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THE SMALL OIL PRODUCER IN THE WORLD ECONOMY
A MACRO MODEL

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ABSTRACT

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by

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This paper models the macro-effects of exogenous oil and other shock on a small open economy (SOE) which is, itself, an oil producer. The model differs from existing literature in three major respects. First, the SOE has bot an oil sector and a manufacturing sector, where oil is used as an intermediate input. Second, the world economy in which the SOE is imbedded is explicitly modelled. It contains two additional nations: a large, dominant-firm-type oil monopolist, OPEC; and a large manufacturer, the rest-of-the-world (ROW), who uses imported oil as an intermediate input. Domestic and foreign manufactures are imperfect substitutes. Third, the SOE's authorities may, as in Canada, prevent world oil prices from being passed through to the domestic economy. Conventionally, the model is short-run while the world is characterized by flexible exchange rates, perfect financial capital mobility and rational expectations.

The paper then analyzes the effects of various domestic and foreign shocks on the SOE's real GNP, consumer price index, and the composition of these two magnitudes. Of particular interest is the insulation properties, if any, of indexing domestic to world oil prices.

THE SMALL OIL PRODUCER IN THE WORLD ECONOMY: A MACRO MODEL

Jon Harkness
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This paper models the macro-effects of exogenous oil and other shocks on a small open economy (SOE) which is, itself, an oil producer. The model differs from existing literature in three major respects. First, the SOE has both an oil sector and a manufacturing sector, where oil is used as an intermediate input. Second, the world economy in which the SOE is imbedded is explicitly modelled. The world contains two additional nations: a large oil producer, OPEC; and a large manufacturer, the rest-of-the-world (ROW), who uses imported oil as an intermediate good. OPEC sets oil's world price by acting, essentially, as a dominant firm which maximizes its profits by exploiting world oil demand. Such behaviour has macro-implications for ROW which, in turn, feed into the SOE via her trade account and, thereby, via her aggregate demand. It also has direct consequences for the SOE, on the aggregate supply side, by altering the level and composition of aggregate output. Third, the domestic authorities may prevent world oil prices from being passed through to the small domestic economy as, for example, is the case in Canada. This domestic oil-pricing policy will, of course, have additional macro-implications.

The model is short-run in the sense that the capital stock in every sector and nation is fixed while there exists no (endogenous) technical change which, for example, might be oil-saving. It is "longer-run" in the sense that, within the SOE, labour is perfectly mobile among sectors. Lastly, the world is characterized by flexible exchange rates, perfect capital mobility and rational expectations. Rationality will imply, in this model, static expectations.

I. THE BASIC MODEL

Consider two oil-producing nations trading with each other and with the rest of the world (ROW). For concreteness, call them OPEC and Canada. OPEC produces only oil and is organized as a profit-maximizing cartel. Canada is a fringe oil producer who also produces a second composite good, "widgets", using oil as an intermediate input. As well, ROW produces only a third composite good, "manufactures", with the aid of imported oil. All production in ROW and in Canada is competitively organized. Lastly, Canada is relatively small in the sense that she accounts for a trivial share of world GNP and of world oil production.

In all nations, expectations are rationally formed on the basis of complete current information. Such information includes knowledge of the relevant structural relations, all of which will be log-linear, as well as the current values of all exogenous variables. The (log of) exogenous variables are subject to additive random shocks. Such shocks are all permanent while being drawn from independently-distributed, stationary distributions with a zero mean. It is well known that the above assumptions imply agents will fully anticipate the current values of all endogenous variables relevant to their choice problem; as well, the currently known and expected future values of any variable will be identical. In short, agents will act as if they were operating in a world of current certainty and as if they had static expectations concerning the future.

Lastly, unless explicitly noted otherwise, all variables will be measured by their natural logarithm.

(a) ROW Production

ROW produces a single composite good, manufactures, using imported oil and a composite bundle of non-traded primary factors, "labour". In the short run, her capital stock is fixed. Let her aggregate technology be log-linear so that:

(1) $$Q^* = \alpha^* + \beta^*.N^* + \gamma^*.H^* \qquad 0 < \alpha^*,\beta^* < 1$$

where Q^* is manufacturing output while N^* and H^* are the employment of, respectively, labour and oil. An increase in α^* would indicate a Hicks-neutral productivity shock.

Given competitive behaviour by firms, real factor rewards will be given by the usual marginal productivity conditions, so that:

(2) $$\begin{cases} w^* = \ln\beta^* + Q^* - N^* \\ \tau^* = (R^* - P^*) = \ln\gamma^* + Q^* - H^* \end{cases}$$

where: w^* is the real wage; R^* is oil's nominal price; P^* is the price of manufactures; and, therefore, τ^* is oil's "real" price. Lastly, let the supply of labour be a log-linear function of the real wage rate.

(3) $$w^* = g^* + h^*.N^{*S} \qquad h^* > 0$$

Given that, in equilibrium, the labour market clears (i.e., $N^* = N^{*S}$) expressions (1) to (3) are sufficient to solve for manufacturing output and the employment of oil. The reader may confirm that[1]

(4) $$Q^* = A.\alpha^* - B.\tau^* + C \qquad A,B > 0$$

(5) $H^* = A.\alpha^* - \eta.\tau^* + D \qquad \eta > 1$

The usual notion of a factor demand when there are two variable inputs involves the profit-maximizing use of, say, oil when labour's use has been optimally chosen. Consequently, expression (5) is ROW's oil demand.

Since ROW imports an intermediate good, oil, I must distinguish between her gross output, Q^*, and her real GNP, q^*. The latter magnitude is, of course, her real domestic value-added or, identically, gross output net of the real oil bill, $q^o = (\tau^* + H^*)$. The fact of log-linear technology implies that:

$$
(6) \qquad \begin{aligned} q^o &= \ln\gamma^* + Q^* \\ q^* &= \ln(1-\gamma^*) + Q^* \end{aligned}
$$

As well, given that Canada's net oil exports are absolutely small while OPEC produces only oil all of which she exports, ROW's real oil bill will (approximately) equal OPEC's real GNP, measured in terms of manufactures. In turn, this implies the combined real GNP of OPEC and ROW is, simply, manufacturing output, Q^*. Consequently, Q^* perfectly proxies ROW, OPEC and combined ROW-OPEC real GNPs.

(b) OPEC and Oil's Price

OPEC is a profit-maximizing cartel who acts as the "dominant firm" in the world oil market. Since Canada's net oil exports are relatively small, the demand for oil faced by OPEC is, essentially, ROW's demand. Moreover, quite realistically, I assume OPEC prices oil in terms of ROW-currency (e.g.,

\$US). Then, according to the oil demand function, expression (5), the logarithm of OPEC's marginal revenue is

$$(7) \qquad MR = R^* - P^* + \ln(1-1/\eta)$$

where, recall, $\tau^* = R^*-P^*$. As well, let oil be produced in accord with a log-linear marginal cost function, where costs are measured in ROW currency.[2]

$$(8) \qquad MC = \varepsilon + k.H^* = \varepsilon + k[D + A.\alpha^* - \eta.(R^*-P^*)] \qquad k > 1$$

To maximize current profit, OPEC equates MR to MC yielding oil's price as:

$$(9) \qquad \tau^* = (R^*-P^*) = a + b.\varepsilon + c.\alpha^*$$

where: $b = (1+\eta k)^{-1} > 0$; $c = kbA > 0$; and $a = -b\ln(1-1/\eta)+kbD$.

In short, OPEC will raise oil's nominal price, R^*, in response to a hike in her marginal costs, ε, or to a hike in oil demand occasioned by an exogenous technical shock, α^*, in ROW. As well, for obvious reasons, R^* is unit-elastic with respect to the price of manufactures, P^*.

(d) ROW Aggregate Demand

Let there be two traded financial assets, Canadian and ROW bonds, which are perfect substitutes. They differ only in being denominated in, respectively, Canadian and ROW currency. The former bonds are issued only by Canada but the latter bonds may be issued by either ROW or OPEC. Thus, there is perfect capital mobility among the three nations while Canada's smallness implies that interest rates are, essentially, determined in ROW's capital markets. Moreover, assume oil is nowhere directly consumed so that, for

OPEC, all final goods are imported.

Now, consider the following log-linear demand sector for ROW:

$$(10)\quad \begin{cases} M^* - P^* = L_0^* + Q^* - L_1^*.r^* & L_1^* > 0 \\ Q^* = D_0^* - D_1^*.r^* & D_1^* > 0 \end{cases}$$

where M* is ROW's nominal money stock while r* is both the nominal and the ex ante real interest rate. The nominal and real interest rates are identical by my previous assumptions about structure and rationality which implied that expectations are, essentially, static and, therefore, that the expected future inflation rate is zero.[3]

The first expression in (10) is a standard LM function where, for simplicity, real money demand is unit-elastic with respect to the real transactions variable, Q*. While money demand ought, perhaps, to depend on ROW's real GNP, q*, I showed above that Q* perfectly proxies q*.[4] The second equation gives the world demand for manufactures and is, in fact, equivalent to ROW's IS function. First, Canada's smallness implies she has a negligible impact on world demand for manufactures so that neither her GNP nor the relative price of her final goods, widgets, enters this equation. Second, for the usual reasons, assume demand for manufactures in ROW or OPEC depends negatively on the real interest rate and positively on their respective real gross national income. Third, let $Y^* = e^{Q^*}$ be the level of manufacturing output so that, from above, $(1-\gamma^*)Y^*$ and γ^*Y^* are, respectively, ROW and OPEC real GNPs. Then, demand for manufactures becomes: $Y^d = C[(1-\gamma^*)Y^*;r^*] + D(\gamma^*Y^*;r^*)$, where C and D are, respectively, ROW and OPEC demands each with a marginal spending propensity less than unity. Letting supply equal demand (i.e., $Y^d = Y^*$), this expression can be solved for Y^* and log-linearized to obtain the above "IS" function. The intercept, D_0^*, captures the influence of exogenous elements of demand, such as fiscal policy.

(d) Foreign Equilibrium

As shown above, ROW and OPEC real GNPs are each fixed proportions of manufacturing output which, in turn, is identical to combined ROW-OPEC real GNP. For simplicity, therefore, I refer to Q^* as "foreign", as distinct from Canadian, real GNP. Moreover, it will be convenient to call a hike in oil's marginal cost, ε, an oil shock while referring to hikes in α^*, D_0^* and M^* as, respectively, supply, demand and monetary shocks.

Now, expressions (4), (9) and (10) can be simultaneously solved for the equilibrium values of foreign real GNP, the foreign interest rate and the price of manufactures.

$$(11)\quad \begin{cases} Q^* = A_0^* + A_1^*.\alpha^* - A_2^*.\varepsilon \\ r^* = (D_0^* - A_0^* - A_1^*.\alpha^* + A_2^*.\varepsilon)\lambda \\ P^* = M^* - L_0^* + \lambda L_1^*.D_0^* + (1+\lambda L_1^*).(A_2^*.\varepsilon - A_0^* - A_1^*.\alpha^*] \end{cases}$$

where $\lambda = 1/D_1^* > 0$; $A_0^* = -Ba < 0$; $A_1^* = (A-cB) > 0$; and $A_2^* = bB > 0$.

First, by raising oil's real price, an oil shock, ε, reduces foreign real GNP. The IS curve then indicates the interest rate must rise to clear the product market. The fall in GNP and the rise in the interest rate conspire to reduce the demand for real balances, requiring a rise in ROW's price level, P^*, to clear the money market. Second, for the usual reasons, a positive supply shock, α^*, raises real GNP which then requires a fall in the interest rate to clear the product market. Both these changes raise real money demand requiring a fall in P* to clear the money market. Third, a demand shock, D_0^*, is accompanied by complete crowding out, serving only to raise the interest rate thereby reducing real money demand and raising prices. Lastly, for the usual reasons, money is neutral with a hike in the nominal money stock merely generating a proportionate price hike.[5]

This completes the specification of the world economy in which the small open economy, Canada, is imbedded. I now turn explicitly to consider Canada.

II. The Canadian Economy

Canada is a small open economy (SOE) who produces two traded goods, oil and widgets. Widget production uses variable amounts of labour and oil but oil production uses only one variable factor, labour. The capital stocks are fixed in each sector, in the short run. Consumption comprises two final goods, widgets and manufactures. As before, financial capital is perfectly mobile among nations. Lastly, the Canadian authorities may follow an explicit policy of maintaining oil's price below the world level.

(a) Production and Real GNP

Let Q and Ø be the production of, respectively, widgets and oil while defining N as the total labour force and H as the employment of oil in widget production. As before, all variables are measured as natural logarithms. The total labour force is divided between the two sectors in the proportions X and (1-X), where X is the fraction of labour devoted to widget production. If $x = \ln X$, one finds that $\ln(1-X) \simeq -X = -e^x$ so that the logarithm of labour put into the oil and widget sectors is, respectively, $(N-e^{x})$ and $(N+x)$.

Assume the following two log-linear production functions:

$$(12)\quad \begin{cases} Q = \alpha + \beta.(N+x) + \gamma.H & \beta,\gamma > 0;\ \beta+\gamma \leq 1 \\ \emptyset = d + \delta.(N-e^{x}) & 0 < \delta < 1 \end{cases}$$

Let W, R and P be the (log of) domestic prices of, respectively, labour, oil and widgets. Then oil's relative domestic price will be $\tau = (R-P)$ while there exist two real-product wages, $w = (W-P)$ and $(W-R) = (w-\tau)$. The usual marginal productivity conditions for competitive firms imply the following factor demands:

$$(13)\quad \begin{cases} \ln\beta + Q - (N+x) = w \\ \ln\gamma + Q - H = \tau \\ \ln\delta + \emptyset - (N-e^{x}) = w - \tau \end{cases}$$

I also assume that aggregate labour supply is positively related to the real consumption wage, $(W-\pi)$, where π is the consumer price index (CPI), according to the following log-linear labour supply curve:

$$(14)\quad w + P - \pi = g + h.N \qquad h > 0$$

Finally, let P* and E be the ROW-currency prices of, respectively, manufactures and Canadian currency. Then, the Canada-ROW terms-of-trade and the CPI are defined by, respectively:

$$(15)\quad \begin{cases} T = E + P - P^{*} \\ \pi = \mu P + (1-\mu)(P^{*}-E) = P - (1-\mu).T \end{cases}$$

where μ is the share of widgets in Canadian consumption.[6] As well, T gives the relative price of the world's only two final goods, widgets and manufactures. I therefore call it the terms-of-trade.

Lastly, nominal GNP or, identically, value-added will be the sum of nominal oil output plus nominal widget output net of the oil bill. For macropolicy purposes, interest centers on real GNP which, from a sensible welfare viewpoint, ought to be measured in terms of the consumption bundle. Therefore, if K is the log of nominal GNP, I define the log of real GNP as: $q = K - \pi$. Making use of expression (15), one obtains:

$$(16) \quad \begin{cases} q = (1-\mu).T + \ln[e^{V} + e^{(\tau+ \emptyset)}] \\ V = \ln(1-\gamma) + Q \end{cases}$$

where, by log-linear technology, V is the log of value-added in widget production, measured in terms of widgets. As well, $(\tau+\emptyset)$ is the widget-value of domestic oil output.

For given values of τ and T, equations (12) to (16) can be solved for q, Q and $\emptyset$. Given that these solutions are approximately log-linear, the Appendix shows that:

$$(17) \quad \begin{cases} q = q_0 + q_1.\tau + q_2.T + q_3.\alpha \\ Q = Q_0 - Q_1.\tau + Q_2.T + Q_3.\alpha \\ \emptyset = \emptyset_0 + \emptyset_1.\tau + \emptyset_2.T - \emptyset_3.\alpha \end{cases}$$

where q_1 is, a priori, indeterminate but all other q_j, Q_j and $\emptyset_j$ are positive.

First, for obvious reasons, a hike in oil's relative price, other things constant, raises oil output but reduces widget output, since widgets use oil as an input. On balance, real GNP may rise or fall. The larger is the oil sector, relative to the widget sector, the greater is the likelihood that real GNP rises. Second, a rise in the terms-of-trade, T, lowers the CPI, according to (15), which raises labour supply and reduces the nominal wage. By raising labour put into both sectors, this must raise widget and oil output, as well as real GNP. Third, a neutral hike in widget-productivity, α, raises widget but lowers oil output. Nonetheless, on balance, real GNP rises. The fall in oil output results from the fact that expansion of the widget sector puts upward pressure on the nominal wage rate and, thereby, on oil's production costs. Lastly, for future reference, the Appendix shows that net oil exports rise with a hike in τ but fall with a hike in T or α.

(b) The Demand Sector

The Canadian demand sector is simply a Fleming-Mundell model of an SOE facing perfect capital mobility and a flexible exchange rate. First, recall that rationality combined with the model's assumed underlying stochastic structure implies static expectations. This means Canadian nominal and ex ante real interest rates will be identical to the foreign ex ante real rate, r^*.[7] Second, I assume the authorities follow a policy whereby domestic may lie below world oil prices. This requires paying subsidies to net oil importers. If such subsidies are financed via taxation (borrowing) they will (not) alter disposable income. Third, I assume zero currency substitution and, for simplicity, that wealth effects are negligible.

I assume a conventional, log-linear LM curve.

$$(18) \qquad M = L_o + (q + \pi) - L_1 . r^* \qquad L_1 > 0$$

where M is the nominal money stock, r* is, with static expectations, the nominal interest rate and, for simplicity, nominal money demand is unit-elastic with respect to nominal income, $(q+\pi)$.

Next, consider the IS curve. Define Y, Y_d, G and B as the levels (not logs) of, respectively, real GNP, disposable income, world widget demand and net oil exports, all measured in terms of widgets. Then, by the national income identity, Y = G+B. I assume, conventionally, that world widget demand rises with domestic disposable income and foreign real GNP while falling with a hike in the real interest rate or the terms-of-trade. I have already shown that net oil exports rise with oil's relative price but fall with a hike in the terms-of-trade or widget productivity. Lastly, let $\rho = (R^*-E-R)$ so that $z = e^{\rho} \geqq 1$ is the ratio of world to domestic oil prices. It is then a simple matter to show that the widget-value of oil subsidies will be $(1-z)B$ when $B < 0$. Then, disposable income will be $Y_d = Y + (z-1)B$ when oil subsidies are financed by taxes and $Y_d = Y$ when subsidies are financed by government borrowing or when there are no subsidies (i.e., when $B \geqq 0$). In short,

$$(19) \qquad \begin{cases} Y = G(Y_d, T, r^*, Q^*) + B(\tau, T, \alpha) \\ Y_d = Y + (z-1).B(\tau, T, \alpha) \qquad \text{but } Y_d = Y \text{ if } (z-1)B \geqq 0 \end{cases}$$

where, $(G_1, G_4, B_1) > 0$ and $(G_2, G_3, B_2, B_3) < 0$. Solve (19) for Y to produce an IS curve in (Y, r^*)-space. Log-linearize this solution and recall that the log of real GNP (or GNE) is given as: $q = \ln Y + P - \pi = \ln Y + (1-\mu)T$. One then obtains the following log-linear IS curve:

$$(20) \qquad q = F_o + F_1.\tau - F_2.T - F_3.\alpha - F_4.r^* + F_5.Q^* - F_6.\rho$$

where, the Appendix shows, F_j is non-negative, for all j. But $F_6 = 0$ if oil subsidies are financed by borrowing, rather than by taxes, or if $B \geqq 0$.

First, the IS curve is negatively-sloped in (q, r^*)-space and rises with foreign real GNP, Q^*, for the usual reasons. Second, any variable which raises net oil exports and/or reduces taxes must raise GNE. This accounts for the noted effects of τ, α, ρ and, partly, T. Third, a hike in the terms-of-trade, T, also leads the world's consumers to shift out of widgets in favour of foreign manufactures. Combined with the above-noted effect on the oil trade balance, Y must fall. But, for any given widget value of GNE, Y, a rise in T reduces the CPI thereby raising real GNE, q. Though T's net effect on real GNE is, a priori, indeterminate, I assume it to be negative.[8] Lastly, the intercept, F_o, captures the influence of all other exogenous variables, such as fiscal policy, which impact on GNE.[9]

(c) Aggregate Supply and Demand

The ROW-currency price of oil, R^*, is exogenous to Canada. From her viewpoint, oil's world price will be (R^*-E). The government sets oil's domestic price according to the indexing scheme:

$$(21) \qquad R = \theta + (1-t).\pi + t.(R^*-E)$$

where $0 \leqq t \leqq 1$ and $\theta \leqq 0$. Thus, oil's price is set as a fraction of a geometrically-weighted average of the CPI and oil's world price. When t = 1, oil's domestic price is perfectly indexed to world oil price changes, with θ giving the extent to which the world exceeds the domestic oil price level. When t = 0, R is indexed only to the CPI with θ indicating the governments permitted "real" oil price, R-π. Of course, when $\theta = 0$ and $t = 1$, world and domestic oil prices would be identical. Since θ and t are exogenous policy parameters, a hike in either constitutes a domestic "oil shock".

Define the positive parameter $\omega = (1-\mu+\mu t)^{-1}$ and recall that world relative to domestic oil prices are $\rho = (R^*-E-R)$. Then, expression (15) and (21) together imply that

$$(22)\quad \begin{cases} T = \omega(\theta - \tau + t.\tau^*) \\ \rho = -\omega\theta + (1-\mu)(1-t).\tau^* + (1-t).\tau \end{cases}$$

It is assumed that the authorities do not permit domestic to exceed world oil prices so that ρ's maximum value is zero.[10]

Now, the values of τ^*, r^* and Q^* are given by expressions (9) and (11). These, along with expression (22), can be substituted into the real GNP function in expression (17) and into the IS curve, equation (20).

$$(23)\quad \begin{cases} q^s = A_o - A_1.\tau + A_2.\theta + q_3.\alpha + tA_2.(b\varepsilon + c\alpha^*) \\ q^d = D_o + D_1.\tau - D_2.\theta - F_3.\alpha - D_4.\varepsilon - D_5.\alpha^* - D_6.D_o^* \end{cases}$$

where, $q^s = q^d = q$. The Appendix shows that D_5 is, a priori, indeterminate; but all other D_j and all A_j are unambiguously positive. Henceforth, I call these two expressions, respectively, the aggregate supply and demand curves.

First, T and ρ both fall with a rise in oil's relative price or with a domestic oil shock. After accounting for these effects, a rise in τ

or a fall in θ unambiguously lowers (raises) aggregate supply (demand). Second, these effects on the terms-of-trade now imply aggregate supply rises with any positive supply or oil shock, be it of domestic or foreign origin. Third, by raising the world interest rate, the foreign demand shock, D_0^*, lowers domestic aggregate demand. By reducing net oil exports, so too does the domestic supply shock, α. Fourth, an OPEC oil shock, ε, was earlier seen to raise r^* and τ^* while lowering Q^*; on all accounts, it lowers aggregate demand. Fifth, a foreign supply shock, α^*, raises Q^* and lowers r^*, tending to raise aggregate demand; at the same time, it raises τ^* which tends to reduce aggregate demand by raising T and ρ. On balance, its impact is ambiguous. Lastly, the Appendix shows that aggregate supply is higher, but aggregate demand is indeterminate, the higher is the oil indexing parameter, t.

III. EQUILIBRIUM AND EXOGENOUS SHOCKS

The real side of the domestic economy is completely characterized by the aggregate supply and demand functions, expression (23). These can be solved for real GNP and oil's relative domestic price. Given such solutions, all other real and nominal magnitudes can be determined from the underlying equations and/or definitions. Complete solutions are given in the Appendix with the results summarized in Table I. Here, it will suffice to discuss the solutions in simple geometric terms.

The aggregate supply and demand curves are plotted in Figure Ia. The relationship between real GNP and the CPI, given by equation (18), is plotted as the LM curve in Figure Ib. This curve is shifted rightward by a hike in the domestic money stock or in the world interest rate. The TT curve

Table I: Effects of Exogenous Shocks

	D_o	θ	α	ε	α^*	D_o^*	t	M	M*
q	+	+(?)	?	-(?)	+(?)	-	?	0	0
Q	+	?	+	-	+(?)	-	?	0	0
Ø	-	+	-	+	-(?)	+	+	0	0
τ	-	+	+	+	-(?)	+	?	0	0
T	+	+	-	-(?)	+(?)	-	?	0	0
π	-	-(?)	?	+(?)	-(?)	+	?	+	0
P	-	-(?)	?	?	-(?)	+	?	+	0
E	+	+(?)	?	?	?	?	?	-	+
q*	0	0	0	-	+	0	0	0	0
r*	0	0	0	+	-	+	0	0	0
p*	0	0	0	+	-	+	0	0	+

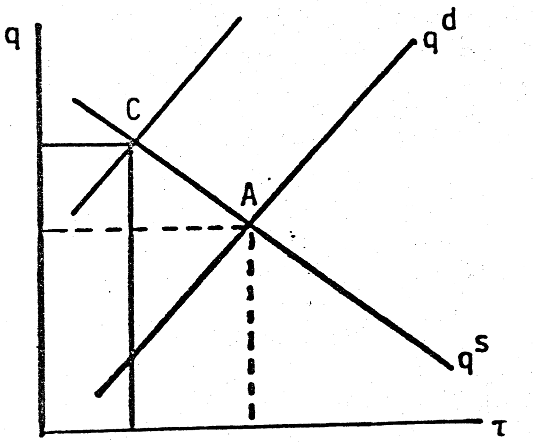
Notes: Bracketed signs refer to the cases where; in Column θ, $q_1 > 0$; in Column ε, $t \neq 0$; in Column α^*, $t \neq 0$ and $F_6 \neq 0$

In any of these columns, the bracked is replaced by the unbracketed sign when aggregate supply rises by more than aggregate demand falls.

in Figure Ic plots the relationship between the terms-of-trade and oil's relative domestic price given by expression (22). It is shifted upward by a domestic oil shock, θ, or, when $t \neq 0$, by a hike in oil's foreign real price, τ^*. Lastly, by defnition, $T = E+P-P^*$ while $\pi = P+(\mu-1)T$. This implies that: $T = [(E-P^*) + \pi]/\mu$. The EE curve in Figure Id plots this positive relationship between the terms-of-trade and the CPI. It must always pass through the (T,π) combination determined by Figures Ia to Ic; this is insured by the appropriate endogenous value for $(E-P^*)$. For a constant P^*, a rise in the EE curve indicates an exchange appreciation and vice versa. The general equilibrium is illustrated by points A in figure I. I now consider the comparative static effects of particular shocks.

First, money is neutral. A hike in the domestic money supply, M, simply raises the LM curve and, thereby, the CPI. With T and P^* unaltered, the EE curve shifts rightward implying a proportionate exchange depreciation. As well, since T is unaffected, the hike in the CPI must all be the result of a rise in the price of widgets, P. The new equilibrium is illustrated by points B in Figures Ib and Id and by points A in Figures Ia and Ic.[11] A hike in the foreign money stock, M^*, was earlier shown simply to raise the price of manufactures, P^*, initially shifting the EE curve rightward. But, since π and T are unaltered, there is simply a proportionate exchange appreciation which restores $(E-P^*)$ and, thereby, the EE curve to their prior levels. Hence, the original equilibrium at point A is undisturbed. Of course, this illustrates the well-known insulation properties of a flexible exchange rate.

Second, a positive domestic demand shock, D_0, simply raises the aggregate demand curve, moving the equilibrium from points A to points C in Figure I. Real GNP, the terms-of-trade and the exchange rate all rise while



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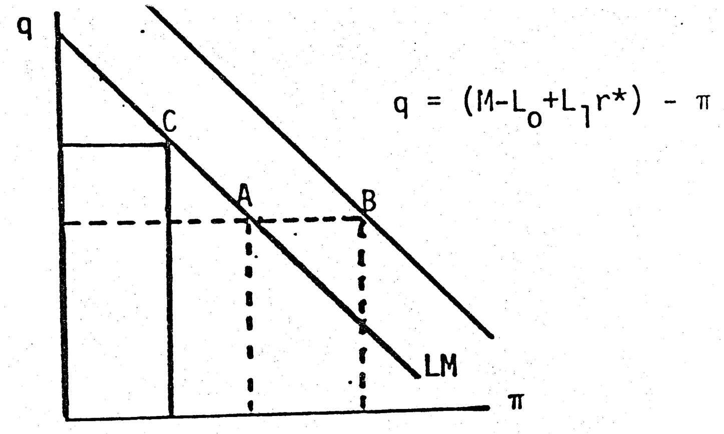
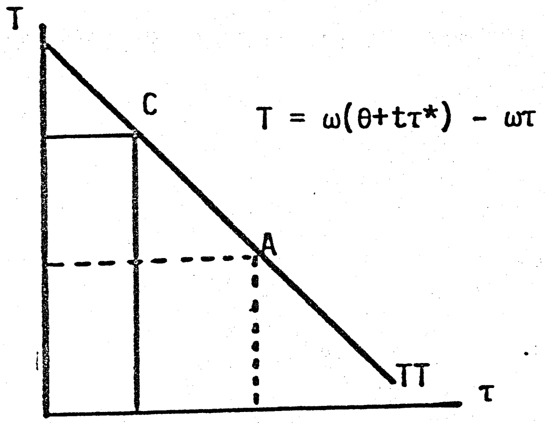
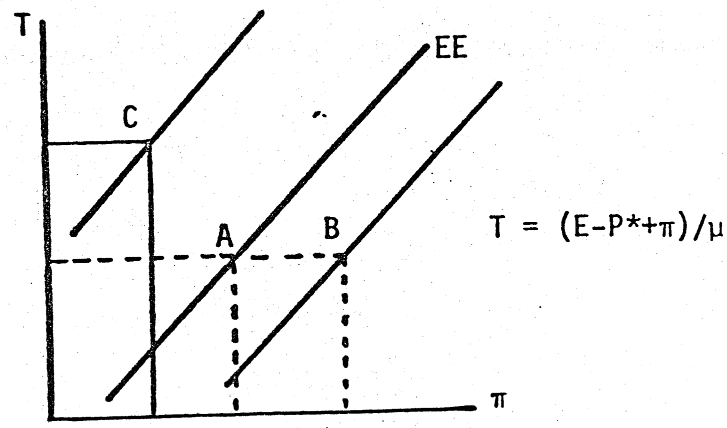


Ib



Ic



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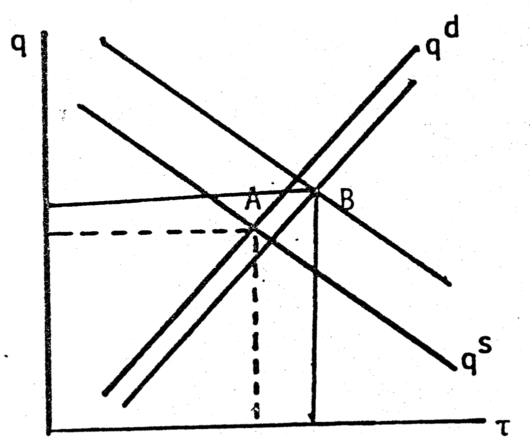
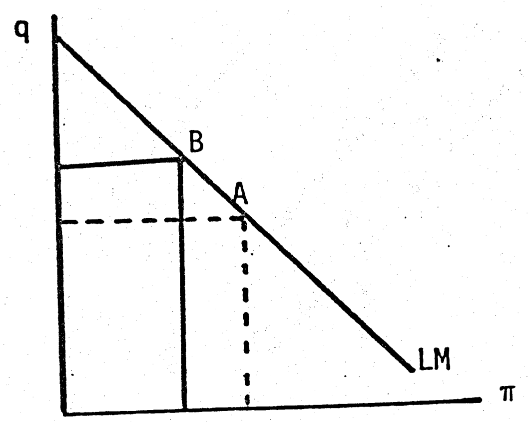


2a



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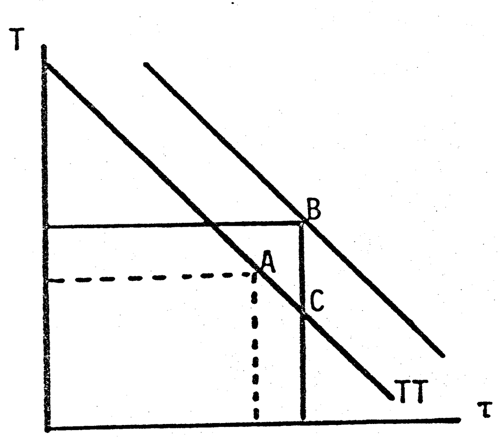

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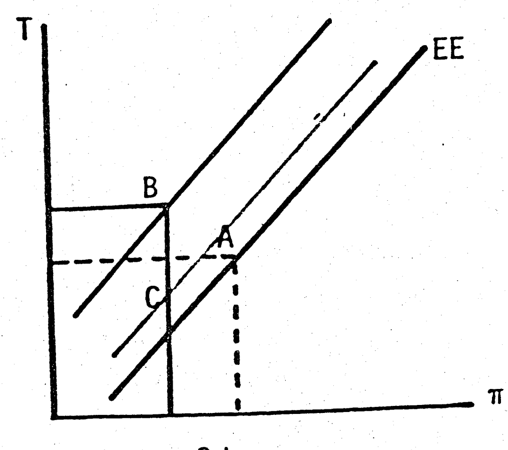


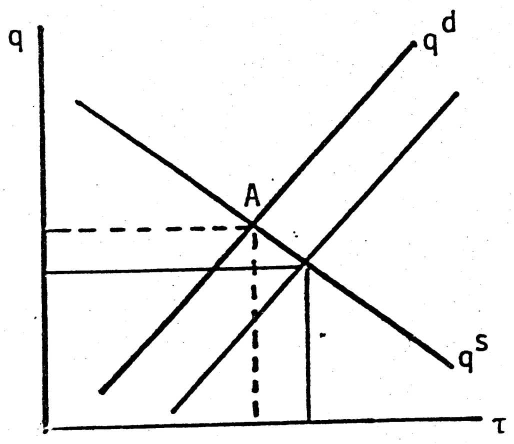
2d

the CPI and oil's relative price fall.[12]

Third, a domestic oil shock, θ, raises aggregate supply and the TT curve but lowers aggregate demand. Geometry will suggest that oil's relative price and the terms-of-trade unequivocally rise but all other magnitudes are, a priori, indeterminate. Nonetheless, the Appendix shows that real GNP rises and, therefore, the CPI falls while the exchange rate appreciates when q_1 is not positive; that is, holding the terms-of-trade constant, when a rise in oil's relative price would not raise real GNP. This will be the case when oil's share of GNP is not overly large. This case is illustrated by the move from points A to B in Figure 2.

Fourth, a domestic supply shock, α, also raises aggregate supply but lowers aggregate demand. However, it has no impact on the TT, LM or EE curves. This must raise oil's relative price, reduce the terms-of-trade and leave all other magnitudes indeterminate, a priori. Should real GNP rise (fall) the CPI would fall (rise) while the exchange rate would be indeterminate (lower). The case where real GNP rises is illustrated by the move from points A to B in Figures 2a and 2b and from A to C in Figures 2c and 2d. In this example, the exchange rate has risen; but, given the slopes of the various curves, there is no guarantee that point C will not lie below the original EE curve.

Fourth, a foreign demand shock, D_0^*, was earlier shown to raise the world interest rate and foreign price level. Thus, the aggregate demand and LM curves shift rightward, as in Figure 3. Real GNP and the terms-of-trade fall while oil's relative price and the CPI rise. With T lower and π higher, there must be a fall in E-P* to insure the EE curve shifts rightward; since P* has risen, the required move in the exchange rate is, a priori, unknown. Moreover, for the moment, assume world oil price changes are not passed through to



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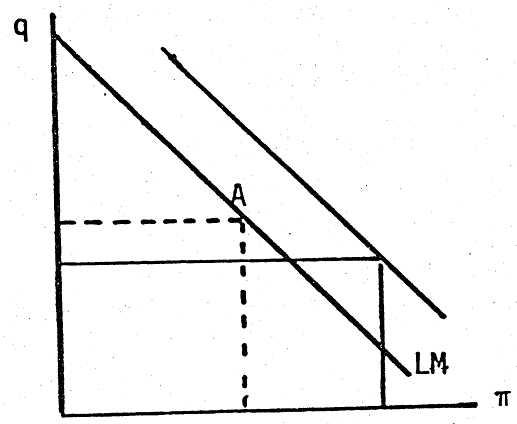

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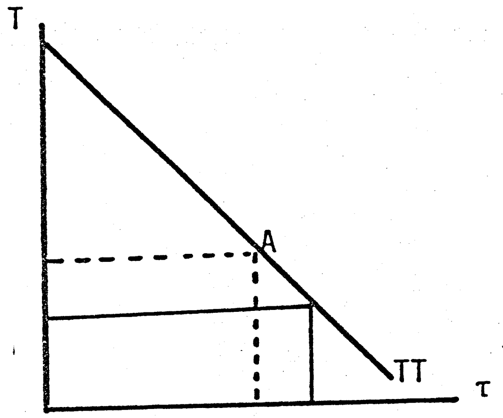

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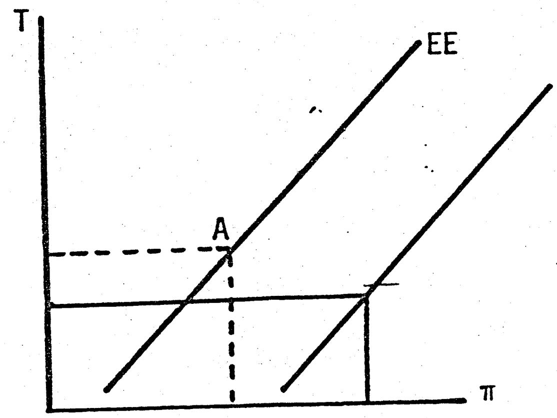

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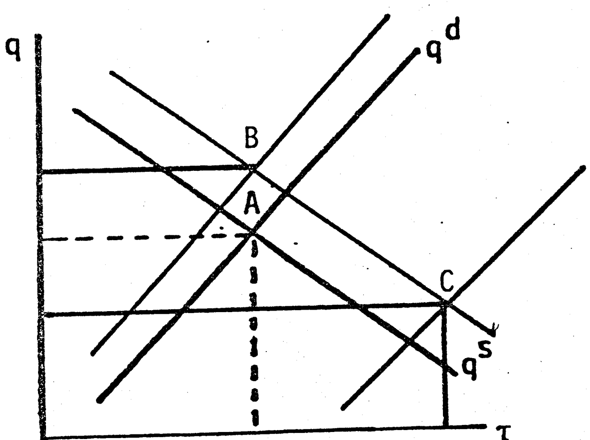

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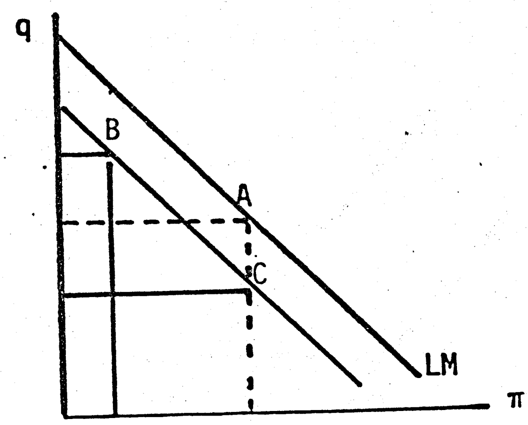

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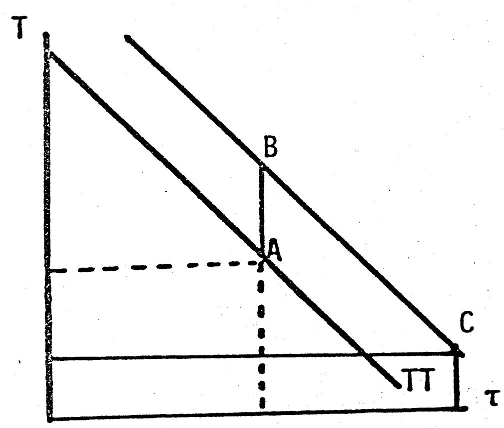

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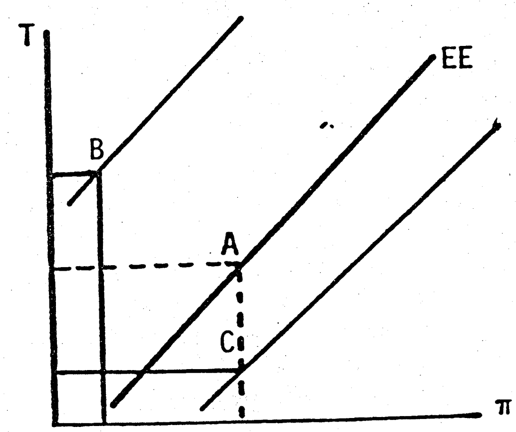
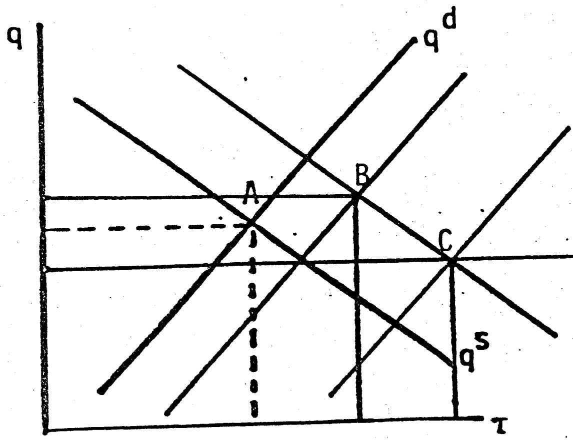


4d

the domestic economy, so that t = 0. Then an OPEC oil shock, ε, simply lowers aggregate demand and raises the world interest rate. It must, therefore, have a qualitatively identical effect on the domestic economy as a foreign demand shock. Lastly, a foreign supply shock, α^*, was seen to have an ambiguous effect on aggregate demand but to lower the world interest rate. Were it to raise aggregate demand, which is the case when taxes needed to pay oil subsidies are not overly large, it would have precisely the opposite qualitative effects on the domestic economy to a foreign demand shock. Otherwise, geometry suggests that, with the exception of leaving the CPI indeterminate, it has the same qualitative effects as a foreign demand shock.

Sixth, assume domestic are indexed to world oil prices, so that $t \neq 0$. A foreign supply or an OPEC oil shock will now raise aggregate supply and, by a hike in $t\tau^*$, the TT curve. As well, each has the above-noted effects on aggregate demand, the world interest rate and the foreign price level. Then, an OPEC oil shock unambiguously raises oil's relative price but leaves all other domestic variables, a priori, indeterminate. Should aggregate supply rise proportionately more than aggregate demand falls, real GNP would rise; otherwise, real GNP would fall and the CPI would rise. These two possible cases are illustrated by, respectively, points B and C in Figure 5. To avoid undue complication, I have drawn this figure such that the CPI always rises while the move from A to B implies an exchange appreciation in proportion to the foreign price hike. Obviously, with aggregate demand indeterminate, a foreign supply shock leaves all domestic variables indeterminate, a priori. Should aggregate demand rise or should it fall proportionately less than aggregate supply rises,



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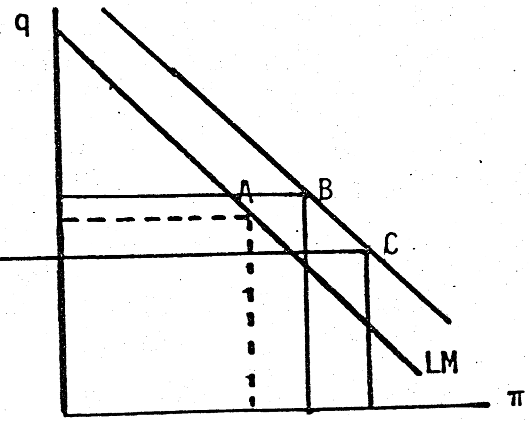

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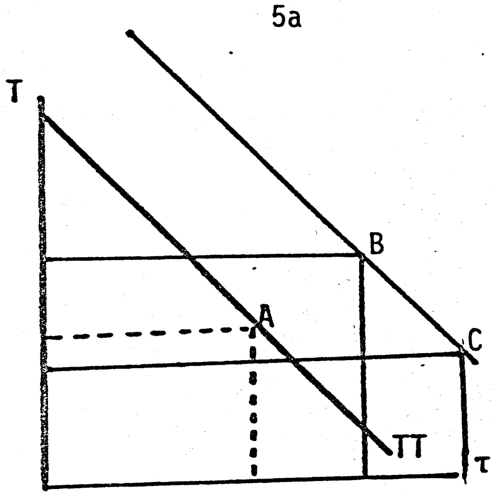

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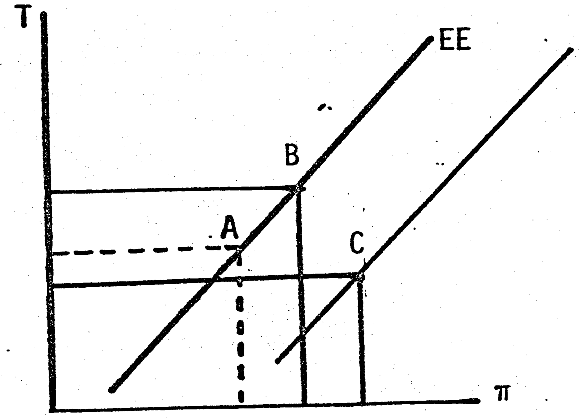

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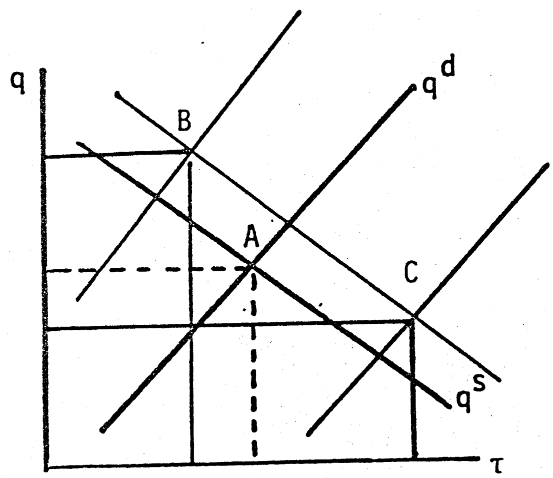

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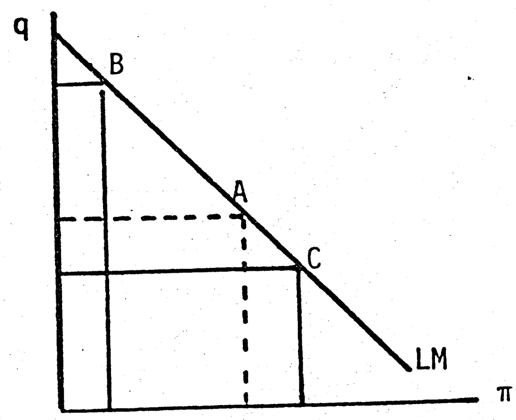

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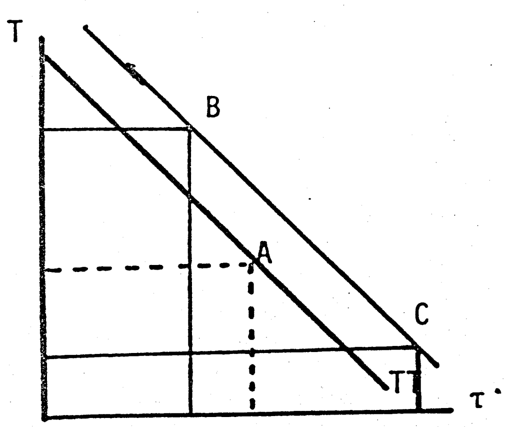

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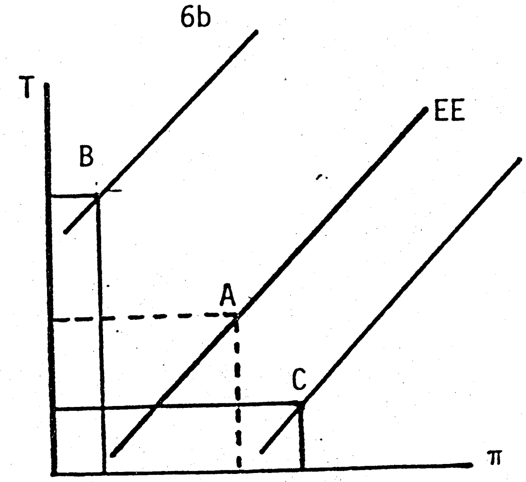

6d

real GNP would rise and the CPI would fall. Should demand fall by more than supply rises, real GNP would fall and oil's relative price would rise. In either case, unmentioned domestic variables would be, a priori, indeterminate. As the Appendix indicates, aggregate demand is most likely to rise, particularly if taxes and/or demand's T-elasticity are relatively low. In fact, it unambiguously rises when the indexing parameter, t, is zero and oil subsidies are financed by borrowing. This is because the foreign supply shock would then influence domestic aggregate demand only via its accompanying lower world interest rate and higher foreign GNP. In the move from A to B, Figure 4 illustrates this case. The move from A to C illustrates a case where demand falls by more than supply rises.

Next, suppose t were higher so that domestic were more closely tied to world oil prices. This would alter the structure, not simply the level, of the aggregate demand, aggregate supply and TT curves. First, the TT curve is given as: $T = \omega(\theta+t\tau^{*}-\tau)$, where $\omega = (1-\mu+\mu t)^{-1}$. Then, with t higher, this curve would be higher and steeper. Second, with T higher, ceteris paribus, and ω lower, the aggregate supply curve would be higher and steeper. Third, the higher T and lower ω tend to lower, but steepen , the aggregate demand curve. On the other hand, with domestic closer to world oil prices, taxes, if any, needed to finance oil subsidies will be lower; this tends to raise and to flatten the aggregate demand curve. On balance, effects on aggregate demand are, a priori, ambiguous. Nonetheless, aggregate demand is higher and/or flatter <u>only</u> if oil subsidies are tax financed.[13] In Figure 6, point B illustrates a case where oil subsidies are tax-financed such that a higher t implies higher aggregate demand. Point C illustrates a case where, regardless of the method of financing oil subsidies, aggregate demand falls by more than aggregate supply rises. Lastly, while all variables are, a priori, indeterminate, a higher t is more likely to imply higher (lower) real GNP (CPI) when oil subsidies are tax, rather than bond, financed.

To the extent that any shock, foreign or domestic, adversely affects real GNP and/or the CPI, it does so by reducing aggregate demand, not supply. At worst, any shock leaves aggregate supply unaltered. This, for example, is the case with foreign or domestic demand shocks. Consider oil and domestic (foreign) supply shocks which raise aggregate supply but (may) lower aggregate demand. I have shown that the higher is the oil-indexing parameter, t, the more (less) would any such positive shock raise (lower) aggregate supply (demand). Thus, while a higher t <u>might</u> imply higher (lower) levels of real GNP (CPI), it will tend to offset (support) the possibly adverse (salutory) effects of such shocks. In short, indexing domestic to world oil prices may, in the face of particular exogenous shocks, be stabilizing or destabilizing. In principle, there exists an optimal value for t.[14]

Finally, any of the above shocks will alter the composition, not only the level, of real GNP. Exogenous hikes in aggregate demand, be they of domestic or foreign origin, raise widget but reduce oil output. With the oil sector being a price-taker, a hike in aggregate demand is, simply a hike in widget demand. Thus, oil production must shrink to release the resources necessary for expansion of the widget sector. Ultimately, this is accomplished by a rise in the terms-of-trade and a fall in oil's relative price.[15] For similar reasons, a hike in widget productivity, α, also raises widget but lowers oil output. Moreover, regardless of its origin, a positive oil shock raises oil output. But the domestic oil shocks, θ and t, may also raise widget output.

While such shocks initially raise oil's relative price, they may also raise the terms-of-trade enough that, on balance, widget output is stimulated. Of course, were this the case, real GNP would unambiguously rise.

IV. CONCLUSIONS

I have investigated the macroeconomic effects of exogenous oil and other shocks on a small open economy (SOE) which is, itself, an oil producer. The SOE was imbedded in a world economy in which oil's world price was set by a dominant-firm-type monopolist, OPEC. This meant that disturbances originating in either OPEC or the rest-of-the world would, in general, alter all foreign variables and, thereby, domestic aggregate demand and supply. As well, the domestic authorities did not necessarily permit domestic to follow world oil prices. While interest centered primarily on domestic real GNP and the CPI, the composition of these magnitudes was also considered.

First, with respect to domestic or foreign demand and monetary shocks, my results do not materially differ from those found in the literature on SOEs which are not oil producers.[16] Because oil's domestic price was partially indexed to the CPI, domestic money was neutral; the flexible exchange rate makes foreign money neutral. A hike in domestic demand raised real GNP and widget output while lowering the CPI, oil output and widget prices. Just the opposite occurred with a foreign demand disturbance. Second, all other shocks had, a priori, ambiguous effects on the domestic economy. This was because they tend to move domestic aggregate demand and supply in opposite directions.

With an OPEC-originated oil shock, the domestic economy found itself caught in a world-wide recession since higher world oil prices raised the world interest rate and reduced foreign real GNP both of which effects conspired to reduce domestic aggregate demand. But the implied adverse effects on real GNP and the CPI would be moderated, or even reversed, by positive supply-side effects were domestic permitted to follow world oil prices. Nevertheless, such moderation may be at the expense of even lower (higher) widget output (prices). Next, were the oil sector not too large, the authorities could raise real GNP and lower the CPI while, possibly, also raising widget output by permitting a one-shot hike in oil's domestic price; that is, through the domestic oil shock, θ. Lastly, by raising aggregate supply but (possibly) lowering aggregate demand, a domestic (foreign) supply shock had ambiguous domestic effects.

The effects of supply and oil shocks are also sensitive to the domestic oil-pricing policy and to its financing method. The possible desirable (adverse) effects of any such positive shock on real GNP and the CPI would be undercut (accentuated) the less closely do domestic follow world oil prices and/or when oil subsidies are tax, rather than bond, financed. Of course, just the opposite would be the case when such shocks are negative. This led me to the unexplored possibility of an optimal oil-price indexing policy. To the extent that the SOE is continually buffetted by both foreign and domestic shocks, it is clear that, in general, the optimal value of t would be neither zero nor unity. Moreover, were the government's goal simply to resist declining (rising) real GNP (CPI) in the face only of OPEC oil shocks, my results suggest it would be appropriate to follow oil's world price when it rises but not when it falls.

FOOTNOTES

1. One finds that: $Z^* = (1-\beta^*-\gamma^*)(1+h^*)+\beta^*h^* > 0$; $A = (1+h^*)/Z^* > 0$; $B = \gamma^*A > 0$; $\eta = (1+h^*+\beta^*)/Z^* > 1$; $C = [\beta^*(\ln\beta^*-g^*)-(1+h^*)\ln\gamma^*]/Z^*$; and $D = (\beta^*\ln\gamma^*/Z^*)-C$.

2. This assumption is immaterial provided oil revenues and costs are given in the same currency, which they are.

3. It makes no material difference when the monetary growth rate and, thereby, the expected future inflation rate is non-zero, so long as shocks to the monetary growth rate are permanent and currently observed.

4. Ignoring distribution effects, Q^* may also be the appropriate transaction variable were there currency substitution in OPEC portfolios or were transactions balances held by manufacturers to finance inputs.

5. Of course, money is neutral because current monetary shocks are observed.

6. In general, μ is variable. However, it will be constant, as I assume, if domestic preferences for final goods are Cobb-Douglas.

7. The usual interest-arbitrage condition indicates that, with static future exchange rate expectations, domestic and foreign nominal interest rates will be identical. Static money stocks and, thereby, future inflationary expectations then imply one world ex ante real interest rate. Nonetheless, were I to permit differing foreign and domestic monetary growth rates and, thereby, expected future inflation rates, nominal (but not real) interest rates would differ.

8. This assumption is related, but not identical, to the Marshall-Lerner condition. Nevertheless, real GNE may, therefore, be quite T-inelastic.

9. Note that I apparently ignore possible effects of the debt-service account on GNE. However, if the domestic nation is a net debtor, such effects are partly captured in the real interest rate's negative effect on GNE.

10. In fact, prior to 1973, Canadian were often above world oil prices which required subsidizing net oil exports. This creates no problem for my model if export subsidies are bond-financed or net oil imports are positive.

11. Unlike ROW's case, domestic money is neutral largely because oil's price is indexed to the CPI, not because current monetary shocks are observed. Were oil's price fixed or were it partially indexed only to world oil prices, a hike in the money stock, by raising P, would lower oil's relative domestic price, R-P, with consequent real effects. However, with the flexible exchange rate, money would be neutral with full indexation to world oil prices.

12. The apparently perverse result that a hike in aggregate demand lowers the CPI and appreciates the exchange rate was originally documented by Findlay and Rodriguez (1977).

13. With respect to the slopes of aggregate supply and demand, the Appendix shows that their τ-elasticities are, respectively: $A_1 = (q_1 + \omega q_2) > 0$ and $D_1 = [F_1 + \omega F_2 + (t-1)F_6] > 0$, where ωq_2 and $\omega(F_2 - F_6) > 0$ are the T-elasticities of, respectively, supply and demand.

14. The value of t (or θ) might be chosen along lines suggested in the optimal wage-indexing literature. For example, see Gray (1976).

15. Similar effects would obtain for a domestic monetary shock, were oil's price not indexed to the CPI and only partially indexed to oil's world price.

16. For examples, see Bruno & Sachs (1979), Findlay & Rodriguez (1977), Harkness (1982), or Schmid (1976;1979).

APPENDIX

A. Domestic Production

Define the positive magnitudes: $j = \beta+\gamma$; $\phi = 1-j$; $k = 1+X+hX$; $D = (1-\delta)[\beta hX+\phi(1+X+h)]+\phi h$; $y = e^{(\tau+\emptyset)}/Y$; and $s = e^{Q}/Y$; where Y is the widget-value of real GNP. Then y and $(1-y) < s$ are the shares of, respectively, oil and widget values-added in GNP. I assume $(1-y) \geqq 1/2$. Then, the coefficients in expression (17) are, by the Implicit Function Theorem:

$Q_1 = [\gamma(1-\delta)k+jh]/D$; $Q_2 = (1-\mu)(1-\delta)(1+X)/D$; $Q_3 = [(1-\delta)k+h]/D$; $\emptyset_3 = hX/D$; $\emptyset_1 = [\phi\delta(1+X)+hX]/D$; $\emptyset_2 = \delta\phi Q_2$; $q_1 = y(1+\emptyset_1)+(y-1)Q_1 = ?$; $q_3 = (1-y)Q_3-y\emptyset_3$; $q_2 = (1-\mu)+(1-y)Q_2+y\emptyset_2$. Excepting q_1, each of these coefficients is positive. q_1 will be negative when the oil sector (i.e., y) is relatively small.

The widget value of the level (not log) of net oil exports will be: $B = e^{\tau}[e^{\emptyset}-e^{H}] = Y-e^{Q} = (1-s)Y$. Then, $B = B(\tau,T,\alpha)$ where $B_1 = Y(q_1+sQ_1) > 0$, $B_2 = Y(q_2-sQ_2+\mu-1) < 0$ and $B_3 = Y(q_3-sQ_3) < 0$ since $s > (1-y)$.

B. Domestic IS Curve

The IS curve implied by solving system (19) takes the form: $pY = F(\tau,-T,-\alpha,-r^*,Q^*,-\rho)$, where $p = e^{(P-\pi)} = e^{(1-\mu+T)}$. Define the positive magnitudes: $J = (1-G_1)^{-1}$ and $m = J[1+(z-1)G_1]$ where, from (19), $G_1 < 1$ is the MPC and $z = e^{\rho}$. It can be shown that the (constant) elasticities of the log-linear IS curve, expression (20), are: $F_1 = mB_1/Y$; $F_2 = -[(mB_2+JG_2)/Y] + (\mu-1)$; $F_3 = -mB_3/Y$; $F_4 = -r^*JG_3/Y$; $F_5 = JG_4Q^*/Y$; and $F_6 = z|B|G_1/Y$. B_j is given in Section A while G_j is defined in system (19). F_2 is assumed positive while all other F_j are, a priori, positive. As well, it can be seen that $(F_1,F_2) > F_6$ while $F_6 = 0$ and $m = J$ when oil subsidies are bond-, not tax-, financed.

C. Aggregate Supply and Demand

Define the positive magnitudes: $V = F_5+\lambda F_4$; $Z = \omega tF_2+(1-\mu)(1-t)F_6$; $v = (1-\mu)\omega-y$; and $K = v(D+jh)+(1-y)(Q_1-jh)+\omega(1-\mu)(q_2-\mu+1)+yhX+jh\omega\mu t$; where, recall, $\omega = (1-\mu+\mu t)^{-1} > 0$. To sign v, note that $t \varepsilon [0,1]$ implies $v \varepsilon [1-y-\mu, 1-y]$. Then, v could be negative only if widgets' share of consumption, μ, exceeds their share of GNP, 1-y; this is not possible since Canada is a net widget exporter. The coefficients in expression (23) become:

$A_2 = \omega q_2$; $A_o = q_o+tA_2a$; $A_1 = A_2-q_1 = K/D$; $D_o = F_o+VA_o^*-aZ$; $D_1 = F_1+\omega F_2+(t-1)F_6$; $D_2 = \omega(F_2-F_6)$; $D_4 = VA_2^*+bZ$; $D_5 = CZ-VA_1^*$; $D_6 = \lambda F_4$; where, recall, $\lambda = 1/D_1^* > 0$. Excepting D_5, all other D_j and all A_j are, a priori, positive. But $D_5 < 0$ when $t = F_6 = 0$. Also note that each coefficient depends on ω and, thereby, on t. In fact, ω is lower when t is higher.

D. Equilibrium

Let $A_3 = q_3$, $A_4 = tbA_2$, $A_5 = tcA_2$, $A_6 = 0$, $D_3 = F_3$, $N = (D_1+A_1)^{-1}$, $D_1' = ND_1$ and $A_1' = NA_1$, all of which are positive. Define the new magnitudes, $\Phi_j = (D_1'A_j-A_1'D_j)$ and $\psi_j = N(D_j+A_j)$, for j = 2,...,6. Solving system (23):

$$\begin{cases} q = D_1'A_o + A_1'D_o + \Phi_2.\theta + \Phi_3.\alpha + \Phi_4.\varepsilon + \Phi_5.\alpha^* + \Phi_6.D_o^* \\ \tau = N(A_o-D_o) + \Psi_2.\theta + \Psi_3.\alpha + \Psi_4.\varepsilon + \Psi_5.\alpha^* + \Psi_6.D_o^* \end{cases}$$

Apparently, $\psi_j > 0$ for all but ψ_5 which is, a priori, indeterminate. As well: $\Phi_6 < 0$; $\Phi_4 < 0$ if $t = 0$; $\Phi_5 > 0$ if $t = F_6 = 0$; $\Phi_3 = ?$; and $\Phi_2 \gtreqless 0$ as $F_1q_2 \gtreqless F_2q_1$. Therefore, $\Phi_2 > 0$ whenever $q_1 \leqq 0$.

Note that r^* and τ^* are given by equations (11) and (9). Substitute these along with the above results into equations (18) and (22).

$$\begin{cases} \pi = M - (L_o+\pi_6 A_o^* + D_1' A_o + A_1' D_o) - \Phi_2 . \theta - \Phi_3 . \alpha + \pi_4 . \varepsilon - \pi_5 . \alpha^* + \pi_6 . D_o^* \\ T = \omega[N(D_o - A_o) - ta + T_2 . \theta - \Psi_3 . \alpha + T_4 . \varepsilon + T_5 . \alpha^* - \psi_6 . D_o^*] \end{cases}$$

where: $\pi_6 = \lambda L_1 > 0$; $\pi_4 = (\pi_6 A_2^* - \Phi_4)$; $\pi_5 = (\pi_6 A_1^* + \Phi_5)$; $T_2 = (1-\Psi_2) > 0$; $T_4 = tb-\Psi_4$; and $T_5 = tc-\Psi_5$. Apparently, if $t = 0$, $(\pi_4, \pi_5, T_5) > 0$ and $T_4 < 0$.

Let $g = Q_1+\omega Q_2$, $g' = \emptyset_1+\omega\emptyset_2$, $g_j = g\Psi_j$ and $g_j' = g'\Psi_j$. Using (17) and above results:

$$\begin{cases} Q = [Q_o - gN(D_o-A_o)] + (\omega Q_2 - g_2).\theta + (Q_3-g_3).\alpha - g_6 . D_o^* \\ \qquad - (g_4+\omega Q_2 tb).\varepsilon - (g_5-\omega Q_2 tc).\alpha^* \\ \emptyset = [\emptyset_o + Ng'(A_o-D_o)] + (g_2'-\omega\emptyset_2).\theta + (g_3'-\emptyset_3).\alpha + g_6' . D_o^* \\ \qquad + (g_4'+\omega\emptyset_2 tb).\varepsilon + (g_5'-\omega\emptyset_2 tc).\alpha^* \end{cases}$$

The reader may also compute the price of widgets and the exchange rate from the definitions: $P = \pi - (1-\mu)T$ and $E = T+P^*-P = \mu T+P^*-\pi$, where P^* is given in the text by expression (11). The reader may confirm that the coefficients in all the above expressions have the signs reported in Table I.

REFERENCES

M. Bruno & J. Sachs (1979), "Macroeconomic Adjustment with Import Price Shocks: Real and Monetary Aspects," Institute for International Economic Studies, Discussion Paper No. 118 (Stockholm), February.

W. Buiter (1978), "Short-run and Long-run Effects of External Disturbances Under a Floating Exchange Rate," Economica, 45, August, 251-72.

R. Findlay (1979), "Oil Supplies and Employment Levels: A Simple Macro Model," Columbia University, Discussion Paper No. 33

R. Findlay & C.A. Rodriguez (1977), "Intermediate Imports and Macroeconomic Policy Under Flexible Exchange Rates," Canadian Journal of Economics, 10, May, 208-17.

J.A. Gray (1976), "Wage Indexation: A Macroeconomic Approach," Journal of Monetary Economics, 2, April, 221-236.

J. Harkness (1982), "Intermediate Imports, Expectations and Stochastic Equilibrium Under Flexible Exchange Rates," Canadian Journal of Economics, 18, February, 137-153.

C.A. Rodriguez (1977), "Flexible Exchange Rates and Imported Inputs: A Dynamic Analysis of the Interection between the Real and Monetary Sectors of a Small Open Economy," Columbia University, No. 76-7708.

M. Schmid (1976), "A Model of Trade in Money, Goods and Factors," Journal of International Economics, 6, November, 347-61.

M. Schmid (1979), "Keynesian and Monetarist Analysis of Oil Price Shocks," Unpublished manuscript, April.