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## Adjustment to Variations in Imported Input Prices: The Role of Economic Structure

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CENTER DISCUSSION PAPER NO. 360

ADJUSTMENT TO VARIATIONS IN IMPORTED INPUT PRICES:

THE ROLE OF ECONOMIC STRUCTURE

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One of the most important economic disturbances in recent years was the fourfold increase in oil prices in 1974. Preceded by a series of harvest failures and a period of expansionary domestic policies in most countries, the explosive rise in oil prices was a factor behind the acceleration of price increases and the formation of adverse inflationary expectations. It also worsened unemployment and current-account positions in most oil-importing countries.

Table 1 shows the improvement in OPEC's terms of trade over the last decade. The terms of trade improved by 270.3 percent in 1973-74, 5.6 percent in 1975-76 and 35.8 percent in 1978-79.

Table 1: OPEC Terms of Trade

Period averages as Index Numbers, 1974 = 100

	Oil Prices <sup>a</sup>	Import Prices <sup>b</sup>	Terms of Trade
1970 - 72	19	66	28
1973	31	84	37
1974	100	100	100
1975	98	111	89
1976	106	113	94
1977	114	124	92
1978	117	144	81
1979	178	163	110
Q4 1979	233	172	135

Source: World Financial Market, Morgan Guaranty Trust Company of New York, May 1979, p. 3.

- Notes:
- Official sales price of OPEC "market crude" in U. S. dollars through 1978; weighted average of all OPEC prices thereafter including surcharges.
  - Wholesale prices of nonfood manufactures in industrial countries expressed in U.S. dollar terms and weighted by these countries share in OPEC imports.

The adjustment of oil-importing countries to the higher oil prices has not been uniform. As can be seen in Table 2, inflation rates have differed considerably across most oil-importing countries despite the common external oil price shocks.

Table 2

Annual % Change of the Consumer Price Index in Selected  
OECD Countries

<u>Country/Year</u>	<u>1965-70<sup>1</sup></u>	<u>1974-75</u>	<u>1975-76</u>	<u>1976-77</u>	<u>1977-78</u>
United States	4.3	9.2	5.8	6.5	7.5
Canada	3.9	10.7	7.5	8.0	8.9
Japan	5.5	11.9	9.3	8.0	3.8
Switzerland	3.4	6.7	1.7	1.3	1.1
Federal Republic of Germany	2.4	5.9	4.5	3.9	2.6
United Kingdom	4.6	24.2	16.5	15.9	8.3
France	4.5	11.7	9.2	9.5	9.2
Netherlands	5.0	10.5	8.8	6.4	4.1
Belgium	3.3	12.7	9.2	7.0	4.5
Denmark	6.6	9.6	9.0	11.1	10.1
Italy	3.0	17.0	16.8	16.9	12.2

Source: IMF, International Financial Statistics

Notes on Table 2

<sup>1</sup> Average annual % change for the whole period.

This differential response can be partly attributed to differences in policy reaction and partly to more fundamental differences in economic structure. Such structural characteristics as an economy's openness,<sup>1</sup>

its degree of market power, the elasticity of substitution among goods, factors or financial assets, the composition of trade, and the extent of wage indexation may affect the way an economy adjusts to an oil price increase.

The implications of variations in structural characteristics for the transmission of external price disturbances have not been adequately or systematically studied. Both the theoretical and empirical literature is relatively sparse with the exception of some pioneering work in the development field (Harberger 1964) and some more recent studies in international finance (Whitman, 1969; Brunc and Sachs, 1979; Katseli-Papaefstratiou, 1980; Flood and Marion, 1980).

Section 2 of this paper develops a simple general equilibrium model to analyze the impact effects of a one-shot increase in the price of an imported intermediate good, such as oil, on domestic prices, income, the domestic interest rate and the exchange rate of an oil-importing economy with developed financial markets and a flexible exchange rate. This framework would apply to most European countries which have various degrees of market power on the export side but can be considered "small" on the import side. The proposed framework of analysis is an extension of some earlier work by both authors (Marion, 1977, 1979; Katseli-Papaefstratiou, 1979, 1980) and others (Findlay and Rodriguez, 1977; Buiters, 1978). The analysis shows that an increase in imported input prices depreciates the nominal exchange rate and reduces the domestic interest rate. Both nominal and real income fall. The impact on nontraded goods prices and on the real exchange rate depends upon specific parameter values.

Section 3 of the paper discusses the role of structural characteristics in the transmission process. While the model can be used to isolate the effects of numerous structural parameters on the transmission process, we choose to focus on four: (1) market power, (2) the marginal propensity to save, (3) the substitutability of financial assets (financial openness), and (4) the share of traded goods in total consumption (real demand-side openness). The present study, which concentrates on the theoretical foundations of the problem, indicates that these structural characteristics affect the transmission process in significant ways. For example, it is shown that decreased market power dampens both the depreciation of the home currency and the drop in nominal income that follow a rise in imported input prices. Increased asset substitutability exacerbates the depreciation of the home currency but dampens the drop in nominal income. An increased marginal propensity to consume traded goods exacerbates the depreciation of the exchange rate but does not modify the drop in income.

## 2. The Model

Consider an economy with a financial sector and a goods sector. The financial sector consists of two domestic, nontraded assets, namely money and interest-earning bonds, and an internationally-traded bond. The goods sector is composed of four goods. The economy produces and domestically consumes a nontraded (home) good, imports a final and an intermediate good, neither of which is produced domestically, and exports a final good which is produced domestically and consumed at home and abroad. While there is some degree of market power on the export side, the country is a price-taker in both import markets. The disaggregated financial and goods sectors together determine four endogenous variables: the domestic interest rate, the exchange rate, the price of nontraded goods and income. The full model is set out and described below.

## Notation

Asterisks refer to foreign variables of foreign-exchange denominated variables

Superscripts  $s$  and  $d$  refer to supplies or demands of goods

- A - the financial wealth of domestic residents, nominal terms
- L - domestic money
- B - domestic nontraded bonds, with fixed price and variable interest rate
- F - net claims on foreigners, with fixed price and variable interest rate, denominated in foreign currency
- $e$  - exchange rate, domestic-currency price of foreign currency
- $l$  - fraction of income held as money balances
- $b$  - domestic demand for nontraded bonds
- $f$  - domestic demand for net claims on foreigners
- $r$  - interest rate on domestic bonds
- V - national income (value added), nominal terms
- H - nontraded (home) goods
- X - export goods
- R - intermediate goods, imported
- MP - imports of final goods
- W - nominal wage
- $P_H$  - price of nontraded goods
- $P_X$  - price of export goods in domestic currency
- $P_{MP}$  - price of final-good imports in domestic currency

- $P_R$  - price of intermediate goods in domestic currency.
- $C$  - desired nominal consumption expenditures
- $S$  - desired nominal saving
- $g$  - desired wealth
- $\lambda$  - speed of adjustment of actual wealth to desired wealth
- $P_x^0$  - shift parameter reflecting domestic supply conditions
- $q_x^0$  - shift parameter reflecting world market conditions

## The Model

$$(1) \quad L - \ell(r)V = 0$$

$$(2) \quad B - b(r, r^*, V, A) = 0$$

$$(3) \quad eF - f(r, r^*, A) = 0$$

$$(4) \quad A = L + B + eF$$

$$(5) \quad H^S \left[ \frac{W}{P_H - P_R} \right] - H^d [P_H, P_X, P_{MP}, C] = 0$$

$$(6) \quad V = P_H H^S + P_X X^S - P_R R$$

$$(7) \quad C = V - S$$

$$(8) \quad S = \lambda [g(r, r^*, V) - A]$$

$$(9) \quad P_X = P_X(e, P_X^O, q_X^O)$$

$$(10) \quad P_{MP} = eP_{MP}^*$$

$$(11) \quad P_R = eP_R^*$$

The asset-market specification draws on the work by Tobin (1969), Kouri (1976), Branson (1977) and others. Asset demands can be written in nominal terms as:

$$L^d = l(r, V) = l(r)V; \quad l_r < 0, l_V > 0$$

$$B^d = b(r, r^*, V, A); \quad b_r, b_A > 0; \quad b_{r^*}, b_V < 0$$

$$eF^d = f(r, r^*, A); \quad f_r < 0; \quad f_{r^*}, f_A > 0$$

The demand for money depends on the domestic interest rate and income. The demands for both interest-bearing bonds depend on the domestic and foreign interest rates and on wealth. The demand for domestic bonds also depends on income. The specification assumes that changes in income affect only the demands for domestic assets while changes in wealth affect only the demands for interest-earning assets. In addition, it is assumed that the demand for money is homogeneous of degree one in income.<sup>2</sup>

The specification of asset demands does not take into account wealth holders' expectations of future exchange-rate movements. These are worked out in Appendix 1. Since we are interested in the short-run effects of the oil price rise, and since the 1974 price hike was generally unanticipated, it does not seem inappropriate to assume static expectations.

Asset demands are stock demands, and they are realized instantaneously so that actual holdings of assets always reflect the desired composition of the portfolio. Because exchange rates are flexible, the

nominal stock of money is exogenously determined by the central bank and equal to the money holdings of the private sector:

$$L = \bar{L} = L^d$$

In the short run, the stocks of interest-bearing assets available to domestic residents are also fixed and equal to the demands for those assets:

$$B = \bar{B} = B^d$$

$$eF = e\bar{F} = eF^d$$

b. Labor Markets

There are two domestically-produced goods in this economy: (1) the exportable good, which uses labor (N) and a fixed stock of capital ( $\bar{K}$ ) in the production process, and (2) the nontraded good, which uses labor, a fixed capital stock and an intermediate import good. The production function for the exportable good is:

$$X^S = F(N_X, \bar{K}_X) ; \quad X_{N_X}^S > 0$$

and for the nontraded good:

$$H^S = \min\{G(N_H, \bar{K}_H), \frac{1}{b_H}R\} ; \quad H_{N_H}^S > 0$$

It is assumed that while capital and labor are gross substitutes in domestic production, value added in the home goods sector and the imported input are used in fixed proportions, with  $b_H$ , the input-output coefficient, set equal to unity for convenience.<sup>3</sup>

Profit-maximizing behavior in the two sectors would imply that the nominal wage is equated to the value of the marginal product of labor in the export-good sector but to the net value of marginal product in the nontraded good sector. Thus,

$$X^S: P_X X_{N_X}^S = W$$

$$H^S: (P_H - P_R) H_{N_H}^S = W$$

The supply of labor in both sectors is assumed to depend on the expected real wage  $\left(\frac{W}{P}\right)$ , where the expected price level is assumed to be a function of the consumer price index.<sup>4</sup> Thus,

$$q(N_i) = \frac{W}{P}; \quad q_{N_i} \geq 0, \quad i = X, H$$

$$\hat{P} = h(P); \quad 1 \geq h' \geq 0$$

$$P = a_1 P_H + a_2 P_X + a_3 P_{MP}; \quad 1 > a_i > 0, \quad \sum_{i=1}^3 a_i = 1$$

This is the most general specification of the labor markets. Several specific cases can be examined. If there is complete money illusion,  $h' = 0$ ; if there is no money illusion,  $h' = 1$ . If real wages are rigid, then  $d\left(\frac{W}{P}\right) = q_{N_i} dN_i = 0$ ; if instead nominal wages are fixed, then  $dW = d(\hat{P}q(N_i)) = 0$ . It turns out that whether real or nominal wages are rigid or whether money illusion prevails or not makes no qualitative difference for the impact effects of an oil price rise.<sup>5</sup>

So long as entrepreneurs watch their own prices while workers watch the CPI, the supplies of nontraded goods and export goods will be positively related to their respective prices. The proof is presented in Appendix

2. Consequently, we will proceed with the analysis assuming nominal wage rigidity. The results hold equally well for the other cases mentioned.

c. Commodity Markets

Equations (5)-(11) describe the market for nontraded goods, which is continuously cleared, the income identity and prices.

Given the assumption of nominal wage rigidity, the supply of nontraded goods in (5) is negatively related to the net real wage in that sector. The demand for home goods depends on the relative prices of all final consumer goods, which are assumed to be gross substitutes in demand, and desired consumption expenditures, which is defined in equation (7) as the difference between income and desired saving. (The distinction between national income and disposable income is ignored.) The demand function is homogeneous of degree zero in all prices and consumption and the indifference curves are assumed to be homothetic.<sup>6</sup>

In the presence of intermediate goods, GNP is equal to value added which, in turn, is equal to the total value of production minus the value of imported inputs (equation 6).

Desired real saving, which is equal to the flow excess demand for wealth, is homogeneous of degree one in real income and real wealth, yielding (8) in nominal terms. If desired wealth exceeds the actual stock of wealth, domestic residents save. In the absence of government debt creation or domestic money creation, the private sector accumulates wealth through the balance of payments.

The price equations for all traded goods are given by equations

(9)-(11). The country is assumed to be small on the import side so that (10) and (11) simply convert the international prices into domestic currency units. The country is not small on the export side, however. It is assumed to possess some market power ( $k$ ) which is measured by decreasing elasticity of demand (in absolute value) for exports. Thus, the domestic-currency price for the exportable is not fixed but is itself a function of the exchange rate, domestic supply conditions, and world market conditions.<sup>7</sup>

d. The Solution

The model can be solved for four endogenous variables - the price of nontraded goods, the exchange rate, the interest rate and value added. Since we are interested in the short-run effects of an increase in intermediate good prices, the model is solved holding asset stocks fixed. In Appendix 3 we show that a sufficient condition for local stability of the system is that the country not be too large on the export side - or more generally, that a depreciation of the home currency, ceteris paribus, must increase value added. In the present model, where an increase in value added implies an increase in saving and hence an improvement in the current account, this condition is equivalent to the Marshall-Lerner condition. Whereas most portfolio-balance models stress the importance of the Marshall-Lerner condition for dynamic stability, in this model the condition becomes relevant for local stability as well.

Imposing the Marshall-Lerner condition, we report the effects of an increase in the international price of the imported input on the endogenous variables in Table 3.

Table 3<sup>1</sup>

Disturbance	Effect					
	$\frac{dP_H}{P_H}$	$\frac{de}{e}$	dr	dV	$d\left(\frac{V}{P}\right)$	$d\left(\frac{e}{P}\right)$
$\frac{dP_R^*}{P_R}$	?	+	-	-	-	?

$$Z_{P_H, P_R^*} = \frac{\frac{dP_H}{P_H} \Big|_{P_R^*}}{\frac{dP_R^*}{P_R^*}} = [\gamma_1 \gamma_3 + \gamma_5] \frac{P_R}{P_H} D^{-1}$$

$$Z_{e, P_R^*} = \frac{de \Big|_{P_R^*}}{dP_R^*} = f_r B_H \ell \frac{P_R}{P_H} P_H^S (1 + E_H) D^{-1}$$

$$Z_{r, P_R^*} = \frac{dr}{dP_R^*} = eF(1 - f_A) B_H \ell \frac{P_R}{P_H} P_H^S (1 + E_H) D^{-1}$$

$$Z_{V, P_R^*} = \frac{dV}{dP_R^*} = -eF(1 - f_A) V \ell_r \frac{P_R}{P_H} P_H^S (1 + E_H) B_H D^{-1}$$

where

$E_i > 0$ ;  $i = X, H$  is the price elasticity of supply

$B_H > 0$  is the own price-elasticity of demand for home goods

$B_{H,j} > 0$ ;  $j = X, MP$  are the cross-price elasticities of demand

$m_H = P_H \frac{dH}{dC}$  is the marginal propensity to consume home goods

$$\gamma_1 = \frac{-E_H P_H}{P_H - P_R} + m_H (1 - \lambda g_V) (1 + E_H) = ?$$

$$\gamma_2 = P_X X^S (1 + E_X) k - \frac{P_R}{P_H} P_H^S (1 + E_H) > 0 \quad \text{for stability}$$

continued. . .

Table 3<sup>1</sup> (cont'd)

$$\gamma_3 = -f_r \lambda \gamma_2 - v \lambda_r eF (1 - f_A) > 0$$

$$\gamma_4 = \frac{E_H P_R}{P_H - P_R} + B_{H,X} k + B_{H,MP} + m_H \frac{1}{P_H H d} \{ (1 - \lambda g_V) \gamma_2 + \lambda eF \} > 0$$

$$\gamma_5 = -\lambda P_H^S (1 + E_H) \left[ m_H \frac{1}{P_H H d} \lambda g_r eF (1 - f_A) - f_r \gamma_4 \right] < 0$$

$$D = (\gamma_1 - B_H) \gamma_3 + \gamma_5 < 0$$

---

1) The sufficient condition for stability is that  $\gamma_2 > 0$

The sign of  $Z_{P_H, P_R^*}$  is ambiguous on account of  $\gamma_1$ , where  $\gamma_1 \frac{P_R}{P_H}$  represents the supply-inflationary and demand-deflationary effects in the nontraded goods market following the increase in the price of the imported input. If the supply-inflationary effect outweighs the demand-deflationary effect, then  $\gamma_1 < 0$  and  $Z_{P_H, P_R^*}$  is unambiguously positive.

Table 3 also shows that the increase in the price of the imported input unambiguously depreciates the home currency, lowers the domestic interest rate, and reduces nominal income. As has been shown elsewhere (Katseli-Papaefstratiou, 1980), the income response depends on the character of the underlying production function. If the imported input is a gross complement to the domestic factors of production, then an increase in the price of the input will, ceteris paribus, increase its total share in income, reducing value added. Table 3 also indicates that an increase in imported input prices lowers real output but has an ambiguous effect on the real exchange rate.

The results in Table 3 are consistent with those obtained by Findlay-Rodriguez (1977) and Buitier (1978) even though their models abstract from a nontraded-goods sector, specify perfect asset substitutability, and are dissimilar in some other respects. In the Findlay-Rodriguez model, an oil price rise reduces real output and has an ambiguous effect on the real exchange rate. In the Buitier model, it reduces real value added and depreciates the nominal exchange rate.

### 3. The Role of Structural Characteristics

As can be seen from Table 3, all the solutions are themselves a function of a number of structural parameters, such as the degree of market power on the export side ( $k$ ), the marginal propensity to save out of income ( $g_v$ ), the substitutability of domestic and foreign interest-earning assets ( $f_x$ ), the marginal propensity to consume nontraded goods ( $m_H$ ), the own and cross-price elasticities of demand ( $B_H, B_{H,i}; i = x, mp$ ), the elasticities of supply ( $E_H, E_X$ ) and so forth. The solutions in Table 3 can be partially differentiated with respect to each of these parameters in order to determine what effects changes in structure have on the transmission of external price disturbances. The differential path of adjustment experienced by industrialized countries after the series of price increases in oil and other raw materials may be understood, in part, by differences in these structural characteristics.

Rather than provide a complete taxonomy, we choose to focus on four structural parameters, namely the degree of market power in the export market ( $k$ ), the marginal propensity to save ( $g_v$ ), the degree of financial substitutability ( $f_x$ ) and the marginal propensity to consume traded goods ( $m_T = 1 - m_H$ ). The results of partially differentiating the solutions in Table 3 with respect to each of these structural parameters are reported in Table 4.

Table 4

Disturbance	Effect			
	$Z_{P_H, P_R^*}$	$Z_{e, P_R^*}$	$Z_{r, P_R^*}$	$Z_{V, P_R^*}$
k	?	-	-	-
$g_V$	?	-	-	-
$-f_r$	?	+	-	-
$m_T = (1 - m_H)$	?	+	0	0

Notes:

1. A positive sign indicates that the change in structure exacerbates the impact effect.
2. A negative sign indicates that the change in structure dampens the impact effect; note that in cases where the impact effect is negative, a negative sign in Table 4 indicates a positive second derivative.
3. An increase in k signifies decreased market power on the export side.
4. An increase in  $g_V$  signifies an increased marginal propensity to save.
5. A greater negative value for  $f_r$  signifies increased asset substitutability.
6. An increase in  $m_T$  signifies an increased marginal propensity to consume traded goods.
7. The signs in the fourth row are derived assuming perfect asset substitutability.

a. Market Power

As noted in footnote (7), market power in the export market can be measured by  $k$ , where

$$(12) \quad k = \frac{d_x}{d_x - s_x} = \frac{1}{1 - \frac{s_x}{d_x}}; \quad 0 < k \leq 1$$

If a country faces an infinitely elastic demand curve for its exports ( $d_x = -\infty$ ), i.e., if the country is "small" in the export market,  $k = 1$ .<sup>8</sup> Alternatively, as demand becomes less than perfectly elastic ( $d_x \rightarrow 0$ ),  $k \rightarrow 0$  and the country can be said to possess market power in the export sector.

Table 4 shows that decreased market power dampens the depreciation of the home currency and moderates the drop in the domestic interest rate and value added that follow an increase in  $P_R^*$ . The effect of decreased market power on the percentage change in domestic prices is uncertain, however.

These findings can best be understood by recognizing that as the country becomes "small" in the export market, the indirect effects of a given depreciation become larger. From footnote (7) we have

$$\frac{dP_X}{P_X} = k \left( \frac{dq_x^o}{q_x^o} + \frac{de}{e} \right) + (1 - k) \frac{dP_X^o}{P_X^o}$$

As  $k$  increases, the depreciation caused by the increase in  $P_R^*$  produces a larger increase in the domestic price of exportables and thus a smaller drop in value added than would otherwise be the case. The increase in  $P_R^*$  now causes a smaller drop in money demand, dampening the depreciation of

the home currency and the drop in interest rates required to restore money-market equilibrium.

Decreased market power also implies that a given depreciation reduces the demand-deflationary effect of a rise in  $P_R^*$  since there is now a higher  $P_X$ , which implies a greater substitution towards home goods and also a bigger income effect. However, since decreased market power actually dampens the depreciation of the home currency, its net effect on the demand for home goods and consequently on the percentage change in home good prices is uncertain.

In summary, the results suggest that economies which differ in market power but are otherwise similar in structure and policy attitude should experience different degrees of currency depreciation. Countries with relatively less market power on the export side should experience a smaller depreciation of their currencies following an increase in imported input prices. The results also suggest that countries which differ in market power may experience different degrees of income decline. These observations might be relevant in analyzing the impact of the oil price increase on various European economies.

b. The Marginal Propensity to Save

An increased marginal propensity to save ( $g_v$ ) also affects the way an external price disturbance is transmitted to the economy. Table 4 shows that an increased marginal propensity to save dampens the depreciation of the home currency and moderates the drop in interest rates and income that accompany a rise in  $P_R^*$ . Its effect on the percentage change in nontraded-goods prices depends on specific parameter values.

These findings can be understood, in part, by examining expression (13)

$$(13) \quad \frac{P_R}{P_H} \gamma_1 = \frac{-E_H P_{HR}}{P_H - P_R} + m_K (1 - \lambda g_v) \frac{P_R}{P_H} (1 + E_H) ,$$

The terms on the right-hand side of (13) represent the supply-inflationary and demand-deflationary effects in the home goods market brought about by the increase in  $P_R^*$ . If the drop in supply exceeds the drop in demand, (13) is negative and home-good prices will increase.

Expression (13) indicates that an increase in the marginal propensity to save reduces the demand-deflationary effect of an increase in  $P_R^*$ , requiring a greater increase in home-good prices to restore equilibrium in that market. Consequently, if an increase in imported input prices raises home-good prices - that is, if the supply-inflationary effect dominates so that  $Z_{P_H, P_R^*} > 0$  - then an increased marginal propensity to save will exacerbate this price increase. If, on the

other hand, the demand-deflationary effect dominates, so that domestic prices fall, an increased marginal propensity to save will dampen or even reverse this price decline.

Since an increased marginal propensity to save requires a greater increase in home-good prices, it causes a smaller drop in value added than would otherwise be the case. Consequently, the drop in money demand will be moderated, dampening the depreciation of the home currency and the drop in interest rates required to restore money-market equilibrium.

These results suggest that differences in the marginal propensity to save can cause economies to react differently to changes in imported input prices. Economies with a greater marginal propensity to save will tend to experience increased upward pressure on home-good prices, a smaller depreciation of their currencies and a smaller drop in nominal income.

c. Asset Substitutability

The substitutability of foreign and domestic bonds, which might be considered an index of financial openness, can be approximately measured by  $f_r$ , the partial derivative of the demand for foreign assets with respect to the domestic interest rate. To see this, suppose that the demand functions for both foreign and domestic bonds are exponential functions:

$$(14) \quad eF^d = \exp^{-ar + \beta r^*} A^\theta ; \quad a, \beta, \theta > 0$$

$$(15) \quad B^d = \exp^{\gamma r - \delta r^*} V^\epsilon A^\psi ; \quad \gamma, \delta, \epsilon, \psi > 0$$

From the specification of the asset demand functions we know that

$$b_r = -f_r - \ell_r V$$

so that

$$\gamma = a + Z \quad \text{where } Z = -\ell_r V$$

We also know that

$$f_r^* = -b_r^*$$

so that

$$\beta = \delta$$

It follows that the ratio of the two demand functions is

$$\frac{eF^d}{B^d} = \exp^{-(2a+Z)r + 2\beta r^*} V^{-\epsilon} A^{(\theta - \psi)}$$

Converting to logs and assuming that  $\ln r$  is approximately equal to  $r$ , we have

$$\ln \left( \frac{eF^d}{B^d} \right) = -r(2a+Z) + 2\beta r^* - \epsilon(\ln V) + (\theta - \psi) \ln A$$

so that

$$(16) \quad \frac{d \left( \frac{eF^d}{B^d} \right)}{dr} \cdot \frac{1}{\frac{eF^d}{B^d}} = -(2a+Z) = 2f_r + \lambda_r V < 0$$

As can be seen in equation (16), there is a correspondence between  $f_r$  and the substitutability of interest-earning assets given a change in the domestic interest rate.

The results of differentiating the solutions in Table 3 with respect to  $f_r$  are reported in Table 4. Greater asset substitutability (i.e., a larger negative number for  $f_r$ ) implies that there will be a larger shift in the demand for foreign assets for any given change in the domestic interest rate. Thus an increase in  $P_R^*$  which reduces the interest rate will create a larger excess demand for foreign bonds and a larger excess supply of domestic assets, thereby exacerbating the depreciation of the home currency and dampening the fall in income and the domestic interest rate. The effect of increased asset substitutability on the percentage change in home-good prices is unclear.

In summary, one would expect countries which are more financially open - whose domestic assets are closer substitutes for foreign assets - to experience a larger depreciation of their currencies and a smaller drop in their interest rates than those which are relatively closed.

d. Demand-side Openness

Real demand-side openness can be measured by the value share of traded goods in total expenditures:

$$m_T = \frac{P_X X^d + P_{MP} MP^d}{C} = 1 - \frac{P_H H^d}{C}$$

Since we have assumed the indifference curves to be homothetic, it follows that

$$\frac{H^d}{C} = \frac{dH^d}{dC} ,$$

so that demand-side openness can be rewritten as

$$m_T = 1 - P_H \left( \frac{dH^d}{dC} \right) = 1 - m_H$$

Note that increased demand-side openness is inversely related to an increase in the marginal propensity to consume nontraded goods ( $m_H$ ). Differentiating the solutions in Table 3 with respect to  $m_T$  gives ambiguous results. If it is assumed instead that the economy faces a world of perfect asset substitutability then an increase in the price of the intermediate input will have the same qualitative effect on home-good prices and the exchange rate but will not alter the domestic interest rate or nominal value added. The reasons for these latter results are straightforward. With perfect asset substitutability and static expectations, the domestic interest rate cannot deviate from the foreign interest rate. Nominal value added does not change because the direct dampening effect on value added due to the increase in imported input prices will be offset exactly by the depreciation of the home currency.

Differentiating this new set of solutions with respect to  $m_T$ , we find that increased demand-side openness exacerbates the depreciation of the home currency but has no effect on nominal value added or the domestic interest rate. Its effect on home-good prices depends on specific parameter values. If the increase in imported input prices raises home-good prices---that is, if the supply-inflationary effect dominates the demand-deflationary effect in the home-goods market---then increased consumption of traded goods dampens the inflationary pressures. If an increase in imported input prices lowers home-good prices, this drop is exacerbated.

These results can best be understood by recognizing that greater demand-side openness increases on net the demand-deflationary effect of a rise in  $P_R^*$ . It reduces the substitution effect away from traded goods as the home currency depreciates and it increases the substitution effect away from home goods towards traded goods once the price of home goods starts rising. Both substitution effects tend to increase the net demand-deflationary effect in the home-goods market.

The results suggest that the degree of demand-side openness has important implications for the way an economy adjusts to a change in imported input prices. Economies with a relatively greater fraction of traded goods consumed should experience a larger depreciation of their currencies but a smaller inflationary effect on nontraded-goods prices.

#### 4. Conclusion

The macroeconomic model shows that an increase in imported raw material prices will depreciate the home currency and lower nominal value added, real output and domestic interest rates. The effects on the real exchange rate and on nontraded-goods prices depend on specific parameter values. If the supply-inflationary effect dominates the demand-deflationary effect in the nontraded-goods market, then prices in that market will rise.

The analysis also suggests that differences in economic structure do affect the transmission of external price increases to the domestic economy. This might account, in part, for the varied experiences of oil-importing countries following the oil-price increase in 1974. Much research still needs to be done to isolate the effects of other structural parameters on the transmission process and to test the resulting hypotheses empirically.

## Footnotes

1. Openness is measured in different ways. Real-side openness can be measured by the value share of exportables in total GDP or by the value share of traded goods in total consumption expenditures. It can also be measured by the degree of dependence on imported inputs. Financial-side openness might be measured by the proportion of foreign assets in total wealth or by the degree of substitutability between domestic and foreign interest-earnings assets.
2. It follows that
  - (a)  $b_r + \lambda_r V + f_r = 0 \implies b_r > |\lambda_r| V ; b_r > |f_r|$
  - (b)  $b_r^* + f_r^* = 0 \implies f_r^* = -b_r^*$
  - (c)  $b_v + \lambda = 0 \implies b_v = -\lambda$
  - (d)  $b_A + f_A = 1$
3. For the implications of relaxing these assumptions, see Katseli-Papaefstratiou (1980).
4. The interesting question of how differences in wage structure qualitatively affect the transmission of external price disturbances is not explored in this paper.

5. The economy-wide supply of labor is fixed, but labor can move freely between the export and nontraded goods sectors.

6. This set of assumptions implies that:

$$(a) \quad B_H - \sum_j B_{H,j} = B_{H,c} ; \quad j = X, MP$$

$$(b) \quad B_{H,c} = 1$$

where  $B_H$  and  $B_{H,j}$  are the own- and cross-price elasticities of demand, respectively, and  $B_{H,c}$  is the consumption elasticity.

The homotheticity assumption will be important when the role of demand-side openness is examined.

7. For a full description of how one can incorporate market power into a macro model, see Branson and Katseli-Papaefstratiou (1980).

Given the supply of exports, which is expressed in

home currency units  $\ln P_X = \ln P_X^0 + s_X^{-1} \ln X$ , and the demand for

exports, which is expressed in foreign exchange units

$\ln P_X^* = \ln q_X^0 + d_X^{-1} \ln X$ , we can solve for the market-clearing price,

$P_X$ . Converting the solution into percentage terms yields

$$\frac{dP_X}{P_X} = \frac{-s_X}{d_X - s_X} \frac{dP_X^0}{P_X^0} + \frac{d_X}{d_X - s_X} \left( \frac{dq_X^0}{q_X^0} + \frac{de}{e} \right)$$

$$= (1 - k) \frac{dP_X^0}{P_X^0} + k \left( \frac{dq_X^0}{q_X^0} + \frac{de}{e} \right)$$

$$\text{where } k = \frac{d_X}{d_X - s_X} = \frac{1}{1 - \frac{s_X}{d_X}} ; \quad 0 < k \leq 1$$

and  $d_X$ ,  $s_X$  are price-elasticities of demand and supply, respectively.

If the country has no market power, the demand for exports curve is infinitely elastic ( $d_x = -\infty$ ) and  $k = 1$ . As demand becomes less than perfectly elastic (as  $d_x$  rises from  $-\infty$ ),  $k$  falls from 1.

8. It should be noted that  $k = 1$  if  $s_x = 0$ , regardless of the degree of market power.

## Appendix 1

The model specified in the text can be modified to reflect the fact that the private sector has nonstatic expectations about the future behavior of prices and exchange rates. Nonstatic expectations will alter the expected nominal rates of return in the asset demand functions and the expected real rates of return in the savings function. Letting  $\pi_1$  and  $\pi_2$  represent the expected rate of change in exchange rates and prices respectively, the model can now be specified as follows:

Asset Markets

$$\begin{aligned} (1-A1) \quad & L - V\ell(r) = 0 \\ (2-A1) \quad & B - b(r, r^* + \pi_1, V, A) = 0 \\ (3-A1) \quad & eF - f(r, r^* + \pi_1, A) = 0 \\ (4-A1) \quad & A = L + B + eF \end{aligned}$$

Goods Market

$$\begin{aligned} (5-A1) \quad & H^S \left[ \frac{W}{P_H - P_R} \right] - H^D [P_H, P_X, P_{MP}, C] = 0 \\ (6-A1) \quad & V = (P_H - P_R)H^S + P_X X^S \\ (7-A1) \quad & C = V - S \\ (8-A1) \quad & S = \lambda [g(r - \pi_2, r^* + \pi_1 - \pi_2, V) - A] \\ (9-A1) \quad & d\pi_2 = a_1 \frac{d\hat{P}_H}{P_H} + a_2 \frac{d\hat{P}_X}{P_X} + a_3 \frac{d\hat{P}_{MP}}{P_{MP}} \\ & = a_1 \frac{d\hat{P}_H}{P_H} + (a_2 k + a_3) d\pi_1 \end{aligned}$$

Expectations can be endogenized in many ways. One simple way is to assume regressive, or inelastic, expectations. This means that a percentage increase in a variable generates the expectation of a percentage decrease.

For example, the expected depreciation of the exchange rate is:

$$d\pi_1 = \alpha \frac{de}{e} ; \quad -1 \leq \alpha < 0$$

When  $\alpha = -1$ , expectations are completely inelastic. The future exchange rate is expected to return completely to its previous level. When  $-1 < \alpha < 0$ , the future exchange rate is expected to be at a level in-between the past rate and the currently prevailing rate. Of course, when  $\alpha = 0$ , expectations are static.

The expected rate of change in home-good prices can be expressed in a similar fashion:

$$\frac{d\hat{P}_H}{P_H} = \gamma \frac{dP_H}{P_H} ; \quad -1 \leq \gamma < 0$$

The three equations (1-A1), (3-A1) and (5-A1) can be solved for the impact effects of a change in international prices on the price of nontraded (home) goods, the nominal exchange rate and the domestic interest rate. A sufficient condition for local stability of the system is that the trade be negative and that the 3 x 3 determinant be negative, where

$$\text{Determinant} = \begin{vmatrix} - & - & ? \\ a_{11} & a_{12} & a_{13} \\ 0 & - & - \\ a_{21} & a_{22} & a_{23} \\ - & + & ? \\ a_{31} & a_{32} & a_{33} \end{vmatrix} \begin{vmatrix} \\ dP_H/P_H \\ \\ dr \\ \\ de/e \end{vmatrix}$$

and where

$$a_{13} = \gamma_4 + m_H \frac{1}{P_H} d\{\lambda g_r (a_2 k + a_3) \alpha - \lambda g_{r^*} (1 - a_2 k - a_3) \alpha\}$$

$$a_{33} = -\lambda \gamma_2$$

and  $\gamma_4$  and  $\gamma_2$  are defined below Table 3 in the text.

Stability requires that  $\gamma_2$  be positive. In other words, a depreciation must increase value-added and thus saving, improving the current account. This condition is equivalent to the Marshall-Lerner condition.

In addition, a negative determinant requires that the bracketed term in  $a_{13}$  be positive. This will be true as long as the Marshall-Lerner condition holds and as long as  $g_r \sim g_{r^*}$ . The interpretation of this second condition is as follows. A depreciation of the home currency generates an expected appreciation, lowering the expected real return on foreign assets and increasing the expected real return on domestic assets. Stability is ensured if the net effect of the actual depreciation

on expected real rates of return is to raise consumption on the home good.

Imposing stability, a change in imported input prices will have the same qualitative effects on the endogenous variables assuming inelastic expectations as it does assuming static expectations.

## Appendix 2

Taking the nontraded goods sector as an example, equilibrium in the labor market requires that

$$(1-2A) \quad (P_H - P_R) f(N_H) = \hat{P} q(N_H) = W$$

where  $f(N_H)$  is the marginal product of labor ( $f(N_H) \equiv H_{NH}^S$ ) and where all initial prices except the price of intermediate goods are set equal to unity, so that  $P_H = \hat{P} = W = 1$ ,  $0 < P_R < 1$ , and thus  $q(N_H) = 1$  and  $f(N_H) = \frac{1}{1-P_R} > 1$  initially.

Totally differentiating (1-2A) and substituting in the expressions for  $P$  and  $\hat{P}$  from the text yields

$$(2-2A) \quad [q_{N_H} - (1-P_R) f_{N_H}] dN_H = \left[ \frac{1}{1-P_R} - h' a_1 \right] dP_H - h' a_2 dP_X - h' a_3 dP_{MP} - \frac{1}{1-P_R} dP_R$$

so that

$$(3-2A) \quad \frac{dH^S}{dP_H} = \frac{dH^S}{dN_H} \frac{dN_H}{dP_H} = H_N^S \left[ \frac{\frac{1}{1-P_R} - h' a_1}{q_{N_H} - (1-P_R) f_{N_H}} \right] > 0$$

If real wages are rigid, so that  $q_{N_H} = 0$ , then (3-2A) is still positive.

The supply of home goods is also positively related to  $P_H$  in the case of nominal wage rigidity, where in lieu of equation (2-2A) we have

$$(4-2A) \quad -(1-P_R) f_{N_H} dN_H = \frac{1}{1-P_R} (dP_H - dP_R)$$

so that

$$(5-2A) \quad \frac{dH^S}{dP_H} = \frac{dH^S}{dN_H} \frac{dN_H}{dP_H} = H_N^S \left[ \frac{1}{-(1-P_R) f_{N_H}} \right] > 0$$

## Appendix 3

Totally differentiating equations (1), (3) and (5) in the text and putting them in matrix form, we have:

$$(1-A3) \begin{pmatrix} - & - & ? \\ a_{11} & a_{12} & a_{13} \\ 0 & - & - \\ a_{21} & a_{22} & a_{23} \\ - & + & ? \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} \frac{dP_H}{P_H} \\ dr \\ \frac{de}{e} \end{pmatrix} = \begin{pmatrix} ? \\ a_{14} \\ 0 \\ a_{24} \\ - \\ a_{34} \end{pmatrix} \frac{dP_R^*}{P_R^*}$$

where

$$a_{11} = \gamma_1 - B_H < 0$$

$$a_{12} = -m_H \frac{1}{P_H^d} \lambda g_r < 0$$

$$a_{13} = \gamma_4 > 0$$

$$a_{21} = 0$$

$$a_{22} = f_r < 0$$

$$a_{23} = -eF(1 - f_A) < 0$$

$$a_{31} = -\lambda P_H^S (1 + E_H) < 0$$

$$a_{32} = -\lambda_r V > 0$$

$$a_{33} = -\lambda \gamma_2 = ?$$

and  $\gamma_1, \gamma_2, \gamma_4$  are defined below Table 3 in the text.

Stability is ensured if the trace is negative and the determinant is negative. Thus stability requires that the expression  $\gamma_2$  embodied in  $a_{13}$  and  $a_{33}$  be positive. Economically this means that a depreciation must raise value added and hence the demand for domestic money. Since an increase in value added also increases saving and the incipient current-account surplus, the condition that  $\gamma_2 > 0$  is equivalent to the Marshall-Lerner condition. Note that stability requires the home country to be sufficiently small on the export side. As  $k \rightarrow 0$  (as the country possesses increasing market power on the export side),  $\gamma_2$  becomes negative and stability is jeopardized.

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