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by

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I. Introduction

In recent years oil price increases have often been associated with downward pressure on the foreign exchange value of the dollar. This correlation has produced some confusion -- among the public, market participants, policy makers, and even some economists -- about the reasons for such a relationship. Often we have heard and read that this relationship is paradoxical, since foreign countries, such as Japan and most of Europe, are much more dependent upon imported oil than is the United States. According to this view, one would expect the dollar to appreciate following an oil price shock. Others have stated that there is no paradox, since the fate of a country's currency depends not upon the percentage of oil imports in total oil consumption, but rather upon the absolute number of barrels imported. It would appear that this theory of exchange-rate determination is based on flow demands and supplies of currencies arising from a non-zero current-account balance. Since the United States imports more oil than Germany, it is hardly surprising to the adherents of this theory that the dollar depreciates relative to the mark following an increase in the price of oil.

Neither viewpoint is consistent with the portfolio-balance approach to exchange-rate determination. In this paper we modify the Girton-Henderson (1977) model to allow us to analyze an oil price shock in a portfolio framework. We model the effects of an oil price shock as the result of a wealth transfer generated by changes in the current accounts of oil-exporting and -importing countries. We show that the effect of such a shock depends crucially not only upon asset preferences of oil-exporting countries but also on the preferences of oil-importing countries. At one extreme, if OPEC's asset preferences happen to be identical to those of oil-importing nations, there is no reason for any exchange-rate change, abstracting from expectations effects relating to longer-run factors. At another extreme, in our model it is possible for the dollar to decline vis-a-vis the currency of another oil importer, such as Germany, even if the United States imports no oil at all.

The importance of asset preferences in determining the impact of an oil price shock on exchange rates is not widely appreciated in the growing volume of papers in this area.[1/] Several studies, such as Bruno-Sachs (1979) and Buiter (1978), have included asset markets in their models, but only under the assumption that home and foreign assets are perfect substitutes.[2/] However, insofar as an oil price shock can be thought of as a wealth transfer, an interesting question concerns the consequence of differences in asset preferences for the exchange-rate effects of this transfer. With perfect substitutes, such differences are, of course, impossible.

In Section II we present the model and then use it in Section III to analyze the effects of an oil price shock with both exogenous and endogenous expectations of the long-run exchange rate. A final section summarizes our results and mentions some of the limitations of our model.

It should be noted that what we examine are the impact effects of an unanticipated increase in the price of oil. In Section IIIa, where exchange-rate expectations are static, there is no difference between an anticipated and an unanticipated shock since portfolio preferences remain unchanged. However, when we endogenize exchange-rate expectations, it becomes clear that we are studying an unanticipated shock since portfolio holders do not react until after the shock occurs.

II. The Model

Our model extends the Girton-Henderson (1977) portfolio balance model to include an extra country, a somewhat more general modeling of asset holdings and, most importantly, a representation of current-account imbalances as wealth transfers. We consider a world composed of three countries: two oil-importing countries, the United States and, for example, Germany, and OPEC. The inclusion of two oil-importers allows us to examine not only the direct effect of a higher oil price on the exchange rate between their currencies, but also the indirect effect through the differential impact of a higher oil price on the domestic price levels in the two countries. Each of the industrial countries imports oil and exports some of its output, in which it is completely specialized, only to OPEC. The residents of each country hold the two assets, U.S. money and Germany money.[3/] We assume that OPEC sets the price of oil in dollars and accepts payment for oil in either asset.[4/] Since we are assuming flexible exchange rates and no official exchange-market intervention, the supply of each currency is exogenous. The model can easily be extended to allow for official intervention or open-market operations.

In keeping with the short-run focus of the paper, output in each country and the level of oil imports are fixed . However, we allow the price level of output to vary in each of the oil-importing countries. The endogenous price response of each country is a particularly important determinant of the expected future spot rate between the currencies of oil importers and, consequently, of the current spot rate. Finally, in contrast to the completely price inelastic demand for oil by the industrial economies, we assume that OPEC's demand for the output of these countries is price elastic.

The demand for money depends on expected rates of return. Since there are no interest-bearing assets in the model, the expected rate of return is e, the expected rate of change in the exchange rate between the dollar and the mark. Moreover, money demand functions are assumed to be homogenous of degree one with respect to wealth denominated in the currency of each country. In this regard, OPEC treats the dollar as its own currency. Specifically, we have:

(1)
$$B_i^d = b_i\,(\bar{e})\,W_i$$
$$E\,F_i^d = f_i\,(\overset{+}{e})\,W_i$$

for i = 1, 3 (the United States and OPEC, respectively), while for Germany,

(2)
$$\frac{B_2^d}{E} = b_2\,(\bar{e})\,W_2$$
$$F_2^d = f_2\,(\overset{+}{e})\,W_2$$

where

B_i^d = demand for dollars by the residents of country i;

F_i^d = demand for marks by the residents of country i;

E = exchange rate (\$/DM);

e = expected rate of change in the exchange rate; $e > 0$ indicates an expected depreciation of the dollar;

W_i = wealth of the residents of country i, measured in dollars (i = 1, 3) and marks (i = 2),

and where the sign above the argument indicates its partial effect on the function. We assume that exchange-rate expectations are stabilizing, that is,

(3) $$e = e(E - \bar{E}) \text{ and } \frac{de}{dE} < 0,$$

where $\bar{E}$ is the long-run value of the exchange-rate. Here we assume that $\bar{E}$ is exogenous; in Section III B we treat it as an endogenous variable.

In this paper we restrict ourselves to a short-run, one-period model. At the start of the period, wealth is given by:

(4) $$W_1^o = B_1^o + E^o F_1^o$$

$$W_2^o = \frac{B_2}{E^o} + F_2^o$$

$$W_3^o = B_3^o + E^o F_3^o$$

For each country, end-of-period wealth is equal to initial wealth plus the current-account balance plus any capital gains or losses on foreign-currency assets resulting from exchange-rate changes.[5/] Thus,

$$(5)\qquad W_1 = W_1^o + P_1X_1 - PQ_1 + F_1^o(E - E^o)$$

$$W_2 = W_2^o + P_2X_2 - \frac{P}{E}Q_2 + B_2\left(\frac{1}{E} - \frac{1}{E^o}\right)$$

$$W_3 = W_3^o + PQ - P_1X_1 - EP_2X_2 + F_3^o(E - E^o)$$

where

P = price of oil ($/barrel);

P_i = price of country i's output ($i = 1,2$);

X_i = quantity of output i, measured in its own units, exported from country $i(= 1,2)$ to OPEC;

Q_i = fixed quantity of oil (in barrels) imported by country $i(= 1,2)$;

$Q = Q_1 + Q_2$ = fixed output of oil by OPEC.

The current account is equal to each country's trade balance since we ignore net interest payments to foreigners.

Given the fixed volume of oil imports, the value of U.S. and German imports is determined by the price of oil, which is exogenously fixed by OPEC. OPEC's imports from each country are determined by income (PQ) and the relative price between goods 1 and 2:

$$(6)\qquad P_1X_1 = \delta_1(\overset{-}{T})\,PQ, \qquad \delta_1' < 0,$$

$$P_2X_2 = \delta_2(\overset{+}{T})\,\frac{PQ}{E}, \qquad \delta_2' > 0.$$

with

$$T = \frac{P_1}{EP_2} = \text{the terms of trade.}$$

We assume that $\delta_1 + \delta_2 \leq 1$, i.e., OPEC may not spend all of its oil revenue. The sign above T in the $\delta_i(\cdot)$ function is based on the assumption that OPEC's demand for the industrial countries' output is elastic with respect to price.6/

Finally, assuming a Cobb-Douglas production function for each good with labor and oil as factors of production, the price of each country's output depends on wages and the domestic currency price of oil, or:

$$(7) \quad P_1 = \gamma_1 w_1^{\alpha_1} P^{\beta_1}$$

$$P_2 = \gamma_2 w_2^{\alpha_2} P^{\beta_2} E^{-\beta_2}$$

where α_i and β_i are each less than one.
The α_i and β_i represent the constant shares of output accruing to labor and oil in each country, and w_i is the nominal wage in country i.7/ Higher oil prices will, ceteris paribus, act to increase output prices in the industrial countries. As shown below, higher oil prices will also tend to change the exchange rate and thereby mitigate or exacerbate the domestic inflationary impact of the oil price shock in country two (Germany).8/ Thus, the effect of higher oil prices on the terms of trade will depend upon: (a) the oil intensiveness of production in each country (β_i), and (b) the effect of oil prices on the exchange rate.

To summarize the workings of our model, a higher price of oil causes a wealth transfer to occur that can be viewed as taking place in two stages: first, a transfer to OPEC due to the higher value of its oil exports, and second, a transfer back to the industrial countries as OPEC spends part of its increased oil revenue on the output of the industrial economies. As Schmid (1980) has noted, it is quite possible that one of the industrialized countries might enjoy an improved current-account balance as a result of the shock if it both imports relatively little oil and is favored by OPEC respending. However, as we show in the next section, one cannot infer from a country's current-account position the change in its exchange rate: an appreciating exchange rate can be associated with either a deficit or a surplus in the current account.

III. The Exchange-rate Effects of Higher Oil Prices

A. Exogenous Long-run Exchange Rate

The model introduced in the last section can be solved for the effect of a change in the price of oil on the exchange rate. The equilibrium conditions for the two asset markets are:

$$(8)\quad B^S = b_1(e)W_1 + Eb_2(e)W_2 + b_3(e)W_3$$

$$(9)\quad E\,F^S = f_1(e)W_1 + Ef_2(e)W_2 + f_3\,(e)\,W_3\ .$$

The supplies of the two monies are assumed to be exogenously fixed. Since only one of these equations is independent,[9/] we can solve for one independent variable. We have chosen the exchange rate as the endogenous variable.

Arbitrarily dropping the foreign money market equation, differentiating equation (8), and substituting from the differentiated versions of equations (3) - (7), we obtain

$$\text{(10)} \qquad \frac{dE}{dP} = \frac{1}{\Delta} \{Q_1 (b_1 - b_3) + Q_2 (b_2 - b_3)$$
$$-Q \left[\delta_1 (b_1 - b_3) + \delta_2 (b_2 - b_3)\right]$$
$$-PQ (\beta_1 - \beta_2) t_1 \left\{\delta_1' (b_1 - b_3) + \delta_2' (b_2 - b_3)\right\}\},$$

with

$$t_1 = \frac{\gamma_1 W_1^{\alpha_1}}{\gamma_2 W_2^{\alpha_1}} P^{\beta_1 - \beta_2} E^{\beta_2 - 1} > 0,$$

$$t_2 = \frac{\gamma_1 W_1^{\alpha_1}}{\gamma_2 W_2^{\alpha_2}} P^{\beta_1 - \beta_2} E^{2 - \beta_2} > 0,$$

$$\Delta = e' \left[W_1 b_1' + EW_2 b_2 + W_3 b_3'\right] + b_1 F_1^{o}$$
$$+ b_2 (W_2 - \frac{B_2^{o}}{E}) + b_3 F_3^{o} + PQ \delta_1' (1 - \beta_2) t_2 (b_3 - b_1)$$
$$+ PQ \delta_2' (1 - \beta_2) t_2 (b_3 - b_2) + b_2 (\frac{PQ_2}{E} - \frac{PQ \delta_2}{E}) .$$

Although the sign of Δ is indeterminate, it must be positive to insure the stability of the model. The importance of this condition can be appreciated by looking at the ambiguous terms in Δ . For example, in the term

$$PQ \delta_1' (1 - \beta_2) t_2 (b_3 - b_1),$$

suppose that b_3 exceeds b_1. In this expression, $(1 - \beta_2)\ t_2$ is the change in the terms of trade (T) due to an exchange-rate change, while δ_1' is the change in U.S. exports due to a change in T. If E rises, T falls and U.S. exports to OPEC increase, raising U.S. wealth and lowering OPEC's wealth. If $b_3 > b_1$, this wealth transfer creates an excess supply of (demand for) dollars (marks), leading to a rise in E. Thus negative terms in Δ mean that changes in E tend to produce further changes in E in the same direction, so if these negative terms are large enough (i.e., if $\Delta < 0$), the model will be unstable.10/

Turning to the numerator of equation (10), it is clear that asset preferences are crucial in determining the sign and the magnitude of exchange-rate changes. If asset preferences are identical -- i.e., if $b_1 = b_2 = b_3$ -- then a rise in the price of oil will leave the exchange rate between the dollar and the mark unchanged ($\frac{dE}{dP} = 0$) regardless of the level of U.S. or German oil imports (Q_1 or Q_2). A rise in P tends to raise OPEC wealth and lower U.S. and German wealth. Ceteris paribus, U.S. (German) wealth holders reduce their holdings of dollars by $b_1\ dW_1$ ($b_2\ dW_2$). If OPEC increases its demand for dollars by the same amount -- which will occur if asset preferences are identical -- there is no reason for any exchange rate change: oil-importing wealth holders exchange a representative basket of assets for oil, and OPEC is content with the mix of assets in the basket.

This explanation suggests what would appear to be a less stringent condition than identical preferences for $\frac{dE}{dP} = 0$. All that is necessary for this result is that OPEC's preferences are equal to some weighted average of preferences by oil importers. However, this condition is in fact not much less stringent than that of identical preferences since there are in effect three wealth transfers taking place: a transfer to OPEC as the value of oil exports increases; a transfer back to the industrial economies as OPEC spends part of its increased oil revenue; and a transfer between OPEC and the two industrial countries due to the impact of a higher P on relative prices and hence on exports to OPEC. Equation (10) can be rearranged as:

$$\frac{dE}{dP} = \frac{1}{\Delta} \{(Q_1 + Q_2)(\omega_1 b_1 + \omega_2 b_2 - b_3) \tag{11}$$

$$-Q(\sigma_1 b_1 + \sigma_2 b_2 - b_3)$$

$$-PQ(\beta_1 - \beta_2) t_1 (u_1 b_1 + u_2 b_2 - b_3)\},$$

where $\omega_i = \frac{Q_i}{Q_1 + Q_2}$

$$\sigma_i = \frac{\delta_i}{\delta_1 + \delta_2}$$

$$u_i = \frac{\delta_i'}{\delta_1' + \delta_2'} .$$

Each of the terms in the numerator will be zero if a weighted average of U.S. and German preferences for dollars equals OPEC's preference for dollars, where the weights refer, respectively, to each country's share of oil imports, of exports to OPEC from higher oil revenue, and of exports gained as a result of the change in the terms of trade.[11/] Since this condition can only be satisfied if $\omega_i = \sigma_i = u_i$, it is not intuitively a less stringent condition for a zero exchange rate change than the case of identical asset preferences.

The above explanation also indicates that the exchange rate will change if OPEC is not content to hold the combination of assets offered in payment for oil. Suppose, for example, that $b_1 > b_2 > b_3$, i.e., of the three countries, OPEC holds the smallest percentage of wealth in dollars. The first set of terms in the numerator of equation (10) is then positive: in other words, if, compared with oil importers, OPEC prefers marks, then a wealth transfer to OPEC -- stemming from higher oil prices -- will lead to excess demand for the mark, excess supply of the dollar, and hence a depreciation of the dollar in terms of the mark. Given the same preference ordering, the second set of terms indicates an appreciation of the dollar as wealth flows back to the industrial countries -- those with a dollar-intensive portfolio -- due to OPEC respending induced by higher oil revenues.

Finally, the last set of terms in equation (10) refers to the reshuffling of OPEC spending due to relative price changes associated with an oil price shock. If U.S. output is oil-intensive relative to output produced by Germany ($\beta_1 > \beta_2$), higher oil prices coupled with the aforementioned preferences will affect the dollar in two opposing directions: (a) depreciate the dollar, since the U.S. current account improves by less as a result of the rise in T (hence less wealth is transferred to wealth holders who favor dollars); and (b) appreciate the dollar, since the German current account is improved due to the rise in T. If $\delta_1' = - \delta_2'$, that is, total OPEC spending is independent of relative prices, then the last term is

$$-PQ\, \delta_1' \,(\beta_1 - \beta_2)\, t_1\, (b_1 - b_2),$$

which is clearly positive if $\beta_1 > \beta_2$ and $b_1 > b_2$. In other words, if total OPEC respending does not change as T varies, then a rise in T causes a wealth transfer from the United States to Germany; if $b_1 > b_2$, this transfer will lead to a depreciation of the dollar.

To summarize this example, if $b_1 > b_2 > b_3$, the dollar will tend to depreciate if (a) δ_1 and δ_2 are small and (b) $\beta_1 > \beta_2$ and δ_2' is small.12/ Thus the dollar will depreciate if the above assumptions hold, even if the United States imports no oil ($Q_1 = 0$). It is true -- given the above preference ordering -- that greater oil imports by the United States (or by Germany) will tend to depreciate the dollar as more wealth is transferred away from portfolios which are relatively intensive in dollars.

However, this marginal impact of U.S. oil imports on the dollar is inextricably bound to the assumed preference ordering. If OPEC prefers dollars, compared with U.S. residents ($b_3 > b_1$), then greater

U.S. imports will tend to appreciate the dollar, while greater OPEC spending on U.S. output will act to produce a depreciation.[13/] Consequently, the notion that the number of barrels of imported oil determines the direction of change of the exchange rate following an oil price shock is only correct for a given set of asset preferences. It is therefore the investment proclivities of oil-importing countries and OPEC that are crucial in determining the outcome.

Other configurations of asset preferences can readily be analyzed by examining equation (10) or (11). Perhaps the most realistic case is $b_1 > b_3 > b_2$, i.e., when each industrial country is the most intensive holder of its own currency and the least intensive holder of foreign currency. An oil price shock will then tend to lead to a lower foreign exchange value of the dollar if (a) Q_1 and δ_2 are large, (b) Q_2 and δ_1 are small, and (c) $\beta_1 > \beta_2$.

These asset preferences, especially those of OPEC, can also change over time. On the one hand, one could argue that in 1973-74, OPEC's propensity to hold dollar-denominated assets exceeded the desire to hold dollars on the part of oil-importing economies taken together, leading to an appreciation of the dollar. On the other hand, by 1979, amid the talk of reserve diversification and with the U.S. inflation performance expected to be worse than Germany's, it is plausible that OPEC preferred the mark, thereby accounting for the fall of the dollar. One way to account for alterations in portfolio preferences is to endogenize the long-run exchange rate, and it is to this task that we shall turn shortly.

Before leaving this section, however, we should mention that in Krugman's paper (1980) the interaction of oil importers' and exporters' asset preferences is less important because of his assumption that each oil importer holds a fixed value (in domestic currency) of foreign assets. Thus when the wealth of an oil importer changes in Krugman's model, the entire amount of the change is absorbed by the domestic asset. In other words, Germans (Americans) pay for oil only with marks (dollars). Given this simplification -- which facilitates Krugman's dynamic analysis -- only OPEC's preferences are said to affect the exchange rate. Moreover, since Krugman assumes that each oil importer pays for the oil only with the domestic asset, it follows in his model that, ceteris paribus, the country which imports more oil will have a depreciating currency unless OPEC holds all of its wealth in that currency. This part of his model -- though not his more elaborate dynamic analysis -- is then a special case of our model.

B. Endogenous Long-Run Exchange Rate

In the previous section we assumed that the oil price shock does not have a direct effect on the expected rate of change of the exchange rate; e changed only due to variations in E, the current level of the exchange rate, as a result of portfolio rebalancing. However, given that our model does allow for a differential price response (equation (7)) for the output produced by each industrial economy, these real effects should have a direct impact on the long-run expected future spot rate. Given our simple formulation of the expected rate of change of the exchange rate in equation (3), these real effects can be modeled by endogenizing $\bar{E}$. A reasonable hypothesis is that the long-run exchange rate is a function of relative prices, or simply

$$(12) \quad \bar{E} = f\left(\frac{P_1}{P_2}\right) = f\left(\frac{\gamma_1 w_1^{\alpha_1} P^{\beta_1 - \beta_2} E^{\beta_2}}{\gamma_2 w_2^{\alpha_2}}\right), \; f' > 0.$$

In other words, a rise in $\left(\frac{P_1}{P_2}\right)$ will tend to reduce the current account below its long run equilibrium level, thereby requiring a depreciation of the exchange rate to return to equilibrium.[14/] In view of our formulation of output prices, relative prices will vary in response to an oil price shock if $\beta_1 \neq \beta_2$. It is of course necessary for stability that $\frac{\partial \bar{E}}{\partial E} < 1$.

We can easily obtain the solution to the model by substituting equation (12) into equation (3) and resolving the model. The effect of the price of oil on the level of the exchange rate is now given by:

$$(13) \qquad \left(\frac{dE}{dP}\right)_{d\bar{E} \neq 0} = \frac{1}{\Delta_1} \left\{ \Delta \frac{dE}{dP} + + (W_1 b_1' + EW_2 b_2' + W_3 b_3') e' f' t_1 E(\beta_1 - \beta_2) \right\},$$

where

$$\Delta_1 = \Delta - e' f' \frac{\beta_2 t_1}{P} \left\{ W_1 b_1' + EW_2 b_2' + W_3 b_3' \right\}$$

and where $\frac{dE}{dP}$ and Δ are given by equation (10).

In other words, the new multiplier is the former one with a new term added to both the numerator and the denominator. The additional term in the denominator is negative and thereby acts to destabilize the model. A depreciation of the dollar lowers the foreign currency price of oil, an imported input, so $\bar{E}$ increases, as does $\underline{e}$. With a higher expected rate of depreciation of the dollar, wealth holders will shift out of dollars and, consequently, cause a further decline of the dollar. Clearly this effect must be small or the model will be unstable. For stability Δ_1 must be positive.

The numerator of equation (13) is the old numerator plus a positive term times $(\beta_1 - \beta_2)$. Therefore, when the ratio of oil to output is higher in country one than in country two $(\beta_1 > \beta_2)$, an oil price rise will lead to a greater depreciation (or smaller appreciation) of the dollar. Higher oil prices would then tend to reduce the current-account position of the United States; other things equal, the dollar will have to depreciate by more (or appreciate by less) to re-establish some long-run equilibrium level of the current account.

It should be noted that with $\beta_1 > \beta_2$, the exchange rate will change (in this case, E will rise) even if portfolio preferences are identical. This result makes economic sense: a higher price of oil affects the expected change in the exchange rate directly though its impact on $\bar{E}$, and thereby leads every portfolio holder to attempt to reduce his holdings of dollars; since this is impossible, the dollar must fall in value until wealth holders expect that the current account will return to its long run equilibrium level. As mentioned in footnote (5), Krugman assumes that the prices of U.S. and German goods are exogenous, so he does not have these effects in his model.

IV. Conclusion

Several conclusions arise from the simple model considered in this paper. First and foremost, the impact of an oil price shock on a country's exchange rate depends crucially on the portfolio preferences of both oil importers and exporters. Some observers who realize the importance of portfolio preferences discuss only the role of OPEC's preferences. However, it is clear from our model that the preferences of both the suppliers and demanders matter in the determination of asset market equilibrium.[15/] Intelligent commentary on the exchange-rate impact of an oil-price shock can only be made with some explicit assumption about both sets of preferences.

Second, current account positions affect the exchange-rate outcome of an oil-price increase but their effect can only be ascertained after asset preferences are known. For example, suppose that $b_1 > b_3 > b_2$, which may be the most realistic configuration of preferences. If the pattern of oil imports and OPEC spending results in a U.S. current-account deficit and a surplus for Germany, the dollar will fall in terms of DM. With opposite asset preferences, however, the dollar will rise as wealth is transferred to the most intensive holders of dollars.

Third, exchange-rate expectations, which are related to countries abilities to adjust to higher oil prices, are also important in determining the impact on the current spot rate. In our formulation of expectations, the shares of oil imports in GNP (the β_i) play a crucial role in determining the effect of an oil price shock on the expected future spot exchange rate. Thus, our model provides a plausible explanation for the evolution of the dollar-yen rate during the 1973-78 period. Aside from possible effects due to changes in OPEC spending on Japanese products, the yen may have fallen in 1973-75 due to the relatively high oil-(and energy-) intensiveness of Japanese output. However, the rise in the yen over the 1975-78 period matches the rapid reduction in oil intensity in Japan.[16/] This reduction in oil intensity was proportionately greater in Japan than in the United States, Germany, or France during the 1975-78 period.

Given its simple structure, our model suffers from several limitations. One obvious limitation -- and also the easiest to rectify -- is the lack of any wage response to higher oil prices. If wages respond positively to higher oil prices, it is easy to show that, ceteris paribus, the value of a country's currency will be lower the greater the rise in its wages if the country is a relatively intensive holder of its own assets.

Another limitation of the approach taken here is that it is confined to a short-run, one-period horizon. We therefore do not describe the long-run equilibrium position of a country after an oil price shock or the path to that long-run position. Krugman (1980) uses a continuous-time dynamic model where the long-run equilibrium position is characterized by a zero current-account balance for all countries. The main dynamic feature of his model is that OPEC's marginal propensity to spend oil revenue is less than unity in the short run but equals unity in long-run equilibrium.

Since we do not consider non-money assets -- such as claims on each country's capital stock -- our model does not take account of changes in wealth resulting from the impact of an oil price rise on the capitalized value of firms' profit streams. For oil-importing countries, there could be differential effects from one country to another depending on the energy intensiveness of the output of a country and the rate at which that intensity is reduced over time. For OPEC countries, since they generally do not sell claims in the private market to their oil in the ground, they do not directly experience an instantaneous windfall gain in wealth as a result of the revaluation of their oil reserves.[17/] Nevertheless, they could borrow against the security of their revalued oil reserves, and thereby indirectly take advantage of their improved wealth position. These instantaneous wealth changes, since they would probably be additive to the wealth effects emananating from non-zero current account positions, are unlikely to alter the main qualitative conclusions of the paper.

Finally, we have assumed that each country's output is exogenous and, contrary to the above discussion about Japan, that the β_i are fixed. A more appealing alternative, especially for long-run analysis, would be to permit substitution in production. However, these two simplifications, in addition to the paucity of assets and the simplicity of expectations formation, were chosen so that we could highlight the central role of asset preferences in the analysis of oil price shocks.

Footnotes

* International Finance Division, Federal Reserve Board. The authors are grateful for clarifying discussions with Dick Freeman, Dale Henderson, Karen Johnson, Ken Rogoff, and other members of the International Finance Division. This paper represents the views of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff.

1/ Krugman (1980) and Golub (1980) are exceptions to this statement. In his paper, Krugman takes an approach which differs from ours in that he puts certain restrictions on the portfolio behavior of residents of industrialized countries and does not model the effects of higher oil prices on relative output prices. Golub also assumes that output prices are constant, and in addition he takes no account of exchange rate expectations. Specific differences between the two models and ours will be highlighted below. Dunn (1979) does not model the exchange rate impact of an oil price increase, but he does emphasize the importance of asset preferences in determining the result.

2/ Others, such as Schmid (1980), omit asset markets entirely.

3/ In an earlier version of this paper, we included both U.S. and German bonds; the basic conclusions are unaffected by their omission. In omitting interest rates we are impliciting assuming that they are pegged by the monetary authorities .

4/ The latter is an inconsequential assumption; indeed, one of the central points of our paper is that the effect of an oil price shock on the exchange rate depends on how the basket of assets offered as payment for oil compares with the basket of assets that OPEC wants to hold. It is immaterial in our model whether OPEC requires payment in a fixed composition of currencies, forcing oil importers to trade for this appropriate basket, or accepts any mixture of currencies and then exchanges them to satisfy its portfolio demand for each.

5/ We make the fairly typical assumption that all countries start from a position of a positive net foreign asset position. For a treatment of the implications of a country having a negative net foreign asset position, see Henderson and Rogoff (1981).

6/ It would be more satisfactory to write OPEC's real demand for X_i as a function of the terms of trade and OPEC's real income. This formulation is tedious to manipulate, however, and as long as a rise in the price of oil does not raise the prices of industrial countries' output by enough to offset a higher oil price, OPEC's real income will rise when P rises and our results will be unaffected. If an oil price rise reduces real income for OPEC, our model can still be used to show how exchange rates are affected. See below, Section III. In Krugman's (1980) formulation, the effect of a rise in P on P_i is not considered -- thus, only the exchange rate, instead of the terms of trade, enters his δ_i functions. In Golub's (1980) model, OPEC imports are in fixed proportions, so that his δ_is are constants.

7/ See Nordhaus (1972) for a derivation of these price equations. In the model presented here we assume that nominal wages are fixed. It is fairly straightforward to relax this assumption and make wages a function of the domestic price level. Doing so does not alter the main conclusions of the paper.

8/ The U.S. price level is not affected by exchange rate changes in this model because a) the price of oil is expressed in dollars and is assumed to be exogenous, and b) trade between the two industrial countries is ignored.

9/ This fact is easily seen by summing equations (8) and (9) and using the identity $b_i + f_i = 1$ for all i.

10/ This reasoning also applies to the second to the last term in Δ. The last term, $\frac{b_2}{E}(PQ_2 - \delta_2\, PQ)$, is negative when OPEC spending on German exports exceeds Germany's oil bill, both of which are fixed in dollars. If the dollar depreciates in such a situation, the DM value of both exports and imports falls and, with an initial current account surplus ($\delta_2\, PQ > PQ_2$), the decline in the DM value of exports exceeds that for imports, so Germany's surplus declines. Thus W_2 falls, as does $b_2\, W_2$, the German demand for dollars. Hence the dollar must depreciate further, so this term must also be small to prevent instability. This term does not depend on how German preferences compare with either U.S. or OPEC preferences since it reflects a wealth gain or loss resulting from a valuation effect rather than from a transfer; when the exchange-rate changes the German current-account (measured in marks) improves due to a lower mark price of oil. No one in our model has suffered a corresponding loss. Even if we re-wrote our model with X_i as a function of real OPEC income (PQ deflated by OPEC's CPI), these valuation effects would not offset each other except in very rare circumstances.

11/ At this point it is not necessary to make any assumption about the sign of $(\delta_1' + \delta_2')$.

12/ Remember we are assuming that the demand for each good by OPEC is price elastic -- i.e., $\delta_1' < 0$, $\delta_2' > 0$.

13/ These two statements can be verified by looking at the first and third terms of equation (10).

14/ The long-run equilibrium level of the current account must be equal to the rate at which the rest of the world desires to acquire the country's assets. Since it is often argued that foreigners will not want to acquire (net) claims on any country forever, it is frequently assumed that the long-run equilibrium level of the current account is zero. The formulation of expectations in equation (12) only requires some well-defined long-run equilibrium level (perhaps zero) of the current account. As relative prices change, the long-run level of the exchange rate must change so that the current account will again equal the rate at which foreigners wish to accumulate (net) claims on the domestic economy.

15/ These observers may be making some implicit assumption about the preferences of oil importers. It should be noted that payment for oil in dollars does not imply that the importers are holding 100 percent of their assets in dollars. In our model, we assume that importers pay for oil with a representative basket of their assets, and OPEC trades this basket until it attains portfolio equilibrium. Clearly, the conclusions are unaffected if importers sell some non-dollar assets, pay for oil with dollars, and then OPEC sells some dollars to attain its optimal portfolio.

16/ See Ronald Johnson (1980). He presents data on net oil imports as a percent of GNP. Since Japan imports all of its oil and refines none of this for re-export, this ratio should equal total oil consumption relative to GNP.

17/ The value of the equities of those oil companies that have ownership interests in oil leases will of course increase as a result of an OPEC-engineered oil price increase.

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