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THE INTERNATIONAL TRANSMISSION OF OIL PRICE EFFECTS

by

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The International Transmission of Oil Price Effects
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I. INTRODUCTION

That increases in oil prices (and/or in the prices of other primary commodities) can upset the world economy has been amply demonstrated in the last ten years. What is not so clearly apparent, however, are the dimensions of the effects and the complex channels of interaction by which they operate.

Interest in modeling the channels through which disturbances are internationally distributed is by no means new. Indeed, starting with Metzler (1950), a vast literature has emerged in an attempt to model these channels of transmission. More recently, large oil price changes have led to modeling approaches with more emphasis on the role of relative price changes (Schmid 1976, Findlay and Rodriguez 1977, Bruno and Sachs 1979, Solow 1980). Greatly simplified, the purpose of these models is to determine how oil price changes affect real income, prices, and employment in a small open oil importing economy, and how these oil price effects may change as a result of monetary policy responses and wage indexation. However, one important limitation of these models is their partial equilibrium nature, i.e., there is no recognition for the fact that the effects of oil price changes on the domestic economy depend on how these price changes affect in turn the rest of the world economy.

Recognition of the international repercussions of relative price changes is important given that economic activity in different regions are linked through international trade. From the standpoint of oil importing economies, an increased recycling of OPEC's revenues through greater imports reduces the income transfer that arises out of higher oil prices. From OPEC's viewpoint, the international transmission of oil price effects

is important in determining oil price strategies since oil price changes affect real income of the world economy, and thus OPEC's oil exports. Furthermore, as we will see below, these income feedback effects may offer an explanation to the question of why oil prices have not increased even more despite the overwhelming empirical evidence pointing to oil demand price inelasticity.

Our purpose in this paper is to formulate a theoretical model of the world economy to highlight the channels by which the effects of an increase in the price of oil are internationally transmitted to the GDP of the developed countries (DC's), OPEC, and the non oil exporting less developed countries (LDC's). The orientation of the paper is primarily short run. There are not so far, any allowances for the long run adjustment of oil consumption and supply from alternative energy sources in response to price increases.

We start our analysis in section II, where we present a theoretical model aimed at capturing these feedback effects of oil price changes. This model is solved analytically and the comparative statics of an increase in the price of oil are derived in section III. We examine, in section IV, the influence of policy responses to oil price changes on income and oil trade. In section V we analyze the effects that oil price changes have on the demand for oil faced by OPEC, taking into account the income effects arising out of a relative price change. Finally, section VI contains our conclusions.

II. A THEORETICAL MODEL OF OIL PRICE EFFECTS

The model we use here differs from those developed in the literature in that we consider three blocks of countries whose analytical structures are different from each other:

- the developed economies, whose GDP is determined from the demand side while the influence of supply enters through price determination;
- the OPEC countries, who recycle their oil revenue by purchasing manufactured goods from the developed economies, with no imports from the non-OPEC developing economies; and
- the non-OPEC developing economies, whose output is determined from the supply side using a production function approach.

The internationally traded goods we consider are:

- oil, exported by OPEC to both developed and non-OPEC developing economies;
- raw materials, exported by non-OPEC developing economies to developed economies; and
- manufactures, exported by developed to both OPEC and non-OPEC developing economies.

We consider three prices for the internationally traded goods:

- the export price of manufactures of developed economies, which we determine endogenously,
- the export price of raw materials, exogenously given; and
- the price of oil.

Table 1 contains the specification of our theoretical model where we see the differences in structure for each block of countries as well as the main trade relations. We now proceed with a more detailed explanation of this model.

Developed Economies

As mentioned earlier, real income (in terms of manufactures) is determined from the demand side as in equation (1). We assume that spending

Table 1
A Theoretical Model of a Three Region World Economy

Developed Countries

$$Y^d = C^d(Y^d) + E^d + B^d \quad (1)$$

$$B^d = X_m^d - [(P_o/P_m)M_o^d + (P_p/P_m)M_p^d] \quad (2)$$

$$M_o^d = M_o^d(P_o/P_m, Y^d) \quad (3)$$

$$M_p^d = M_p^d(P_p/P_m, Y^d) \quad (4)$$

$$P_m = \pi_o P_o + \pi_p P_p \quad (5)$$

Non-OPEC Developing Countries

$$Y^l = f(K^l, L^l) \quad (6)$$

$$K^l = K_{-1}^l + I^l \quad (7)$$

$$I^l = i_o + i M_m^l \quad (8)$$

$$M_m^l = (R + P_p M_p^d - P_o M_o^d) / P_m \quad (9)$$

$$M_o^l = M_o^l(P_o/P_p, Y^l) \quad (10)$$

OPEC

$$Y^o = F(K^o) \quad (11)$$

$$K^o = K_{-1}^o + I^o \quad (12)$$

$$I^o = b_0 + b M_m^o \quad (13)$$

$$M_m^o = \beta P_o X_o^o / P_m \quad (14)$$

EQUILIBRIUM CONDITIONS

$$X_m^d = M_m^o + M_m^l \quad (15)$$

$$X_o^o = M_o^d + M_o^l \quad (16)$$

$$X_p^l = M_p^d \quad (17)$$

Notation

1) Variables

M: imports

K: capital

L: labor

C: consumption plus investment

Y: GDP
P: prices
I: investment
B: trade account
E: exogenous variable
X: exports
R: Resource transfers

2) Superscripts

λ: Non-OPEC LDC's
o: OPEC
d: DC's

3) Subscripts

o: oil
p: raw materials
m: manufactures

on consumption and investment, $C^d(Y^d)$, both in terms of manufactures, depend on the level of real GDP, Y^d . The term E^d represents exogenous variables such as government expenditures. The balance of payments, B^d equation (2), equals the trade account since the only type of capital movements we recognize are those that compensate for the flow of goods. Notice also that the trade balance is expressed in terms of manufactures (by deflation by the price of manufactures). This is an important consideration because it means that the model recognizes the terms-of-trade effect of changes in oil prices since oil imports are valued in terms of the exports of manufactured goods that would be required to pay for them.

On the export side, we have exports of manufactures to both OPEC and non-OPEC LDC's depending on the terms of trade and export revenues for these two blocks of countries. On the import side we assume that both oil imports, M_o^d in equation (3), and raw materials imports, M_p^d in equation (4), depend on terms of trade and real income.

The price of manufactures, equation (5), is assumed to be a linear function of the prices of raw materials and oil¹. This is a simplification of a more realistic formulation in which the price of manufactures depends, in addition to the variables just mentioned, on the price of labor and excess capacity utilization. Our formulation can be derived from a production function with constant returns to scale while assuming zero profits.

Non-OPEC Developing Countries

Real income of non-OPEC developing economies, Y^L in equation (6), is determined from the supply side within a production function framework with capital, K^L , and fixed labor, L^L as factors. The assumption of fixed labor may be justified since what is relevant for production decisions is not just the number of man-hours, but the number of effective man-hours which captures education and experience of the labor force. However, education is a process that takes place only gradually and for our purposes it can be left out.

The capital stock is obtained by accumulation of net investment, which in turns depends on the amount of imports of capital goods. This relation between net investment and imports of capital goods can be derived by treating the aggregate capital stock as an aggregate of a domestic component and foreign component as suggested by McKinnon (1964) and Taylor (1979). Following their approach, we obtain equation (8).

It has been widely recognized that foreign exchange constraints play a role in determining the growth of output of developing economies (Chenery-Strout 1966, McKinnon 1964, Taylor 1979). In our model, foreign exchange constraints apply to imports of manufactures, M_m^L equation (9). In this way, if foreign exchange constraints are binding, then imports of manufactures will be limited thus dampening capital accumulation and income growth. We deduct oil payments from the computation of foreign exchange resources, and assume that these countries use whatever is left over to finance imports of manufactures.² This implies that their trade account is in balance except for external credits. Finally, oil imports, M_o^L in equation (10), are determined as a function of terms of trade and real income.

OPEC

OPEC income determination is analogous to the case of non-OPEC developing countries. Since OPEC does not import oil, we focus on the recycling of OPEC's exports earnings via the purchase of manufactures from developed economies. We assume at this stage that OPEC recycles a constant fraction β of their export revenues, as indicated by equation (11). This type of relation was first introduced by Adams (1979) in an analysis showing that higher oil prices are not necessarily associated with declining growth rates in developed economies. A constant value of β implies that OPEC's absorption capacity does not change over time. We assume here that it is constant because (1) it simplifies the analytical derivations, and (2) we study in section III the effects of changes in this parameter on the analytical solutions by simply using alternative values of β .

III. THE INTERNATIONAL TRANSMISSION OF OIL PRICE EFFECTS

We use the model represented by equations (1 - 17) to identify the channels through which an increase in oil prices is internationally transmitted to both OPEC and the oil consuming economies, as well as to establish the direction of the effects.

We have divided the channels of oil price effects into two types, direct and indirect. One direct channel is the transfer of real income from oil importing countries to OPEC. In the case of the LDC's this transfer takes the form of reduced foreign-exchange availabilities with subsequent indirect dynamic effects on output growth through the influence on imports of manufactured goods and the growth of capital stock. In the case of the DC's the direct effect is on the real balance of payments which deteriorates with the increased cost of oil imports in terms of manufactured goods. As anticipated, the direct effects of oil price increases on real income are

negative.

The indirect channels of influence are through OPEC's real recycling and increases in the export price of manufactures of DC's. An increase in oil prices raises oil revenues of OPEC who in turn recycles a fraction β in the form of imports of manufactures from DC's. This increased recycling represents a stimulus to activity in the DC's--one which may or may not be offset by the direct negative effect. In turn, this stimulus to real activity in the DC's causes an increase in the volume of imports of primary commodities from Non-OPEC LDC's, enlarging LDC's foreign-exchange resources which in turn are used to purchase imports of manufactured goods from the DC's.

The second channel of indirect effects is through changes in the price of manufactured goods which is a markup on oil and primary-commodity prices. An increase in the price of oil, when translated into an increase in the price of manufactured goods, reduces the terms of trade deterioration of the DC's. This means a reduction in the value of their imports (assuming price inelasticity) in terms of manufactures. But it also decreases imports of manufactured goods of both OPEC and LDC's and thus adversely affects the GDP of the DC's. This adverse indirect effect of oil prices on DC's real income is then fed back to OPEC in the form of lower oil imports and to non-OPEC LDC's in the form of lower imports of raw materials; the decline in exports of LDC's reduces foreign exchange resources beyond the reduction due to the higher price of manufactures, and thus induces a decline in imports of capital goods and capital accumulation with a dampening effect on output growth.

Analytical Solution of the Model

From the discussion of the international transmission of oil price effects we notice that the direction of the impact of an increase in the price of oil is not unambiguous. The direct and negative impacts of oil price increases on oil importing economies may be offset by the indirect impacts arising out the effects of oil price changes on the world economy. In addition, changes in real income due to changes in oil prices affect import activities which in turn affect real income given the simultaneous nature of the model. To solve the model simultaneously we begin by totally differentiating the system of equations (1) - (17). Using the equilibrium condition that world export supply of one commodity equals the world import demand for that commodity, we can reduce the system from a seventeen equation system to a three differential equation system. In addition, we adopt the (very) common practice in international trade theory, of setting initial prices equal to 1. The resulting system of equations is:

$$\Gamma(\gamma_{ij}) \underline{dy} = \Omega(\omega_{sk}) \underline{dx} \quad , \quad i,j=1,3;s=1,3;k=1,2;$$

where

$$\underline{dy}' = (dY^d \quad dY^e \quad dY^o),$$

$$\underline{dx}' = (dP_o \quad dE^d).$$

The elements of Γ are:

$$\gamma_{11} = 1 - c^d + (1-\beta)\phi_o^d \eta_o^d > 0,$$

$$\gamma_{12} = (1-\beta)\phi_o^e \eta_o^e > 0,$$

$$\gamma_{13} = 0,$$

$$\gamma_{21} = -f^i \phi_p^d \eta_p^d < 0,$$

$$\gamma_{22} = 1 + \phi_o^e \eta_o^e f^i > 0,$$

$$\gamma_{23} = 0,$$

$$\gamma_{31} = -F' b \beta \phi_0^d n_0^d < 0,$$

$$\gamma_{32} = -F' b \beta \phi_0^l n_0^l < 0,$$

$$\gamma_{33} = 1.$$

The elements of Ω are:

$$\omega_{11} = -R\pi_0 - (1-\beta)(M_0^l(1+\epsilon_0^l - \pi_0) + M_0^d(1+\epsilon_0^d)(1-\pi_0)) > 0,$$

$$\omega_{12} = 1,$$

$$\omega_{21} = -f' i (R\pi_0 + M_p^d(1+\epsilon_p^d)\pi_0 + M_0^l(1+\epsilon_0^l - \pi_0)) > 0,$$

$$\omega_{22} = 0,$$

$$\omega_{31} = F' b \beta (M_0^d(1+\epsilon_0^d) + M_0^l(1+\epsilon_0^l - \pi_0)) > 0,$$

$$\omega_{32} = 0,$$

where the following notation has been used:

$$\phi_j^i \equiv M_j^i / Y^i, \quad \eta_j^i \equiv (1/\phi_j^i)(\partial M_j^i / \partial Y^i), \quad \epsilon_j^i \equiv (P_j/M_j^i)(\partial M_j^i / \partial P_j),$$

$$F' \equiv \partial F / \partial K^0, \quad f' \equiv \partial f / \partial K^l, \quad \text{for } i = d, o, l \text{ and } j = p, o, m.$$

Partitioning Γ as:

$$\Gamma = \begin{bmatrix} \Gamma_{11} & \vdots & \overline{0} \\ \dots & \dots & \dots \\ \Gamma_{21} & \vdots & \underline{1} \end{bmatrix}, \quad \text{with} \quad \underline{0}' = (0 \ 0), \quad \Gamma_{11} = (\gamma_{ij}) \quad i=1,2; j=1,2,$$

$$\Gamma_{21} = (\gamma_{31} \ \gamma_{32}),$$

we obtain the impact of an increase in the price of oil on real income for each of the regions as:

$$dy = \begin{bmatrix} \Gamma_{11}^{-1} & \underline{0} \\ -\Gamma_{21}\Gamma_{11}^{-1} & \underline{1} \end{bmatrix} \begin{bmatrix} \omega_{11} & 1 \\ \omega_{21} & \omega_{22} \\ \omega_{31} & \omega_{32} \end{bmatrix} \begin{bmatrix} dP_o \\ dE^d \end{bmatrix}. \quad (19)$$

To determine the direction of the impact of an increase in the price of oil on the real income of both developed and non-OPEC developing economies, i.e., the sign of the derivatives, we apply the "Correspondence Principle" developed by Samuelson (1947), which allows us to use the stability conditions of the model in determining the sign of the comparative static results. Following Metzler (1950), the model is stable if and only if, all the principle minors of the Γ matrix are positive. This implies that the following conditions must hold:

$$\gamma_{11} = 1 - c^d + (1-\beta)\phi_0^n \eta_0^d > 0,$$

$$\det(\Gamma_{11}) = \begin{matrix} + & + \\ \gamma_{11}\gamma_{22} & - \gamma_{12}\gamma_{21} \end{matrix} > 0, \quad (20)$$

$$\det(\Gamma) = \det(\Gamma_{11}) > 0.$$

Examining these stability conditions we conclude that a sufficient condition for the model to be stable is that $1 - c^d > 0$, i.e., the marginal propensity to consume should be less than one.

Limiting our attention to oil importing economies, we derive the impact of an increase in the price of oil on developed economies as:

$$dY^d/dP_0 = ((\begin{matrix} + & \pm \\ \gamma_{22}\omega_{11} & - \gamma_{12}\omega_{21} \end{matrix}) + \begin{matrix} + \\ \gamma_{22} \end{matrix} (dE^d/dP_0)) / \det(\Gamma) < 0. \quad (21)$$

For non-OPEC developing countries, the impact of an increase in the price of oil on their real income is:

$$dY^L/dP_0 = ((\bar{\gamma}_{11}^+ \bar{\omega}_{21} - \bar{\gamma}_{21} \bar{\omega}_{11}^+) - \bar{\gamma}_{21} (dE^d/dP_0)) / \det(\Gamma) < 0. \quad (22)$$

Assuming no fiscal policy response to the change in oil prices and price inelasticity, we find that

$$dY^d/dP_0 = (\bar{\gamma}_{22}^+ \bar{\omega}_{11} - \bar{\gamma}_{12} \bar{\omega}_{21}^+) / \det(\Gamma) > 0, \quad (23)$$

$$dY^L/dP = (\bar{\gamma}_{11}^+ \bar{\omega}_{21} - \bar{\gamma}_{21} \bar{\omega}_{11}^+) / \det(\Gamma) < 0. \quad (24)$$

The signs for dY^d/dP_0 may be ambiguous even in this simple model because the direct effect of an increase in the price of oil, the transfer of real income to OPEC, could be offset by the indirect effects of increases in the price of manufactures and the recycling activities of OPEC. This clearly suggests that the direction of the impact of an increase in the price of oil on the real income of DC's depends on the volume of trade, i.e. the openness of the various economies and on the parameters π_0 , β , η_j^i , and ϵ_j^i .

In Table 2 we present the signs for dY^d/dP_0 for alternative values of π_0 and β assuming price inelasticity. The results in Table 2 are consistent with the results of previous models and with what one might expect intuitively, i.e., if there is no markup in oil prices and the value of the recycling coefficient is less than one, then an increase in oil prices results in a net transfer of real income to OPEC and therefore has negative impact on DC's real income. Moreover, the effect of oil price increases on real income is zero if the initial transfer to OPEC is recycled back to DC's, i.e. if $\beta=1$. However, as soon as the markup takes positive values, the impact of an oil price increase on the GDP of the DC's may be positive

Table 2
Effects of Oil Prices on GDP of DC's:
Summary of dy^d/dp_o

β	π_o		
	0	$0 < \pi_o < 1$	1
0	-	- or +	- or +
$0 < \beta < 1$	-	- or +	- or +
1	0	-	-

or negative given that an increase in π_0 reduces both exports of manufactures and the value of imports in terms of manufactures. In other words, the sign $(\partial(dY^d/dP_0))/\partial\pi_0 = \theta(\beta)$ is not unambiguous, although we find that $\theta(1) < 0$. That is, if OPEC recycles all their export revenues, then an increase in the markup of oil prices reduces real income of developed economies, i.e., oil price increases have a stagflationary effect.

For any $\pi_0 > 0$, we conjecture that the larger the recycling coefficient, β , the less negative (or more positive) is the impact of an oil price increase on the income of the DC's. The positive impacts may appear on the surface to be counterintuitive. However, recall that the ambiguity of the sign of the oil price multiplier of the GDP of the DC's is due to mutually offsetting effects arising from the multiple channels of transmission. In particular, the increase in P_0 initially worsens the trade account of the DC's and thus their GDP. However, OPEC imports more manufactured goods at a higher price and thus it may offset the original income deterioration.

In contrast to the case of developed economies, the impact of oil price increases on the GDP of non-OPEC developing countries is unequivocally negative. As Table 3 suggest, this result holds for all values of β and π_0 between zero and one. Furthermore, as the value of the indexing parameter π_0 increases, the effect of an oil-price increase on the GDP of the LDC's decreases, i.e., becomes more negative:

$$\text{sign} \left(\partial(dY^L/dP_0) / \partial\pi_0 \right) < 0 \text{ for } \beta \in [0,1].$$

This result is reasonable since the available foreign exchange resources of the LDC's have been reduced not only through the higher oil

Table 3
 Effects of Oil Prices on GDP of LDC's:
 Summary of dY^L/dP_O

β	π_O		
	0	$0 < \pi_O < 1$	1
0	-	-	-
$0 < \beta < 1$	-	-	-
1	-	-	-

prices but also as a result of higher prices of manufactured goods despite the positive effect of a higher markup coefficient on income of the DC's. For a given value of the markup coefficient, increases in the price of oil reduce LDC's real income by less the higher is the recycling coefficient. This is because as β increases, OPEC imports more and this represents a stimulus to real income of DC's which is then transmitted to developing countries in the form of more imports of raw materials.

In summary, our analysis indicates that the effects of an increase in oil prices on an oil importing economy depend, in addition to the economy's internal characteristics, on the volume of international trade and the values of structural parameters such as price and income elasticities. And as a corollary of recognizing the international repercussions of oil price effects, we find that an increase in the price of oil may have a negative or positive impact on the GDP of the DCs. Marquez (1983) reaches similar conclusions. It is important, however, to remember that no offsetting counterinflationary policy or capacity constraints have been assumed in the DC's so that the demand-side impacts can work out fully; we deal with the counterinflationary policies below.

IV. COUNTERINFLATIONARY POLICIES AND THE EFFECT OF OIL PRICES ON THE WORLD ECONOMY

The impact of an increase in the price of oil on real income, as represented by equations (23) and (24), is derived under the assumption that government expenditures (E^d) do not respond to changes in oil prices. In principle, if prices are perfectly flexible, then it might not be necessary to alter economic policies in response to a change in the price of oil because an increase in oil prices will be followed by a decrease in other prices leaving the overall inflation rate unchanged. However, there is

substantial statistical and theoretical evidence pointing to a relationship between relative price changes (a change in oil prices) and the overall inflation rate (Fischer 1982, Cukierman 1982, and Marquez and Vining 1983). For our purposes, what matters is that an increase in the price of oil will increase the inflation rate, to which government economic policies respond:³

$$dE^d/dP_0 = (dE^d/dP_m)(dP_m/dP_0), \text{ or}$$

$$dE^d/dP_0 = (dE^d/dP_0)\pi_0,$$

where we capture the influence of oil prices on inflation by their effect on the price of manufactures. If we assume a linear response of government expenditures to changes in P_m equal to $\psi < 0$, then the response of E^d to changes in P_0 can be represented as:

$$dY^d/dP_0 = ((\gamma_{22}\omega_{11} - \gamma_{12}\omega_{21}) + \gamma_{22}\psi\pi_0)/\det(\Gamma). \quad (25)$$

The oil price multiplier allowing for changes in government expenditures can be decomposed into two terms. The first term captures the impact of oil prices on real income taking into account only the international transmission channels, direct and indirect. The second term captures the direct effect of fiscal policy changes as well as the feedback effects that fiscal policy changes have on DC's income via their impact on OPEC and other LDC's.

With this decomposition we see that even if oil prices have a positive impact on real income (given that the first term of equation could be positive) a large enough restrictive fiscal policy response to an oil price

increase could offset the initial positive impact. In particular, if

$$\psi < -(\gamma_{22}\omega_{11} - \gamma_{12}\omega_{21})/(\pi_0\gamma_{22}) ,$$

then the combined effect of an increase in the price of oil and of a restrictive fiscal policy will reduce real income of developed economies.

V. THE INTERNATIONAL TRANSMISSION OF OIL PRICE EFFECTS AND OPEC'S PRICING POLICY

So far we have assumed that the only supplier of oil is OPEC. Given that a monopolist (with zero marginal cost) increases prices to the point where the direct price elasticity equals one, it seems natural to ask what prevents OPEC from increasing the price of oil even more. This is an important question since empirical estimates of the (absolute value) of the demand price elasticities are well below one and it is well known that, from a theoretical viewpoint, it is not optimal for the monopolist of non-renewable resources to operate on the inelastic portion of the demand curve.

We address this question by considering the demand for oil that OPEC faces:

$$D^O = M_O^d + M_O^l .$$

The total effect of an increase in the price of oil on D^O can be decomposed in a direct effect and an indirect, or feedback effect since oil price changes affect real income of oil importers, and this in turn affects oil imports:

$$dD^0/dP_0 = [M_0^d \epsilon_0^d (1-\pi_0) + M_0^l \epsilon_0^l] +$$

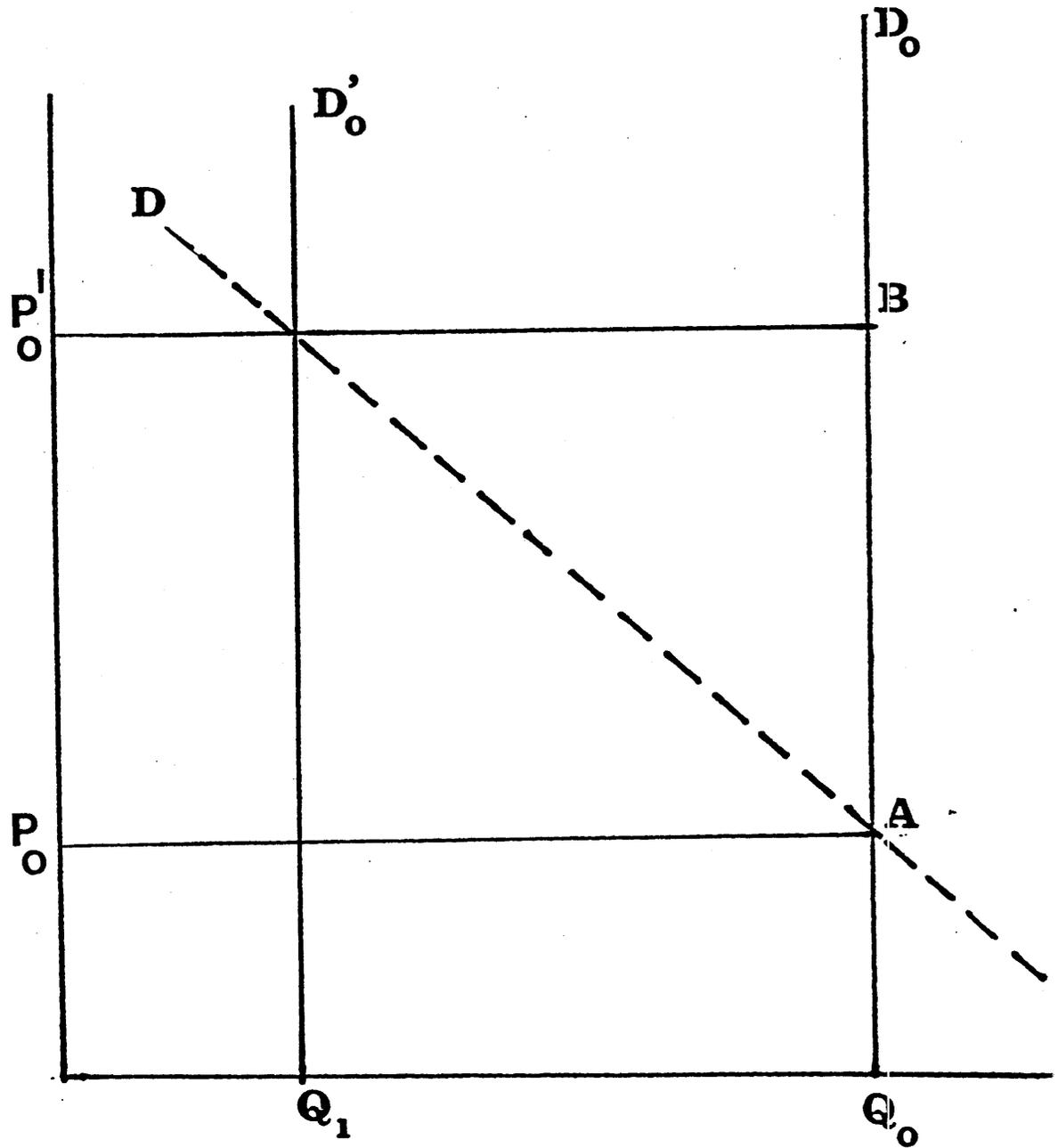
$$+(\phi_0^d \eta_0^d \quad \phi_0^l \eta_0^l) \begin{bmatrix} \Gamma_{11}^{-1} & \bar{0} \\ -\Gamma_{21} \Gamma_{11}^{-1} & 1 \end{bmatrix} \begin{bmatrix} \omega_{11} & 1 \\ \omega_{21} & \omega_{22} \\ \omega_{31} & \omega_{31} \end{bmatrix} \begin{bmatrix} \bar{1} \\ dE^d/dP_0 \end{bmatrix},$$

where the first term represents the direct effect of oil price changes, and the second term represents the indirect, or income feedback effect. In figure 1 we show the feedback effect of an increase in the price of oil on D^0 assuming that $\epsilon_0^d = \epsilon_0^l = 0$, and that the initial price-quantity combination is given by point A. An increase in the price of oil from P_0 to P'_0 increases oil revenues of OPEC by the area ABP'_0P_0 as long as the demand function D^0 remains stable. But as we have seen, the increase in the price of oil may reduce real income of oil importers (especially if followed by counterinflationary policies) shifting the demand for oil leftward to D' . As a result, we find that the decision to increase oil prices might lead to a loss of oil revenues, which clearly is suboptimal. This is because what matters for optimal price determination is the total effect of oil price changes on the demand for oil. And thus, even if there is no direct effect of oil prices on oil demand, there is an income feedback effect, which increases the price elasticity relevant for OPEC pricing decisions and therefore explains why it is that oil prices do not increase in the face of estimated demand price inelasticities.

Finally, we notice that as a consequence of the existence of income feedback effects, the price elasticity relevant for OPEC's pricing strategies is no longer a constant parameter but rather is an endogenous

Figure 1

Effects of Oil Price Changes on Oil Revenues



variable depending on (1) the effect that oil price changes have on income of oil importing economies and (2) their counterinflationary policies.

VI. CONCLUSIONS

In this paper we have developed a three-region world model to study the international transmission of oil price effects. We find that, in general, the effect of oil price changes on real income of oil importers depends on:

- the import price elasticities of DC's and LDC's, ϵ_0^d and ϵ_0^l ,
- the absorption capacity of OPEC, β ;
- the markup coefficient of manufactures prices on the price of oil, π_0 ;
- the response of fiscal policy to the increase in the price of oil; and
- the volume of international trade.

Secondly, we find that the existence of international repercussions makes ambiguous the impact of oil price increases on the real income of developed countries, even though these price increases reduce unambiguously real income of non-OPEC developing countries. Finally, there are feedback effects of oil price changes to the demand for oil which should be taken into account in setting the optimal price of oil. Not recognizing these feedback effects raises the price elasticity relevant for OPEC pricing decisions and the oil price path, neither of which is in OPEC's best interest.

Endnotes

* This paper represents the views of the author 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 Equation (5) postulates a strictly proportional relation between commodity prices and the price of manufactures. Adams (1979) has shown that the inclusion of a constant intercept is relevant for taking capacity constraints into consideration. However, the inclusion of a constant term does not affect our results here because in the process of differentiation the constant term drops out.

² We also studied the case where only a fraction γ of foreign exchange resources is used to finance manufacture imports. The analytical solutions, equations (23) and (24), represent the limiting cases of the general solutions as $\gamma \rightarrow 1$. We choose to use $\gamma=1$ so as to give the LDC's all the leverage possible to finance their growth.

³ A more general formulation would be:

$$dE^d/dP_0 = \alpha(dE^d/dP_m)(dP_m/dP_0) + (1-\alpha)(dE^d/dY^d)(dY^d/dP_0),$$

i.e., government policies respond to inflation and to recession (see Marquez 1983).

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