments (source: IMF 1982b) to GNP (source: IMF 1982a) in 1981 (except Ireland: 1980, cf. paragraph 12); for Portugal and Spain, we have updated the available GNP figures for 1980 on the basis of OECD (1982b, 1982c).

(11) Share of net foreign interest payments in total imports ϵ .

This parameter can be expressed as $\epsilon = (Er^*D^*/Py)/(z/y + En/Py + Er^*D^*/Py)$, and can be computed directly from the estimates already obtained for Er^*D^*/Py (paragraph 10), z/y (paragraph 8), and En/Py (paragraph 5).

(12) Ratio of net foreign debt to net real wealth ϕ . This ratio

can be written as $\phi = (ED^*/Py)/(M/Py + A/Py - ED^*/Py)$. For Argentina, Brazil, Korea, Morocco, and the Philippines we use the estimates of OECD (1982a, Tables 7 and 8) for the net debt/GNP ratio ED^*/Py at the end of 1982. These estimates comprise almost ~~all short-, medium-, and long-term fixed and variable interest~~ assets and liabilities of these countries, including arrears and foreign exchange reserves (which are assumed to be invested in short-term variable interest rate instruments). Direct foreign investment, gold, IMF transactions, flight capital to foreign countries, and foreign exchange deposits of local residents in domestic banks are excluded from the net debt position. Since no figures on the net debt/GNP ratio are available for the remaining 10 countries, we estimate the net interest-bearing debt position in mid-1981 by dividing net interest payments Er^*D^* in 1981 (source: IMF 1982b, lines 15-20) by country-specific estimates of the relevant interest rate r^* in 1981; more recent data are not available. Specifically, for Kenya and Pakistan we use $r^* = 0.04$ which was the average nominal interest rate paid by low income countries (OECD, 1982, Table 6). For Turkey we use $r^* = 0.086$ which is the average for middle income countries. For Portugal and Spain we use $r^* = 0.014$,

the average for newly industrialized countries. For the rest of the countries in the sample we use the average 1981 Euro-Dollar London Rate ($r^* = 0.1651$), except for Ireland where we use the 1980 Euro-Dollar rate because the latest available figures on interest payments are from 1980. This indirect method gives an estimate of the net interest-bearing debt position. Noninterest-bearing assets such as gold and SDRs and direct foreign investment income are not included in the above estimates. As before, the 1981 GNP figures used in the denominator of the debt/income ratio are taken from IMF (1982a); compare paragraph 10. Finally, we obtain the denominator of the expression for ϕ --i.e., the ratio of total net wealth to GNP--by assuming this ratio to equal 4.5 in the industrial countries and 3 in the developing countries, including Portugal and Spain. The number 4.5 is based on available evidence on the net worth of households in the United States (see, e.g., Gylfason 1981), while the number 3 is a guess. Hence, ϕ is approximated by $(ED^*/Py)/4.5$ and $(ED^*/Py)/3$ for the industrial and developing countries, respectively.

(13) Ratio of current account deficit to merchandise exports ω .

This ratio, defined to include private and official unrequited transfers, is computed from the balance of payments statistics for 1981 reported in IMF (1983).

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