Volume Title: Exchange Rates and International Macroeconomics

Volume Author/Editor: Jacob A. Frenkel, ed.

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-26250-2

Volume URL: http://www.nber.org/books/fren83-1

Publication Date: 1983

Chapter Title: Oil Shocks and Exchange Rate Dynamics

Chapter Author: Paul Krugman

Chapter URL: http://www.nber.org/chapters/c11382

Chapter pages in book: (p. 259 - 284)

8 Oil Shocks and Exchange Rate Dynamics

Paul Krugman

8.1 Introduction

In studying the determination of exchange rates, theorists have traditionally relied on models of a two-country world, often further simplified by the assumption that one of the countries is "small" relative to the other. The two oil shocks of the 1970s, however, confronted the international financial system with disturbances of an essentially multilateral nature. When we speak of the effect of the price of oil on the exchange rate, it is not the dollar rate but the dollar-mark or dollar-yen rate that we have in mind. That is, we are concerned with the effects on a bilateral rate of the actions of a third party, OPEC.

The "small-country" approach is particularly misleading when applied to an oil shock. At first sight it might seem obvious that for an oil importing country a rise in the price of oil leads to currency depreciation; after all, its direct effect is to worsen the balance of payments. But suppose the world consisted of several "symmetric" oil importers and OPEC—that is, the oil importers accounted for equal shares of world oil demand, equal shares of OPEC spending, etc. Then surely an oil price increase would leave exchange rates among the oil importing countries unchanged. How can this be? The reason is that while an oil price increase directly worsens an oil importer's balance of payments, it indirectly improves it as OPEC spends its increased income on purchases of goods or assets. It is not enough to know that a country imports oil and that its import demand is inelastic; we must know that it has *relatively* high import dependence, or *relatively* inelastic demand, or receives a

Paul Krugman is a professor in the Department of Economics at Massachusetts Institute of Technology and a research associate of the National Bureau of Economic Research.

relatively small share of OPEC spending, before we can be sure that its currency depreciates when the price of oil goes up.[1]

To model the exchange rate effects of an oil shock, then, it is necessary to work with a world containing at least two oil importing countries and OPEC, and to systematically allow for asymmetries between the oil importers. In this paper I make an effort in this direction. Three related three-region models are developed. The first is a trade balance model, in which it is assumed that OPEC immediately spends all of its income. This model develops the basic theme that asymmetries determine the direction of exchange rate movement. The second model sacrifices some detail on trade balance determination, but opens the world to capital flows, allowing OPEC to adjust its spending only gradually after the oil price rises. The main point here is the interplay between "real" and "financial" asymmetries, which may push the exchange rate in different directions. Finally, the third model simplifies the asset markets but introduces "rational" speculation.

8.2 A Trade Balance Model

Consider a world containing three countries: America, Germany, and OPEC. America and Germany export manufactured goods to OPEC and to each other; OPEC exports oil and imports manufactures.

The bilateral trade balance between America and Germany, measured in dollars, depends on the mark price of the dollar:

$$T = T(V). \tag{1}$$

In both America and Germany, oil imports depend on the domestic currency price of oil:

$$O_A = O_A(P_o), \tag{2}$$

$$O_G = O_G(V \cdot P_o), \tag{3}$$

where P_o is the dollar price of oil. We assume elasticities of demand ϵ_A, $\epsilon_G < 1$. Also, it will be useful to use the notation $O = O_A + O_G$ for world oil imports, and $\sigma = O_G / O$ for the German share of world oil imports.

OPEC will be assumed to fix the price of oil in dollars and to spend all of its income, dividing this expenditure between American and German products. Letting X_G, X_A be the exports to OPEC, we have

$$X_G = \gamma(V) P_o O, \tag{4}$$

$$X_A = [1 - \gamma(V)] P_o O, \tag{5}$$

where γ is the share of OPEC expenditure falling on German exports.

1. Papers on the exchange rate implications of an oil shock in a small-country framework include Findlay and Rodriguez (1977), Buiter (1978), and Obstfeld (1980). A three-country simulation model is developed by Sachs (1982).

Notice that there is a difference in the treatment of the industrial countries and OPEC. The trade flows of the industrial countries are determined by partial equilibrium, "elasticity" equations, while OPEC's imports depend explicitly on income. The main reason for this difference in treatment is simplicity—income effects in OPEC play a clear and crucial role in our story; income effects in the industrial countries, while readily introduced, add complication without changing much. It may also be defended as an empirical approximation that OPEC's marginal propensity to import manufactures is much higher than its customers' marginal propensity to spend on oil; so income effects on the OPEC side will be much more noticeable.

Given this simple structure, then, we can solve for the exchange rate. Germany's balance of trade is

$$B_G = T(V) + X_G - P_o O_H, \tag{6}$$

and we assume $\partial B_G / \partial V > 0$, which is the Marshall-Lerner condition for this model. If there are no capital movements, the exchange rate is determined by the condition

$$B_G = 0. \tag{7}$$

Consider now the effect of an increase in the price of oil. After some manipulation, this can be shown to be

$$\begin{aligned} dV/dP_o = & -(\partial B_G / \partial V)^{-1} \cdot O \cdot [\gamma\sigma(1-\epsilon_G) + \gamma(1-\sigma)(1-\epsilon_A) \\ & - \sigma(1-\epsilon_G)]. \end{aligned} \tag{8}$$

The sign of this depends on whether $\tilde{\sigma} \gtrless \gamma$, where

$$\tilde{\sigma} = \frac{\sigma(1-\epsilon_G)}{\sigma(1-\epsilon_G) + (1-\sigma)(1-\epsilon_A)}. \tag{9}$$

Now $\tilde{\sigma}$ contains three sorts of parameters. The parameter σ is Germany's share of world oil imports; ϵ_G, ϵ_A are elasticities of demand for oil; γ is Germany's share of world exports to OPEC. It can be interpreted as Germany's share of the *increase* in world spending on oil when its price increases. If Germany's share of OPEC imports is more than its share of the marginal oil payments burden, the mark will appreciate; if it is less, the mark will depreciate.

If elasticities of demand were the same, the expression would reduce to a simple comparison of shares: $\gamma \gtrless \sigma$. Countries which are relatively oil-dependent will tend to have depreciation after an oil shock; countries which are relatively successful at selling to OPEC tend to have appreciation. But it is important to note that success at reducing oil imports will also matter. The elasticity of import demand exerts a first-order effect on the exchange rate response.

This simple model already reveals several determinants of the exchange rate effects of an oil shock. It does, however, miss a crucial aspect of the actual experience of the 1970s, the enormous recycling of oil revenues through international financial markets. OPEC did not immediately increase its imports to match its increased export revenue, so that it is necessary to introduce this lag, and the corresponding capital flows, into the model.

8.3 Capital Flows and Dynamics

8.3.1 Structure of the Model

Let us retain the basic structure of the last model, but introduce the possibility of capital movements. These will be assumed to be two internationally traded assets, marks and dollars, that is, the currencies of the oil importers. Also, OPEC will adjust its spending to its income with a lag. This will give rise to some dynamic complications, because the burden of oil payments may not fall where OPEC wants to invest, nor will investment and import spending be divided in the same proportion between the oil importers.

We begin with the goods markets. The determination of the America-Germany trade balance is the same as before. OPEC, however, is now assumed to adjust its spending to its income only with a lag, assumed to take the simple form

$$\dot{X} = \lambda(P_o O - X), \tag{10}$$

where X is OPEC dollar expenditure.[2]

As before, OPEC allocates this expenditure between American and German products:

$$X_G = \gamma(V)X, \tag{11}$$

$$X_A = [1 - \gamma(V)]X. \tag{12}$$

Turning now to the asset markets, each country allocates its wealth between dollars and marks. We will treat these markets in the same way as we treated trade flows: that is, partial equilibrium equations for the oil importers; explicit consideration of wealth effects for OPEC. The justifications are also the same. First, this simplification brings out the main points with a minimum of complication. Second, in reality OPEC has a much higher marginal propensity to hold wealth in foreign assets than the oil importing countries, so that the theoretical simplification can also be defended as an empirically valid approximation.

We assume, then, following Kouri (1982), that America holds in its portfolio a fixed dollar value of marks, and that Germany holds a fixed mark value of dollars:

2. It would be more reasonable to assume that it is OPEC's *real* expenditure which lags behind income; but this complicates the exposition without changing the results.

(13) $$D_G = H_G/V,$$

(14) $$M_A = H_A \cdot V.$$

OPEC allocates its dollar wealth W_o in fixed proportions between dollars and marks:

(15) $$M_o = \alpha W_o \cdot V,$$

(16) $$D_o = (1-\alpha)W_o.$$

Our next step is to consider balance of payments. First, the current accounts of the three countries may be written as follows:

(17) $$B_G = T(V) + X_G - P_o O_G,$$

(18) $$B_A = -T(V) + X_A - P_o O_A,$$

(19) $$B_o = P_o O - X.$$

A crucial variable is the rate of wealth accumulation by OPEC. This is not simply the OPEC current account, because it also includes capital gains and losses from changes in the exchange rate:

(20) $$\dot{W}_o = B_o - \alpha W_o(\dot{V}/V).$$

The second step is to consider capital accounts. The German capital account is sales of marks to America and OPEC, less German purchase of dollars:

(21) $$K_G = \dot{M}_o/V + \dot{M}_A/V - \dot{D}_G,$$

or, substituting,

(22) $$K_G = \alpha B_o + [M_A/V + D_G + \alpha(1-\alpha)W_o]\dot{V}/V.$$

A similar expression may be derived for the American capital account.

8.3.2 The Dynamic System

We can now derive the equation of change for the exchange rate. The balance of payments must balance; thus we must have

$$B_G + K_G = 0,$$

or, from (22),

(23) $$\dot{V}/V = -\frac{B_G + \alpha B_o}{M_A/V + D_G + \alpha(1-\alpha)W_o}.$$

This expression has a natural interpretation. The numerator is what we might call an ex ante balance of payments, that is, it is what Germany's balance of payments would be if the exchange rate did not change. The ex ante balance of payments includes not only the German current account, but also that part of OPEC's current account which is recycled into marks. A surplus or deficit in the ex ante balance requires that the exchange rate change to induce offsetting capital flows as investors reallocate their portfolios. The denominator determines the extent of exchange rate change needed; it may be read as an index of the size of the international investment pool.

The dynamics of the exchange rate may now be determined. For a given price of oil, the state of the world may be summarized by the exchange rate and the level of OPEC spending, whose laws of motion are determined by (10) and (23). The resulting dynamic system is illustrated in figure 8.1.

The schedule $\dot{X} = 0$ represents points where OPEC income and expenditure are equal. For simplicity, we will assume that demand elasticities for oil are zero. This means that world oil imports, and hence OPEC income, are independent of the exchange rate; thus $\dot{X} = 0$ is a vertical line. To the right, expenditure exceeds income and is falling; to the left, expenditure falls short of income and is rising.

The schedule $\dot{V}/V = 0$ represents points where Germany's (and America's) ex ante balance of payments is zero. For reference we also show the loci where America's and Germany's current accounts are zero. The slopes of these lines are[3]

$$(24) \quad \left.\frac{dV}{dX}\right|_{B_A = 0} = \frac{(1-\gamma)}{\partial B_G/\partial V},$$

$$(25) \quad \left.\frac{dV}{dX}\right|_{B_G = 0} = \frac{-\gamma}{\partial B_G/\partial V}.$$

The line $\dot{V}/V = 0$ may slope either upward or downward, but it must lie between these lines:

$$(26) \quad \left.\frac{dV}{dX}\right|_{B_G + \alpha B_o = 0} = \frac{\alpha - \gamma}{\partial B_G/\partial V}.$$

The implication is that, in general, neither country's current account determines the direction of exchange rate change. Thus at point R America runs a current account surplus, yet the dollar is falling; at S America runs a current account deficit, yet the dollar is rising. The only situation in which a country's current account is related one-to-one with $\dot{V}/V$ is when OPEC does not hold that country's currency. Thus when OPEC holds no marks, $\alpha = 0$, the line $\dot{V}/V = 0$ coincides with $B_G = 0$; when OPEC holds no dollars, $\alpha = 1$; it coincides with $B_A = 0$.

3. We use here the fact that, when oil demand is inelastic, $\partial B_G/\partial V = -\partial B_A/\partial V$.

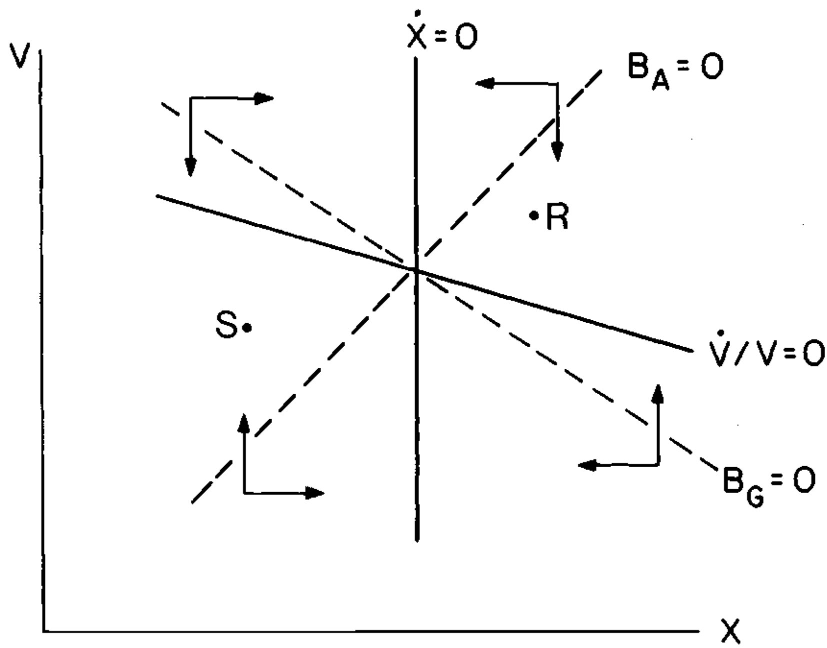

Fig. 8.1 The dynamic system.

8.3.3 Effects of an Oil Price Increase

Suppose now that the price of oil goes up. In the short run this will create ex ante payment imbalances, forcing gradual appreciation or depreciation of the dollar which generates offsetting capital flows. In the long run the exchange rate must be such as to produce current account balance.

The short-run effect is easily computed from (23):

$$(27) \qquad \frac{d(\dot{V}/V)}{d P_o} = \frac{(\sigma - \alpha) O}{M_A/V + D_G + \alpha(1-\alpha)W_o}.$$

Thus the mark will initially depreciate or appreciate depending on whether Germany's share of world oil imports is more or less than the share of marks in OPEC's portfolio. This makes obvious sense. The effect of an oil price increase in the short run is directly to worsen Germany's ex ante balance of payments via increased spending on oil, but indirectly to improve it via recycled oil revenues (since OPEC expenditure is fixed in the short run, there is no impact effect on Germany's exports).

The long-run effect—after OPEC's spending has risen to match its income, so that $B_o = 0$—may be determined by the condition of current account balance:

$$(28) \qquad \left.\frac{dV}{dP_o}\right|_{B_G = 0} = \frac{(\sigma - \gamma)O}{\partial B_G / \partial V}.$$

Again, this makes intuitive sense. In the long run, recycling has ended. The direct burden of higher oil prices is now offset by the indirect benefit of increased exports to OPEC; whether the mark depreciates or appreciates in the long run depends on whether Germany's share of world oil imports is more or less than its share of exports to OPEC.

Interestingly, the short-run and the long-run effects can run in opposite directions. Suppose that $\gamma > \sigma > \alpha$—loosely speaking, OPEC prefers American investments and German products. Then initially the dollar

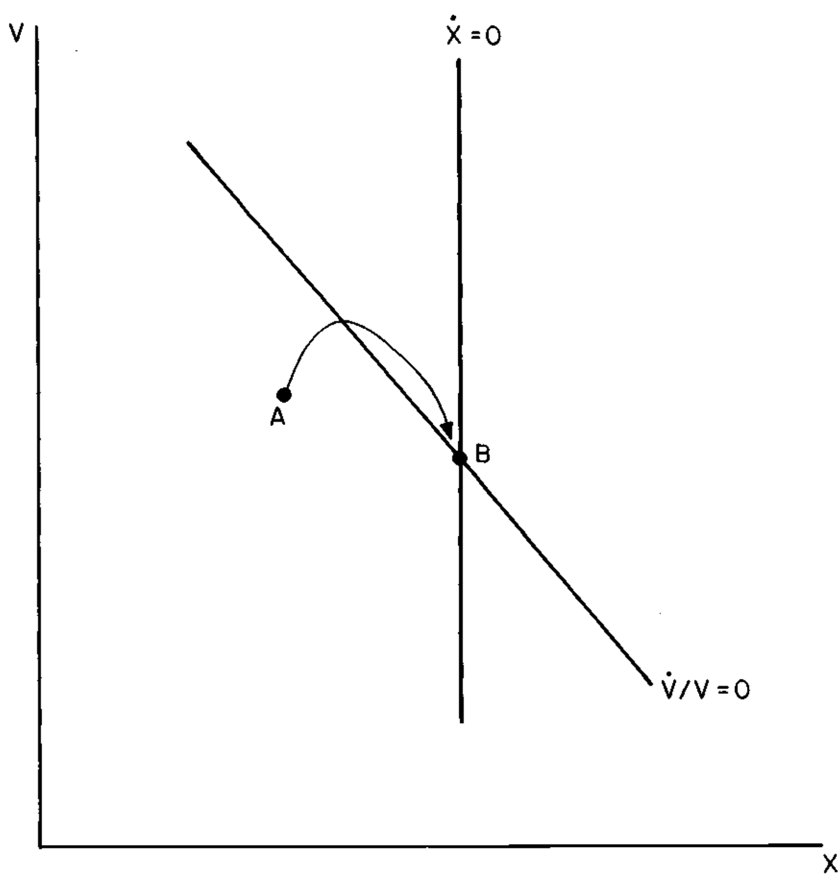

Fig. 8.2 The effect of a rise in the price of oil.

must appreciate, but in the long run it must be below its original level. The dynamics of this process are illustrated in figure 8.2. Point A represents the initial equilibrium, point B, the new long-run equilibrium. The dollar at first appreciates; then, as OPEC's spending rises and exports of goods become more important relative to exports of assets, the dollar declines past its original level.

This is a simply, plausible story. But there is a major question which immediately arises. If the dollar is going to depreciate in the long run, won't this be expected? And won't this expectation tend to make the dollar depreciate in the short run as well? Clearly the next step must be to introduce speculation into the model.

8.4 Speculation: A Perfect Foresight Model

Speculation can fundamentally alter the results of the last model. If asset demands are affected by the expected rate of change of the exchange rate, and these expectations take long-run factors into account, long-run "real" factors may dominate short-run "financial" ones, even at the outset.

To study the effect of expectations, we will consider a model which makes further simplifications on both the goods and asset markets. First, we replace the gradual adjustment of OPEC expenditure in (10) with a step function. Suppose the price of oil is increased at time t_0. We assume that OPEC expenditure remains constant until time $t_0 + T$, then rises immediately to equal income. Letting X_0 be the original level of expenditure, and X_1 the new level, we have

(29)
$$X = X_0, \quad t < t_0 + T,$$
$$X = X_1, \quad t \geq t_0 + T,$$

On the asset side, we now assume that *dollars are the only traded asset.* Thus OPEC holds only dollars; America holds no marks. Germany holds dollars; the mark value of dollars it demands is assumed to depend positively on the expected rate of dollar appreciation,

(30)
$$D_G = H_G(\Pi)/V.$$

We next assume that, except at the instant of the oil shock, expectations are characterized by perfect foresight:

(31)
$$\Pi = \dot{V}/V.$$

These assumptions make it possible to analyze the effects of an oil shock in a two-dimensional phase plane, even though there are really three state variables—D_G, V, and X. The method will be to analyze the dynamic system in D_G and V, holding X constant; then to introduce the effects of an anticipated change in X. For when the price of oil rises, X initially does not change; but it is known that it will rise T periods later.

Let us begin with the dynamic system holding X constant. The rate of change of D_G is simply the German current account:

$$\dot{D}_G = T(V) + \gamma(V)X - P_o O_G. \tag{32}$$

Since X and P_o are held constant, the locus $\dot{D}_G = 0$ is a horizontal line in (V, D_G) space, as shown in figure 8.3.

Next, equations (30) and (31) imply an equation for $\dot{V}/V$ of the form

$$\dot{V}/V = f(D_G \cdot V), \tag{33}$$

with $f' > 0$. Thus $\dot{V}/V = 0$ is a downward sloping line. The small arrows indicate the laws of motion. As the representative paths indicate, the system is saddlepoint unstable.

An increase in the price of oil changes these laws of motion *twice*. First, there is an unanticipated shift in the $\dot{D}_G = 0$ schedule at the time of the oil shock. Second, it can be anticipated the $\dot{D}_G = 0$ will shift again T periods later, when OPEC expenditure rises to match its higher income. The first shift must be an upward movement in $\dot{D}_G = 0$, since the rise in the price of oil worsens Germany's current account at any given exchange rate. Later, when OPEC expenditure rises, $\dot{D}_G = 0$ shifts back down; if $\gamma > \sigma$, it shifts past its original position, so that the equilibrium involves a lower V than

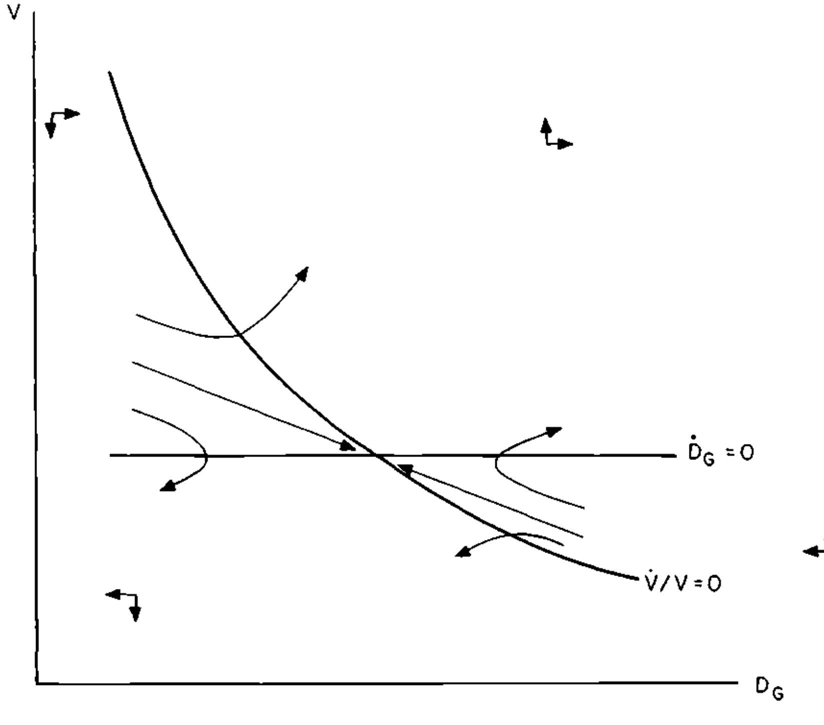

Fig. 8.3 Dynamics in the perfect foresight model.

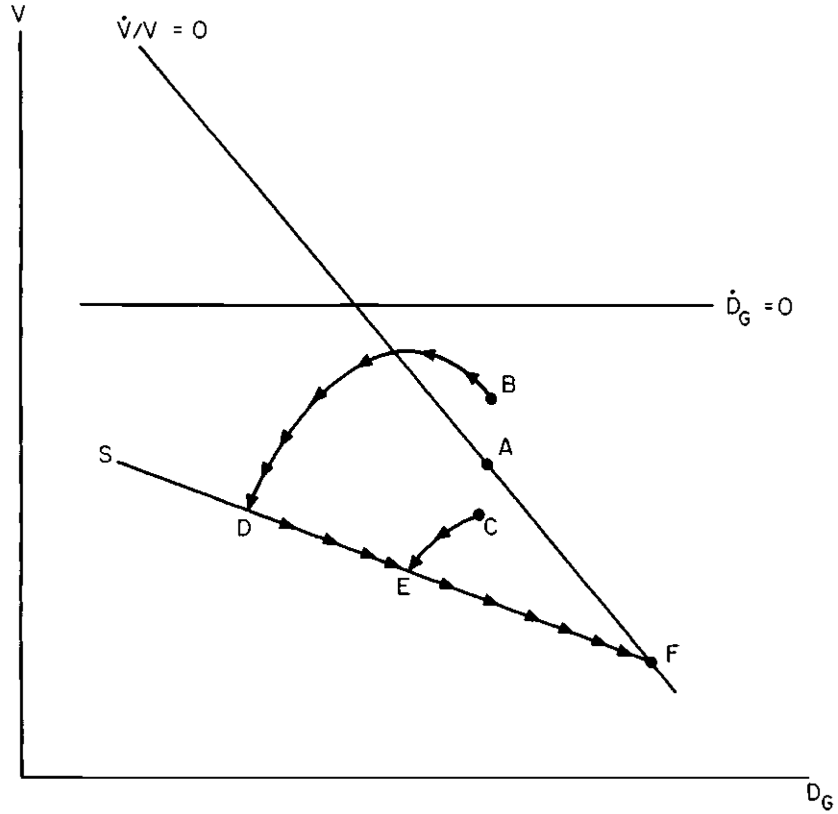

Fig. 8.4 Examples of possible paths toward the saddle paih.

the initial one. We will impose the "no speculative bubbles" assumption that the system does eventually converge to the long-run equilibrium; this closes the system.

Figure 8.4 illustrates two possible paths. Point A is the initial equilibrium position. After an oil shock, the schedule $\dot{D}_G = 0$ first shifts up, for T periods, then moves down to below A, so that the new long-run equilibrium is at F. The unique stable path of the long-run dynamic system is indicated by SF. If the world is to converge to F at time $t_0 + T$, it must have reached a point on SF.

Until time $t_0 + T$, the system follows the laws of motion implied by the initial level of OPEC expenditure. Two ways in which these laws can put the world onto SF are illustrated by BD and CE. The dollar may either appreciate or depreciate when the price of oil increases. The subsequent paths are illustrated against time in figure 8.5. The economic intuition behind these cases is as follows. In one case the financial asymmetry between the countries—the fact that OPEC recycles its surplus into

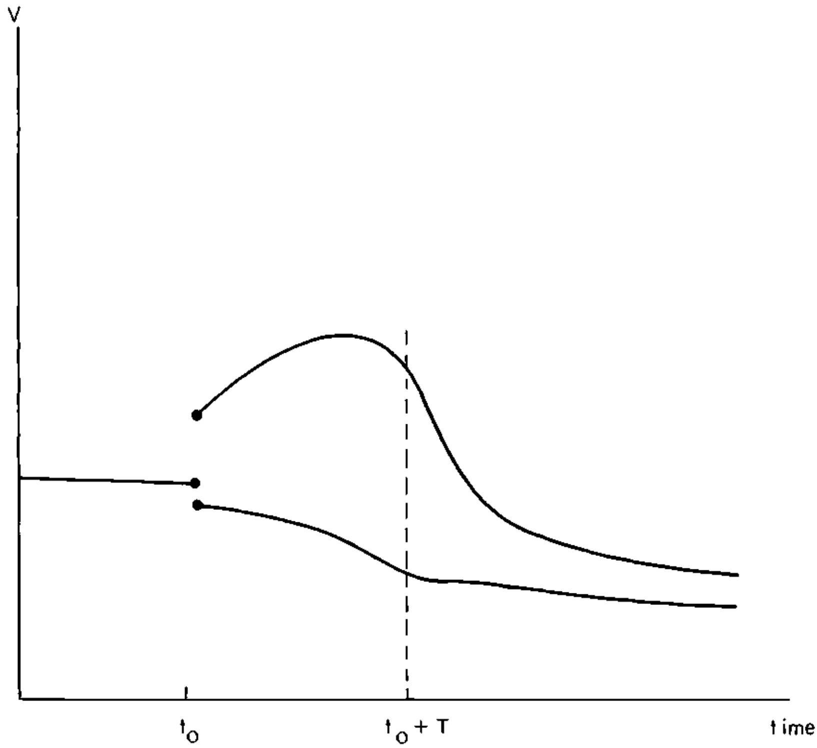

Fig. 8.5 Two possible patterns.

dollars—leads to an initially rising dollar. But the expected gradual rise makes dollars more attractive, so that there is a step jump. Eventually, however, the long-run factors lead to an expectation of a depreciating dollar, pulling the dollar down even before the end of OPEC recycling. In the other case, these long-run factors dominate from the start. Although OPEC recycles into dollars, the expectation of future dollar depreciation is enough to produce a step drop in the exchange rate.

Which path will the exchange rate follow? The crucial point is that the system must arrive at the stable path at just the right time. In figure 8.4, *BD* takes a longer time than *CE*, because the required fall in German dollar holdings is larger, yet the German current account deficit is smaller (because *V* is larger). For each initial jump in *V* there is a corresponding length of time needed to reach *SF*; the right initial *V* is that value for which the time to *SF* is exactly *T* periods. It is also immediately obvious that the direction of the initial exchange rate movement depends on *T*, that is, the more quickly OPEC adjusts its spending, the more likely it is that the dollar's long-run real disadvantage will outweigh its short-run financial advantage.

8.5 Summary

In this paper I have set out three closely related models of the effect of an oil shock on exchange rates. The first model emphasized real factors: the shares of countries in imports from and exports to OPEC and the elasticity of demand for oil. The second model emphasized financial factors: in the short run, when OPEC runs a surplus, it matters where they invest it. The third model emphasized the dependence of the financial side on the real side through expectations.

These models represent highly oversimplified representations of the factors at work. They do, however, give some suggestive guidance. And they make clear a point which is too easily overlooked in models which at first sight may seem more realistic and sophisticated: namely, that an oil shock affects all countries, and its exchange rate effects must arise from asymmetries between countries. They cannot be determined by considering each country in isolation.

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Comment Pentti J. K. Kouri

Paul Krugman's excellent paper is concerned with the short-run and long-run effects of oil shocks in a three-country (U.S., Germany, and OPEC) partial equilibrium balance of payment model. My comments will be mainly concerned with issues and problems that he does not discuss or assumes away for reasons of convenience. The thrust of my comment is that Krugman's partial equilibrium, "elasticities" approach to the oil transfer problem leaves out effects that may be of first-order importance. I do think, however, that what Krugman does is extremely useful as a step toward a more comprehensive analysis of global adjustment to oil price disturbances.

Oil Price and the Exchange Rate

Section 8.2 develops a familiar partial equilibrium trade balance model to study the effect of an exogenous increase in the dollar price of oil on the dollar-mark exchange rate, ceteris paribus. In this analysis, Krugman assumes that macroeconomic policies in the United States and Germany keep U.S. and German prices and output levels unchanged despite the oil shock. He also assumes that OPEC supply of oil adjusts to the demand for oil at the exogenously given dollar price. Given these assumptions, the dollar-mark exchange rate has to adjust following an oil shock in such a way as to keep the German, or equally the U.S. trade balance equal to zero.

The effect of an increase in the dollar price of oil on the German trade balance consists of two parts. First, there is an increase in oil import payments, assuming realistically that the price elasticity of oil demand is less than one. This effect is equal to $-O_G P_o(1-\epsilon_G)\hat{P}_o$, where O_G is the quantity of German oil imports, P_o the dollar price of oil, and ϵ_G is the price elasticity of German oil demand and the caret denotes proportional change. The second effect of an oil price increase on the German trade balance is an increase in OPEC demand for German exports. This effect is equal to $\gamma O P_o[(1-\epsilon_G)\sigma + (1-\epsilon_A)(1-\sigma)]\hat{P}_0$, where σ is Germany's share of world oil imports, and ϵ_A is price elasticity of American oil demand. The net effect on the German balance of trade is accordingly $[\gamma(1-\sigma)(1-\epsilon)-(1-\gamma)\sigma(1-\epsilon_G)]P_o O\hat{P}_o$. If the demand elasticities are the same in the two countries, this expression simplifies into $(\gamma-\sigma)(1-\epsilon)P_o O\hat{P}_o$, so that an increase in the price of oil improves the ex ante German trade balance if Germany's share of world oil imports is less than its share of OPEC's imports from industrial countries. An increase in the German oil demand elasticity relative to the American oil demand elas-

Pentti J. K. Kouri is a professor in the Department of Economics at New York University and a research associate of the National Bureau of Economic Research.

ticity has the same effect as a reduction in German "oil dependence" as measured by σ.

Given a change in the ex ante German trade balance, the dollar-mark rate has to adjust in such a way as to offset it. A depreciation of the mark has three effects on the German trade balance in Krugman's model. First, it improves Germany's trade balance with the United States, provided that the bilateral Marshall-Lerner condition holds. In an initial situation of equilibrium, this effect is equal to $E_{GA}P_G/V\ (\eta_A + \eta_G - 1)$, where $E_{GA}P_G/V$ is the dollar value of German exports to the United States; and η_A and η_G are U.S. and German import price elasticities. The second effect is a change in OPEC demand for German exports. This is equal to $\gamma OP_0\ (\eta_o - 1)$, where η_o is the price elasticity of OPEC's demand for German exports. The third effect is a reduction in German oil imports induced by the increase in the mark price of oil. The net effect of this change on the German balance of trade is $(1-\gamma)\ O_G P_o \epsilon_G$. The sum of these three effects is equal to

$$EP_G/V\ [\theta_{GA}(\eta_A + \eta_G - 1) + \theta_{Go}(\eta_o - 1) + (1-\gamma)\theta_{oG}\,\epsilon_G]\hat{V},$$

where $\theta_{GA}(\theta_{Go})$ is the share of U.S. (OPEC) in total German exports, θ_{oG} is the ratio of the value of oil imports to total German exports, and EP_G/V is the dollar value of German exports. Stability requires that the total exchange rate effect on the trade balance be positive.

From the above, the effect of an increase in the dollar price of oil on the mark-dollar exchange rate is given by:

$$(1) \qquad \hat{V} = \frac{\gamma(1-\sigma)(1-\epsilon_A) - (1-\gamma)\,\sigma(1-\epsilon_G)}{\Delta}\ \frac{P_o O}{E_G P_G/V}\hat{P}_o,$$

where

$$\Delta = \theta_{GA}(\eta_A + \eta_G - 1) + \theta_{Go}(\eta_o - 1) + (1-\gamma)\theta_{oG}\epsilon_G.$$

This is a useful formula, but we have to be careful in applying it. I shall next discuss the many qualifications that one must keep in mind when interpreting this equation and the conclusions drawn from it.

Introducing Income Effects

Krugman's analysis of the oil transfer problem is reminiscent of Keynes's analysis of the German reparations problem. Like Keynes, he assumes away the direct effect of the oil transfer payment on U.S. and German imports.

With allowance for income effects, the trade balance equilibrium condition (for Germany or the United States) is given by:

$$(2) \qquad B_G = D_G^A[V, X_A(1-\delta_A P_o)]/V - D_A^G[V, X_G(1-\delta_G P_o V)] + D_G^o(V, OP_o)/V - \delta_G X_G P_o = 0,$$

where $V = eP_A/P_G$ is the relative price of U.S. and German products which equals the "real" dollar-mark exchange rate; P_o is the "real" price of oil in terms of U.S. output, and $\delta_A(\delta_G)$ is the ratio of U.S. (German) oil consumption to U.S. (German) gross output. I shall assume for simplicity that oil demand elasticities are equal to zero so that $\delta_A(\delta_G)$ are fixed parameters.

From equation (2) the effect of an increase in the price of oil on the ex ante German trade balance is equal to:

$$(3) \qquad dB_G = OP_o[\pi^o_G - \sigma\pi^G_G - (1-\sigma)\,\pi^A_G]\,\hat{P}_o,$$

where π^o_G is OPEC's marginal propensity to import from Germany ($= \gamma$ in Krugman's model), π^G_G is Germany's marginal propensity to spend on German output, π^A_G is the U.S. marginal propensity to import from Germany, and σ is Germany's share in world imports. This expression brings out the importance of differences in marginal spending propensities between the three regions—a point emphasized by Ohlin in his debate with Keynes. If the marginal propensity to spend on German output is the same in the three regions, that is, if $\pi^o_G = \pi^G_G = \pi^A_G$, the effect of an oil price increase on the German ex ante trade balance is zero, irrespective of relative oil dependence as measured by σ. In that special case neither Germany nor the United States has to suffer a secondary burden in the form of terms of trade deterioration. Krugman assumes that $\pi^G_G = 1$ and $\pi^A_G = 0$, in which case the effect of an oil price increase on the terms of trade depends only on the sign of $(\pi^o_G - \sigma)$ as discussed above.

The effect of (real) devaluation or revaluation, ceteris paribus, depends also on differences in marginal spending propensities. Assuming "representative individuals" in each of the three regions, we can use the Slutsky decomposition to obtain the following expression for the effect of devaluation on the German trade balance:

$$(4) \qquad dB_G = (\epsilon^G + \theta^A_G\,\pi^A_G + \theta^o_G\,\pi^o_G + (\theta^G_G - 1)\pi^G_G)\,(X_G/V)\,\hat{V},$$

where

$$\epsilon^G = \theta^A_G\,\epsilon^A_G + \theta^G_G\,\epsilon^G_G + \theta^o_G\,\epsilon^o_G,$$

and θ^i_G is the share of German output absorbed by region i, and ϵ^i_G is the Hicksian compensated elasticity of demand for German output, $i = $ A, O, G. If all the marginal spending propensities are the same, the effect of real depreciation of the mark on the German trade balance, ceteris paribus, depends only on the weighted average of compensated price elasticities of demand for German output and is therefore unambiguously positive. The failure of the Marshall-Lerner condition is thus intimately connected with differences in marginal spending patterns. In particular, the Marshall-Lerner condition is likely to fail when (1) the compensated price elasticities are low and (2) domestic marginal propensity to spend on domestic output (π^G_G) is high relative to the foreign marginal propensities to spend on domestic output (π^{o}_{G} and π^{A}_{G}). In such a case the income effect of an increase in the price of domestic output causes a shift of world demand toward domestic output which may more than offset the substitution effect that works in the opposite direction.

From equations (3) and (4), the effect of an oil price increase on the dollar-mark exchange rate is:

(5) $$\hat{V} = \frac{\pi^{o}_{G} - \sigma\pi^{G}_{G} - (1-\sigma)\pi^{A}_{G}}{\epsilon^{G} + \theta^{A}_{G}\pi^{A}_{G} + \theta^{o}_{G}\pi^{o}_{G} + (\theta^{G}_{G} - 1)\pi^{G}_{G}} \frac{OP_o}{X_G/V}\hat{P}_o.$$

Note that spending propensities appear both in the numerator and in the denominator. The greater the bias of demand toward domestic output (as measured by π^{G}_{G} and $(1 - \pi^{A}_{G})$), the greater the exchange rate impact of an oil price increase, and the higher the probability that the Marshall-Lerner condition fails. Krugman's formula is a special case of (5) with π^{G}_{G} equal to one and π^{A}_{G} equal to zero.

Introducing Interest Income and Capital Movements

Next we introduce exogenous capital movements and interest earnings on holdings of foreign assets. For this purpose we need the following notation: FA^{A}_{G} is the stock of German mark-denominated bonds held by Americans in the units of German output. FA^{G}_{A} is the stock of American-dollar denominated bonds held by Germans in the units of U.S. output. FA^{o}_{G} is the stock of American dollar-denominated bonds held by OPEC in the units of U.S. output. $R_A(R_G)$ is the U.S. (German) real interest rate in terms of U.S. (German) output. $CF^{i}_{j} = \Delta\, FA^{i}_{j}$ is the capital flow from region i to region j.

The German balance of payments equilibrium condition is now given by:

(6) $$B_G + (R_A\, \mathrm{FA}^{G}_{A} - R_G\, \mathrm{FA}^{A}_{G}/V - R_G\, \mathrm{FA}^{o}_{G}/V) + (\mathrm{CF}^{A}_{G}/V + \mathrm{CF}^{o}_{G}/V - \mathrm{CF}^{G}_{A}) = 0.$$

The trade account, B_G, is determined by:

(7) $$B_G = D^{A}_{G}(V, Y_A)/V - D^{G}_{A}(V, Y_G) + D^{o}_{G}(V, Y_o)/V - \delta_G X_G P_o,$$

where Y_i is the total expenditure in region i in the units of U.S. output, and:

(8a) $$Y_A = X_A(1 - \delta_A P_o) + R_G\, \mathrm{FA}^{A}_{G}/V - R_A\, \mathrm{FA}^{G}_{A} - R_A\, \mathrm{FA}^{o}_{A} - \mathrm{CF}^{A}_{G}/V + \mathrm{CF}^{G}_{A} + \mathrm{CF}^{o}_{A}.$$

(8b) $$Y_G = X_G\left(\frac{1}{V} - \delta_G P_o\right) + R_A\mathrm{FA}^{G}_{A} - R_G\mathrm{FA}^{A}_{G}/V - R_G\mathrm{FA}^{o}_{G}/V - \mathrm{CF}^{G}_{A} + \mathrm{CF}^{A}_{G}/V + \mathrm{CF}^{o}_{G}/V.$$

(8c) $$Y_o = (\delta_A X_A + \delta_G X_G)P_o + R_A\mathrm{FA}^{o}_{A} + R_G\mathrm{FA}^{o}_{G} - \mathrm{CF}^{o}_{A} - \mathrm{CF}^{o}_{G}/V.$$

From equations (6), (7), and (8) the effect of a devaluation of the mark on the German balance of payments, ceteris paribus, is given by:

$$dB_G = \Delta\, X_G / V\, \hat{V},$$

where

$$\begin{aligned}\Delta &= \{\epsilon^G + (\theta_G^A + \tau_G^A - \alpha_G^A)\,\pi_G^A + (\theta_G^G - \tau_G^A - \tau_G^o - \alpha_G^G)\pi_G^G \\ &\quad + (\theta_G^o + \tau_G^o - \alpha_G^o)\pi_G^o\}.\\ \epsilon^G &= \theta_G^A\,\epsilon_G^A + \theta_G^G\,\epsilon_G^G + \theta_G^o\,\epsilon_G^o.\end{aligned}$$

As before, θ_G^i is the share of German output consumed in region i. τ_G^i is the "capital transfer" from region i to Germany as a fraction of German output; thus $\tau_G^A = CF_G^A / X_G$ and $\tau_G^o = CF_G^o / X_G$. α_G^i is the share of German mark income received by residents of region i; thus $\alpha_G^A = R_A\, FA_G^A / X_G$; $\alpha_G^G = 1 - R_G\,(FA_G^A + FA_G^o)/X_G$; and $\alpha_G^o = R_G\, FA_G^o / X_G$.

An interesting and important implication of this equation is that if each region completely hedges its import payments and purchases of foreign assets, the income effects wash out, and the Marshall-Lerner condition must hold without ambiguity. As an example, consider the United States in the model. It imports German products in the amount D_G^A and buys German assets at the rate of CF_G^A, which we take to be exogenous. Therefore, an increase in the relative price of German products ($1/V$) reduces U.S. real income by $(D_G^A + CF_G^A)/V$ in the units of U.S. income and increases German real income by the same amount. To hedge themselves against the possibility of such changes in real income, U.S. residents could borrow in U.S. dollars and invest in German marks to earn real income in Germany equal to their purchases of German imports and assets. With $R_G\, FA_G^A$ equal to $D_G^A + CF_G^A$, American real income, and also German real income, is unaffected by marginal changes in the terms of trade.

Apart from borrowing and lending, hedging could be achieved through the forward market. Thus U.S. residents could buy German marks forward at the rate of $D_G^A + CF_G^A$ per unit of time, and be completely hedged against changes in V.

Hedging by means of borrowing and lending in dollars and marks, or by means of forward market transactions, is possible, however, only if domestic currency prices of German and U.S. products are stable. Only in that case will a German mark bond, for example, represent a "real claim" on German output.

Consider now the short-run effect of an increase in the price of oil and the associated change in capital movements on the German balance of payments, ceteris paribus. From equations (6), (7), and (8) we obtain:

$$\begin{aligned}(10)\qquad dB_G &= [\pi_G^o - \sigma\pi_G^G - (1-\sigma)\,\pi_G^A]\,OP_o\,\hat{P}_o\\ &\quad + (\pi_G^G - \pi_G^A)(dCF_G^A / V - dCF_A^G)\\ &\quad + (\pi_G^A - \pi_G^o)\, dCF_A^o + (\pi_G^G - \pi_G^o)\, dCF_G^o / V.\end{aligned}$$

The first term is exactly the same as before. The second term represents the effect of a change in bilateral capital flows between Germany and the United States: a net inflow of capital to Germany improves Germany's balance of payments, ceteris paribus, only if German marginal propensity to spend on German output is greater than U.S. marginal propensity to spend on German output. The last two terms represent the net effects of changes in OPEC investments in the two countries. Again, what matters are the differences in marginal spending propensities. It is illuminating to rewrite equation (10) in a slightly different form:

$$(11)\quad \begin{aligned} dB_G = & -\sigma OP_o\hat{P}_o + dCF^o_G/V + (\pi^o_G + \pi^G_A)(\sigma OP_o\hat{P}_o - dCF^o_G/V) \\ & + (\pi^o_A - \pi^A_G)[(1-\sigma)\,OP_o\hat{P}_o - dCF^o_A] \\ & + (\pi^G_G - \pi^A_G)(dCF^G_A/V - dCF^G_A) \equiv (\pi^o_G - \pi^G_G)\,dB^o_G \\ & + (\pi^o_A - \pi^A_G)\,dB^o_A + (\pi^G_G - \pi^A_G)\,dB^A_G . \end{aligned}$$

The term $-\sigma OP_o\hat{P}_o + dCF^o_G/V$ represents the impact effect of an oil price increase on the German balance of payments: an increase in the cost of oil imports minus the increase in capital flow from OPEC to Germany. To obtain the net effect on the German balance of payments we have to add the increase in OPEC imports from Germany and the reduction in German imports from the United States. This is the second term. If $\pi^o_G + \pi^G_A = 1$, or $\pi^o_G = 1 - \pi^G_A = \pi^G_G$, the secondary effect offsets the primary effect and the German balance of payments remains unaffected. The third term captures the effect of redistribution of spending between OPEC and the United States. The fourth term is the same as before.

To obtain the effect of an oil shock on the exchange rate, we simply equate the right-hand sides of equations (9) and (11), and solve for V.

$$(12)\quad \begin{aligned} \hat{V} = & \frac{I}{\Delta}(\pi^o_G - \pi^G_G)\frac{dB^o_G}{X_G/V} + \frac{1}{\Delta}(\pi^o_G - \pi^A_G)\frac{dB^o_A}{X_G/V} \\ & + \frac{1}{\Delta}(\pi^G_G - \pi^G_A)\frac{dB^A_A}{X_G/V} . \end{aligned}$$

Since the effect of changes in flows of interest income is exactly the same as that of capital movements we may also use equation (12) to establish the long-run effect of a wealth transfer to OPEC. The main point to be noted is that the long-run effect of capital flows is the opposite of the short-run effect: if the dollar appreciates in the short run because of capital inflow into the United States, it must depreciate in the long run because there will be an increase in the outflow of interest income.

Krugman assumes that $\pi^G_G = 1$ and $\pi^A_G = 0$, in which case equation (11) becomes:

$$(13)\quad \begin{aligned} dB_G = & -\sigma\, OP_o\,\hat{P}_o + dCF^o_G/V \\ & + \pi^o_G\,(O\,P_o\,\hat{P}_o - dCF^o_G/V - dCF^o_A) . \end{aligned}$$

The only secondary effect that is taken into account is the increase in OPEC imports from Germany, given by the third term.

Average versus Marginal Spending Propensity and Nontraded Goods

How restrictive or misleading is Krugman's simplification? This is obviously an empirical question, but we may note one or two points to clarify the issue. It is, of course, true that U.S. *average* propensity to spend on domestic output is much greater than German average propensity to spend on U.S. output. But what matters for the absence of distribution effects is not the difference in average spending propensities but rather in marginal spending propensities. A simple demand system that would explain large differences in average spending propensities with identical marginal spending propensities would be:

$$U^i = (C_A - \bar{C}^i_A)^{\pi_A} (C_G - \bar{C}^i_G)^{\pi_G}, \quad (14)$$

where $\pi_A + \pi_G = 1$ and $i =$ A, G. In this example the United States and Germany have different consumption preferences, as captured by differences in $\bar{C}^i_A$ and $\bar{C}^i_G$. However, world demand for German output is independent of the distribution of income between the two countries and would not be affected by transfer payments between them.

The second point that I want to raise in this context has to do with nontraded goods. It is generally accepted that transfer payments between countries will change the relative price between traded and nontraded goods. Increase in export revenue in the OPEC countries, and in the Netherlands, Norway, and the United Kingdom, or indeed, for a different reason, in Australia which is experiencing a boom in the minerals sector, will lead to an increase in the relative price of nontraded goods in those countries. This relative price adjustment can be achieved either through domestic inflation or currency appreciation, or some combination of the two. In the "paying countries" the oil transfer will lead to a decline in the relative price of nontraded goods.

Changes in the relative price between traded and nontraded goods will not, however, have the same international distribution effects as changes in the international terms of trade since both gainers and losers are in the domestic economy.

The existence of nontraded goods is, nevertheless, relevant in analyzing the effect of transfer payments on the international terms of trade as well. Equality of marginal spending patterns on traded goods is no longer a sufficient condition for zero distribution effects. The reason is that a transfer payment (such as an increase in the cost of oil imports) will change the relative price between traded and nontraded goods, as discussed above, and therefore will have a secondary effect on the demand for, and the supply of, traded goods. If these secondary effects are biased, an international transfer payment will have an effect on the international terms of trade as well.

Determinants of Capital Movements and the Current Account

Why does an increase in the price of imported oil lead to a surplus in OPEC's current account, and an equal deficit in the combined current account of the oil importing countries? In a partial equilibrium model à la Krugman, the answer is obvious since the current account and the capital account are determined independently of one another.

In a properly specified general equilibrium model, the current account and the capital account are, however, jointly determined, and a transfer payment will have a primary effect on both sides of the balance of payments.

Jeffrey Sachs, among others, has argued that a permanent transfer payment should have no effect on the current account because the propensity to consume out of permanent income should be equal to one. This proportion is not quite right, however, as Lars Svensson and Nancy Marion have pointed out. First of all, the marginal propensity to consume out of permanent income is equal to one only in very special cases. Thus, suppose that the intertemporal utility function is of the form $U(C_1) + [1/(1 + \rho)]V(C_2)$. With the rate of interest equal to r, the optimal intertemporal consumption pattern equates marginal utility of today's consumption with discounted marginal utility of tomorrow's consumption: $U'(C_1) = [(1 + r)/(1 + \rho)]V'(C_2)$. From this first-order condition the effect of a permanent increase in income on first-period consumption is equal to $(2 + r)/(1 + \alpha + r)$, where $\alpha = U''(C_1)/U'(C_1)/V''(C_2)/V'(C_2)$ is the ratio of the elasticities of the marginal utility schedules in the two periods. Therefore, marginal propensity to consume out of permanent income is greater than, equal to, or less than one depending on whether α is greater than, equal to, or less than one.

To get back to the problem of OPEC surpluses, we can explain them with this sort of a model if the marginal utility of current consumption is more elastic with respect to an increase in consumption than is the case with future consumption, in other words, if there are "absorption problems" in the short run.

The marginal utility of consumption of *traded goods* depends in general on the available supply of nontraded goods. Thus the difference in elasticities could be the result of a difference in the supply of nontraded goods between the present and the future.

Another issue that I want to mention concerns the allocation of OPEC investments between different countries. Ultimately, the only reason why OPEC invests abroad is that it wants to import more in the future and less at the present time. Corresponding to each outflow of capital is an implicit plan to import goods and services in the future. This means that the allocation of "oil deficits" between various oil importing countries should correspond to the pattern of future surpluses, which in part depends on the relative abilities of countries to satisfy OPEC demand in the future. A country that cannot increase its supply of tradable goods in the future should not be running a deficit in its current account at the present time.

Krugman assumes that asset preferences are determined independently of future spending patterns, and thus there is no relationship in his model between today's current account deficits and tomorrow's current account surpluses. Furthermore, he assumes that interest rates are zero so that OPEC investments are pure transfer payments to the deficit countries. This assumption simplifies the dynamic analysis because the long-run equilibrium exchange rate does not depend on the capital account. But it surely is not an assumption that we want to make in today's economic environment.

Effect of OPEC Surpluses on Interest Rates

It is commonly argued that because OPEC's propensity to save is greater than that of oil consuming countries, an increase in the price of oil leads to an excess of saving over investment and therefore to a reduction in the rate of interest.

This proposition is, in general, incorrect. The error in the reasoning is the implicit assumption that OPEC surpluses are evidence of a higher marginal saving propensity. As was shown above, this need not be the case: a permanent transfer between oil consuming countries and OPEC will *reduce* saving in oil consuming countries and increase it in the OPEC countries without necessarily any change in total world saving. This would happen if the α parameters discussed above were equal and less than one in both regions.

Concluding Remarks

The above remarks have discussed the problem of oil price increases from the point of view of transfer theory. The main message is that oil transfers need not have any effect on international terms of trade or on international interest rates. The income effects which Krugman largely assumes away may be sufficient to induce appropriate adjustments in spending in the various regions to enable OPEC both to consume and to save more at unchanged international relative prices.

There will, of course, always be important changes in domestic relative prices and real wages in each country. The discussion of these adjustment problems, as well as of the inflationary impact of oil shocks is, however, beyond the scope of this comment.

Comment Charles Wilson

Krugman's paper effectively demonstrates the importance of examining the implications of the asymmetry in the location of OPEC's exports, imports, and foreign investment for exchange rate dynamics. Although it might be desirable to relax the strictly partial equilibrium assumptions about the current account and to incorporate a less naive portfolio theory, the primary point of the paper is still valid. Namely, that if there is a lag in the adjustment of OPEC expenditures to its revenues, then differences in OPEC's propensity to invest in one country relative to their propensity to import from that country may lead to differences in the direction of exchange rate movements between the short run and the long run. Krugman examines the case of an oil price increase in some detail. I would like to examine some possible implications of his model for exchange rate movements during the course of a worldwide recession. Throughout I will follow Krugman in assuming that α, the proportion of OPEC wealth invested in marks, is less than σ, the proportion of OPEC oil purchased by Germany, is less than γ, the proportion of OPEC expenditure on German products.

Suppose, first of all, that we model a world recession as merely a temporary decrease in the demand for oil. Assuming that demand falls by the same proportion in each country, the analysis is exactly parallel to the case of a temporary increase in the price of oil. A decrease in oil revenue of ΔO reduces German expenditure on oil by $\sigma\Delta O$ and reduces OPEC investment in oil by $\alpha\Delta O$. The net demand for marks thus increases by $(\sigma - \alpha)\Delta O$ resulting in an appreciation of the mark. Over time, however, OPEC expenditure falls. For each unit decrease in expenditure this results in a decrease in the demand for marks of γ which is only partially offset by an increased investment in marks of α. At some point the decrease in expenditure ΔE is just large enough so that $(\sigma - \alpha)\Delta O + (\gamma - \alpha)\Delta E = 0$. Given the mark has already appreciated, so that the trade balance with the United States has deteriorated, the mark must be depreciating at this point. It will continue to depreciate until the economy recovers and the demand for oil returns to its initial level.

When the economy does recover, the impact on the direction of the exchange rate movement depends on the current value of the mark as well as the current level of OPEC expenditure. Suppose the mark is at or above its initial value. Then the German trade account with the United States will be no higher than it was initially, and since OPEC expenditure is now less than OPEC revenues, the assumption that $\alpha < \sigma$ implies that OPEC will also demand fewer marks than it did initially. Hence the mark will depreciate. The depreciation must persist as long as the mark exceeds

Charles A. Wilson is a professor in the Department of Economics at New York University and a research associate of the National Bureau of Economic Research.

its initial value, rising only to the long-run level as expenditure rises to match revenue. If the recession is very long-lived, however, so that the value of the mark is less than its initial value, then it may begin appreciating immediately to the long-run value. In either case, the pattern is for the mark rate to appreciate, then depreciate, then appreciate again to its initial value.

A very different pattern emerges if we suppose that OPEC expenditure is actually a function of its wealth and that the impact of a recession on OPEC wealth has a significant effect on its expenditure. For concreteness suppose that there are two assets in each country, money and real capital. Americans hold only their own capital, in addition to the money holdings. OPEC allocates a fraction α of its wealth into German assets and the rest into American assets. A certain fraction of its assets in each country are then held in the form of real capital.

If we suppose that the value of real capital adjusts to the value of its discounted returns, then a recession will lower the value of the capital stock owned by OPEC. There will be a shift in OPEC's portfolio away from currency and into real capital to maintain its portfolio balance, but so long as the same percentage of its assets in any country are held in real capital, there will be no change in the excess demand for the aggregate stock of German assets. Otherwise, a discrete change in the exchange rate will be required to maintain portfolio balance.

If we suppose that the level of OPEC expenditure depends on the level of wealth, however, then there will be an additional effect on the flow demand for marks. A reduction expenditure and hence an increase in investment by an amount ΔX will decrease the demand for marks by $(\gamma - \alpha)\Delta X$, since the propensity to invest in German assets is less than the propensity to spend on German goods. As we noted above, a decrease in oil revenues of ΔO increases the demand for marks by $(\sigma - \alpha)\Delta O$, since the proportion of oil revenues sold to Germany is greater than OPEC's propensity to invest in German assets. Assuming that $\gamma > \sigma$, however, if the decline in X is at least as large as the decline in O, then the net effect on the demand for marks will be negative and the mark will begin to depreciate.

The exact time path of the exchange rate will then depend to a large extent on how the value of real capital changes over time. Suppose, for instance, that the drop in OPEC expenditure exactly equals the fall in oil revenue. Then there will be no change in OPEC wealth as long as the value of real capital does not change. The mark will then depreciate until the trade balance with the United States grows sufficiently to offset the fall in the trade balance with OPEC. As we near the end of the recession, however, we might expect the real value of capital to rise in anticipation of higher future returns, even while the demand for oil stays depressed. This would generate an increase in OPEC expenditure and, by our previous assumptions, a net increase in the demand for marks. The resulting appreciation of the mark might then result in the mark actually overshooting its long-run value.

To summarize, the impact of decreased business activity in the industrialized countries on exchange rate movements will depend critically on how sensitive the level of OPEC expenditure is to its level of wealth. If expenditure merely adjusts to OPEC revenues with a lag, then we should expect to see the values of the mark first rise and then fall during the course of a recession. If, however, the decline in OPEC wealth induces a significant decrease in its expenditure, then the opposite pattern will emerge. First the mark will depreciate and then appreciate, perhaps even overshooting its long-run value.