# OIL, DISINFLATION, AND EXPORT COMPETITIVENESS : A MODEL OF THE "DUTCH DISEASE"

Willem H. Buiter

and

Douglas D. Purvis

NUMBER 185

WARWICK ECONOMIC RESEARCH PAPERS

DEPARTMENT OF ECONOMICS

UNIVERSITY OF WARWICK
COVENTRY

OIL, DISINFLATION, AND EXPORT COMPETITIVENESS :
A MODEL OF THE "DUTCH DISEASE"

Willem H. Buiter

and

Douglas D. Purvis

NUMBER 185

October, 1980.

The work reported here commenced during the Warwick Summer Workshop. Financial support from the SSRC is gratefully acknowledged. An earlier version of this paper was presented to the Annual Meetings of the American Economics Association in Denver, September 1980. We would like to thank Slobodan Djajic, Robert Dunn, and Marcus Miller for their helpful comments.

Oil, Disinflation, and Export Competitiveness:

A Model of the "Dutch-Disease"

## ABSTRACT

This paper examines three possible sources of "de-industrialization" in an open economy: monetary disinflation, an increase in the international price of oil, and a domestic oil discovery. The analysis is conducted using a model which incorporates different speeds of adjustment in goods and asset markets; domestic goods prices respond only sluggishly to excess demand while the exchange rate (and hence the price of imported goods) adjusts quickly.

Monetary disinflation leads to reduced real balances, higher interest rates, and a lower nominal exchange rate. In the short-run this causes a real appreciation and a decline in domestic manufacturing output.

Perhaps surprisingly, an increase in world oil prices can create similar effects even for a country which is a net exporter of oil. Although the direct effect of an oil price increase for such a country is an increase in the demand for the domestic manufacturing good, that effect may be swamped by a real appreciation created by the increased demand for the home currency. This corresponds rather closely to the recent experiences of several oil and gas exporting countries, and is commonly referred to as the "Dutch-Disease". In our analysis, however, this is only a transitional phenomeon.

Domestic oil discoveries, though necessarily finite in nature, generate permanent income effects in demand which last beyond the productive life of the new oil reserve. Initially, current income is above permanent income, leading to an improvement in the trade account; this is eventually reversed when permanent income exceeds current income. A wide variety of output response patterns are possible.

Willem H. Buiter
Department of Economics
University of Bristol
Bristol, U.K.

(272) 24161

Douglas D. Purvis
Department of Economics
Queen's University
Kingston, Canada K7L 3N6

(613) 547-3207

## I. Introduction

The 1970's were a decade of major economic upheaval and turbulence, leaving many unresolved issues competing for the attention of economists. Although consensus on the appropriate analysis of, and policy response to, these events is no doubt still a long way off, there is considerable agreement as to what the major issues are. Two phenomena which share honors in this regard are the advent and questionable performance of flexible exchange rates, and the developments associated with the price and availability of oil. Both of these are important elements of the "great stagflation" experienced during the seventies; as both are well documented elsewhere,[1] in the remainder of this introduction we outline only briefly the aspects that we wish to focus on. Our main objective is to provide a framework which can be used to disentangle the effects on the real exchange rate of increases in the world price of oil, of discoveries of domestic oil reserves, and of monetary disinflation. While the main part of the paper involves a small analytical model that we hope to be of fairly general interest, much of what follows is motivated by our observations of recent developments in the United Kingdom.

With respect to the "oil shocks" of the 1970's, the major developments ensued from the formation of the OPEC cartel leading to the quadrupling of oil prices in 1974 and a doubling in 1979. One of the paradoxical features of the 1970's was that industrial economies which were net exporters of oil (and other energy related products whose prices also rose) experienced considerable problems adjusting to a price increase which, on standard microeconomic grounds, should have made them better off. More generally, the burden of adjustment

---

[1] See, for example, Dornbusch [1980] and Blinder [1980].

to the oil price shocks does not appear to have been inversely related to a country's net export position in oil. These adjustment problems often took the form of a decline in the level of activity in the export oriented and import-competing manufacturing sector. This experience is now commonly referred to as the "Dutch-disease" whereby a booming resource sector is presumed to lead to a contraction of the manufacturing sector via the loss of "competitiveness" due to appreciation of the domestic currency.

In this paper we critically examine the implicit analysis leading to this diagnosis; while a detailed description is postponed until the model is set out, there are a number of comments concerning "oil shocks" that we wish to make at the outset.

First, the nature of an oil price shock is obviously such that a country does not face it in isolation; it is a disturbance which also influences its major trading partners simultaneously. One possible explanation of the paradox noted above is then that the non-oil export sectors of the oil-rich manufacturing nations experienced a decline in foreign demand simultaneously with the oil price shock, due to recession set off in major oil importers such as the United States. However, this possibility is not explored further in this paper.

Second, it is obviously desirable to distinguish between price and quantity shocks; that is, between the impact of an exogenous increase in the world price of oil and that of an exogenous "discovery" of new domestic reserves of oil.[2] To the extent that the returns from a new discovery are captured by agents who consume the domestic manufactured goods, the discovery of a new re-

---

[2] A third shock, not considered in this paper, is a change in the relationship between the domestic and world prices of oil measured in terms of a common currency, say because of taxes, subsidies or tariffs on oil.

serve is essentially an income, or "demand" shock. An oil price shock in principle involves elements of both a supply and a demand shock. In this paper we focus on the (positive or negative) income or wealth motivated demand effects; in the conclusions we offer some comments on extending the model to incorporate supply effects arising from oil's role as an intermediate input and possible domestic factor market responses.

A third issue is that the long-run effects of an oil shock on the trading sector are usually couched in terms of the condition of current account balance. Occasionally this condition is even extended to the short-run. Abstracting from service account developments, a resource boom then implies that net non-oil exports must fall. The first point to note is that this does not automatically imply a shrinking of gross manufacturing exports or output. E.g., in a small economy that takes the world price of manufactures as given, manufacturing output could be maintained with the increased domestic absorption associated with the resource boom accounting for the required decline in net exports. If the domestic non-oil good is an imperfect substitute for the imported manufactured good and if the home country is large in the world market for domestically produced good, as we shall henceforth assume, then an "oil shock" will in most cases raise the relative price of the home good, thus reducing net exports. The response of output of the home good depends upon the nature of the shock and on details of the model. However, oil discoveries are not likely to be a source of unemployment, nor is there any presumption that oil price increases will be more harmful to countries with large oil reserves.

The model used in our paper differs from others in the literature in a number of important ways. First, we abstract from oil's role as an intermediate good, a feature emphasized for example by Findlay and Rodriguez [1977], Bruno and Sachs [1979], Djajic [1980] and others. One result of this specification is that there are no long-run negative implications for the manufacturing sector of an increase in oil prices. This allows us to focus on short-run macroeconomic adjustment problems. Our short-run dynamics arise from sluggish adjustment of domestic prices; that is, we have a nominal rigidity rather than a real rigidity as analysed, for example, by Bruno and Sachs [1979], Branson and Rothenberg [1980] and Purvis [1979]. Our specification is more in conformity with that of Dornbusch [1976], a point we return to below.

Our model also abstracts from the role of non-traded goods, a feature that has been emphasized in other theoretical and applied discussions. For example, in the Dutch case the Slochteren gas discoveries led in the 1960's and 1970's to a substantial public sector revenue increase, a large part of which was allocated to an expansion of the labour-intensive public service sector. This put upward pressure on wages in the manufacturing sector which exacerbated the unfavourable exchange rate effects on competitiveness resulting from the gas discovery. Corden and Neary [1980], for example, focus on this aspect of the issue. They examine a specific factor model in which the resource boom creates an excess demand for labor hence driving up manufacturing wages. One problem with this model is that the "demise" of the manufacturing sector is seen as the mirror image of a boom in prosperity for labor. This does not seem to accurately reflect the experience of countries currently experiencing the Dutch disease, particularly the U.K.. Nevertheless, the role of the non-traded goods sector is likely an important part of the Dutch disease story, but one we shall not address in this paper; we do return briefly to this issue in our conclusions.

Given nominal inertia in domestic prices and costs, our model can generate transitional deindustrialization and unemployment in response to an oil price (or indeed an oil discovery) shock. We wish to argue, however, that this is not a complete explanation of the real appreciation, deindustrialization, and unemployment experienced by many industrial countries in the late 1970's. There is no necessary reason to associate all or even most of the "deindustrialization" with the oil shocks; due consideration must also be given to the role of domestic stabilization policies. In particular, we wish to suggest as an additional explanation the tight monetary policies implemented in some countries in response to the acceleration of inflation set-off by the initial 1974 increase in oil prices. Under flexible exchange rates, with international capital mobility, monetary contraction will lead to a large and rapid fall of the nominal exchange rate. As Dornbusch [1976] has emphasized, if in addition inflation inertia is strong so that domestic prices are sluggish to adjust, then there will also be a real appreciation in the short-run with adverse consequences for the competitiveness of the domestic manufacturing sector.[3]

In the next section of this paper, we present a model designed to address these issues. We then compare the effects on the real exchange rate, manufacturing output, and employment of monetary disinflation, oil price shocks, and oil discoveries.

---

[3]Indeed, as Dornbusch showed, the sluggishness of prices may in fact cause the nominal exchange rate to overshoot its long-run equilibrium path in addition to the real exchange rate overshooting its long-run equilibrium value.

## II. A Macroeconomic Model with Oil as Income and Wealth

In this section we consider the effects of an unanticipated discovery of oil, an unanticipated increase in the world price of oil, and an unanticipated reduction in the rate of monetary growth using a model that abstracts from the use of oil as an intermediate input. Oil is produced and consumed domestically and can be imported or exported at an exogenous world price in terms of the foreign currency. The flow of domestic oil production is treated as exogenous, the relationship between current oil production and the permanent income derived therefrom is treated in detail below. There is also a non-oil domestic good which is produced at home but consumed at home and abroad; foreign demand is less-than-perfectly elastic. The home country also imports a non-oil good available in infinitely elastic supply; by appropriate choice of units the foreign price of the non-oil import is unity so its domestic price equals the nominal exchange rate. The model is given in equations (1) - (9), where the symbols are as defined in Table 1.

(1) $m-p = ky^p + (1-k)y - \lambda^{-1}r$ $\qquad k,\lambda>0$

(2) $q_H = -\gamma_1(r-\dot{p}) + \gamma_2(e-p_H) + \gamma_3 y^p + \gamma_4(e+p_b^f-p_H)$ $\qquad \gamma_1,\gamma_2,\gamma_3,\gamma_4>0$

(3) $p = \beta_1 p_H + \beta_2(e+p_b^f) + (1-\beta_1-\beta_2)e$ $\qquad 0\leq\beta_1,\beta_2,1-\beta_1-\beta_2\leq 1$

(4) $\dot{p}_H = \phi q_H + \mu$ $\qquad \phi\geq 0$

(5) $r = r^f + \dot{e}$

(6) $y = \nu q_H + (1-\nu)q_b + (1-\nu-\beta_2)p_b^f + (\beta_1-\nu)(e-p_H)$ $\qquad 0\leq\nu\leq 1$

(7) $y^p = \nu q_H^p + (1-\nu)q_b^p + (1-\nu-\beta_2)p_b^f + (\beta_1-\nu)(e-p_H)$

(8) $c = e-p_H$

(9) $\ell = m-p_H$

TABLE 1

List of Symbols

| | |
|---|---|
| $m$ | logarithm of the nominal money stock |
| $p$ | logarithm of the domestic general price level (c.p.i.) |
| $p_H$ | logarithm of the price of domestic non-oil goods |
| $e$ | logarithm of the nominal exchange rate (domestic currency price of foreign exchange) |
| $p_b^f$ | logarithm of the world price of oil (exogenous) |
| $r$ | domestic nominal interest rate |
| $r^f$ | world nominal interest rate (exogenous) |
| $y^p$ | permanent real income (logarithm) |
| $y$ | actual real income (logarithm) |
| $q_H$ | actual production of domestic non-oil goods (logarithm) |
| $q_b$ | actual production of oil (logarithm) |
| $q_H^p$ | permanent production of domestic non-oil goods (logarithm) |
| $q_b^p$ | permanent production of oil (logarithm) |
| $\mu$ | $\dot{m}$, rate of growth of the nominal money stock (exogenous) |
| $v$ | share of non-oil production in domestic value-added |
| $\ell$ | logarithm of real liquidity in terms of the non-oil domestic good |
| $c$ | logarithm of the real exchange rate |

A dot ("·") over a variable indicates a time derivative.

The demand for real money balances depends on permanent income (wealth), actual income (transactions demand), and the nominal interest rate (equation 1). Output of non-oil goods is demand-determined and depends on the real interest rate, on the relative prices of foreign and domestic goods, and on permanent income (equation 2). The domestic cost of living is a weighted average of the price of domestic non-oil goods, the price of oil, and the price of non-oil imports (equation 3). The rate of change of the price of domestic non-oil goods in excess of the underlying trend rate of inflation depends on the excess demand for them; the underlying rate of inflation is proxied by the rate of growth of the nominal money supply (equation 4).[4] This specification has also been adopted by Liviatan [1979] and Dornbusch [1980b]. The domestic rate of interest equals the world rate plus the expected rate of exchange rate depreciation (equation 5). Perfect foresight is assumed throughout. Equations (6) and (7) contain the definitions of actual and permanent income; they are log-linear approximations to real income given by 6' and 7', where uppercase symbols are the antilogarithms of the corresponding lowercase ones.

$$(6') \qquad Y = (P_H Q_H + EP_b^f Q_b)/P$$

$$(7') \qquad Y^P = (P_H Q_H^P + EP_b^f Q_b^P)/P$$

Note that $\nu \equiv P_H Q_H/PY$ is the share of non-oil production in total value added. In what follows we abstract from changes in $\nu$ occurring as a result of the oil discovery and so treat $\nu$ as the same in actual and permanent income and as constant through time. For convenience, we define permanent income in terms of actual rather than permanent prices. We use the ratio of the price of non-oil

[4] Capacity output of domestic non-oil goods is exogenous and, through choice of units, is set equal to zero.

imports to the price of the domestic non-oil manufactured goods as a measure of competitiveness; this ratio, denoted by $e-p_H$, is also referred to as the real exchange rate (equation 8). The predetermined state variable is real balances in terms of the home good (equation 9).

Oil prices and output enter this model through their influence on income. In analysing demand responses, we focus on the implications for permanent income. While exogenous price increases might well be viewed as being permanent and hence change the steady-state terms of trade, new discoveries of oil resources are necessarily finite so that the flow of current income they generate is of limited duration. Nevertheless we argue that the relevant concept for determining demand patterns is the permanent income change thus elicited; increased demand for the home good will thus be spread out over time so that even an oil discovery leading to an oil flow of finite duration will alter the steady state terms of trade.

Permanent production of non-oil goods is identified with its steady state value; we choose units so that $q_H^P = 0$. We abstract from the possibility that steady-state changes in relative prices alter $q_H^P$.

Actual oil production evolves according to

$$(10) \quad q_b(t) = \begin{cases} \bar{q}_b \quad , & t < 0 \text{ and } t > T,\ T > 0 \\ \bar{\bar{q}}_b > \bar{q}_b, & 0 \leq t \leq T \end{cases}$$

Output is small prior to t=0, rises unexpectedly to a new constant level for a period of length T, and then returns to its previous low level. We do not model output decisions in the oil producing sector; the new discovery is of known size and the flow of production from it occurs at a given, known rate. In addition, oil production is assumed not to require labour so that the non-oil equation (4) is not affected by changes in the volume of oil production. The increase in output is unanticipated as at t=0. But, at t=0, the return of oil production to its original low level at t=T is anticipated. To formalize this, let $\hat{q}_b^A(t,s)$ be the volume of actual oil production at time t, anticipated at time s. We assume

$$(11)\quad \hat{q}_b(t,s) = \begin{cases} \bar{q}_b & \text{for all } t,\ s \leq 0 \\ q_b(t) & \text{for all } t,\ s \geq 0 \end{cases}$$

Permanent income accruing from oil production is[5] given by

$$(12)\quad q_b^P(t) = \begin{cases} \bar{q}_b & t<0 \\ \alpha\bar{q}_b + (1-\alpha)\bar{\bar{q}}_b & t>0\ ;\ \alpha = \alpha(T)\ ;\ \alpha' < 0\ , \\ & \alpha(0) = 1\ ,\ \alpha(\infty) = 0 \end{cases}$$

Figure 1 illustrates the behaviour of $q_b$ and $q_b^P$.

Using equations (2) and (7), we define for future use the following "gross price elasticities" of demand.

---

[5] Permanent oil production for t>0 is derived below. The real interest rate used in these calculations is the steady state real interest rate, $r^f$

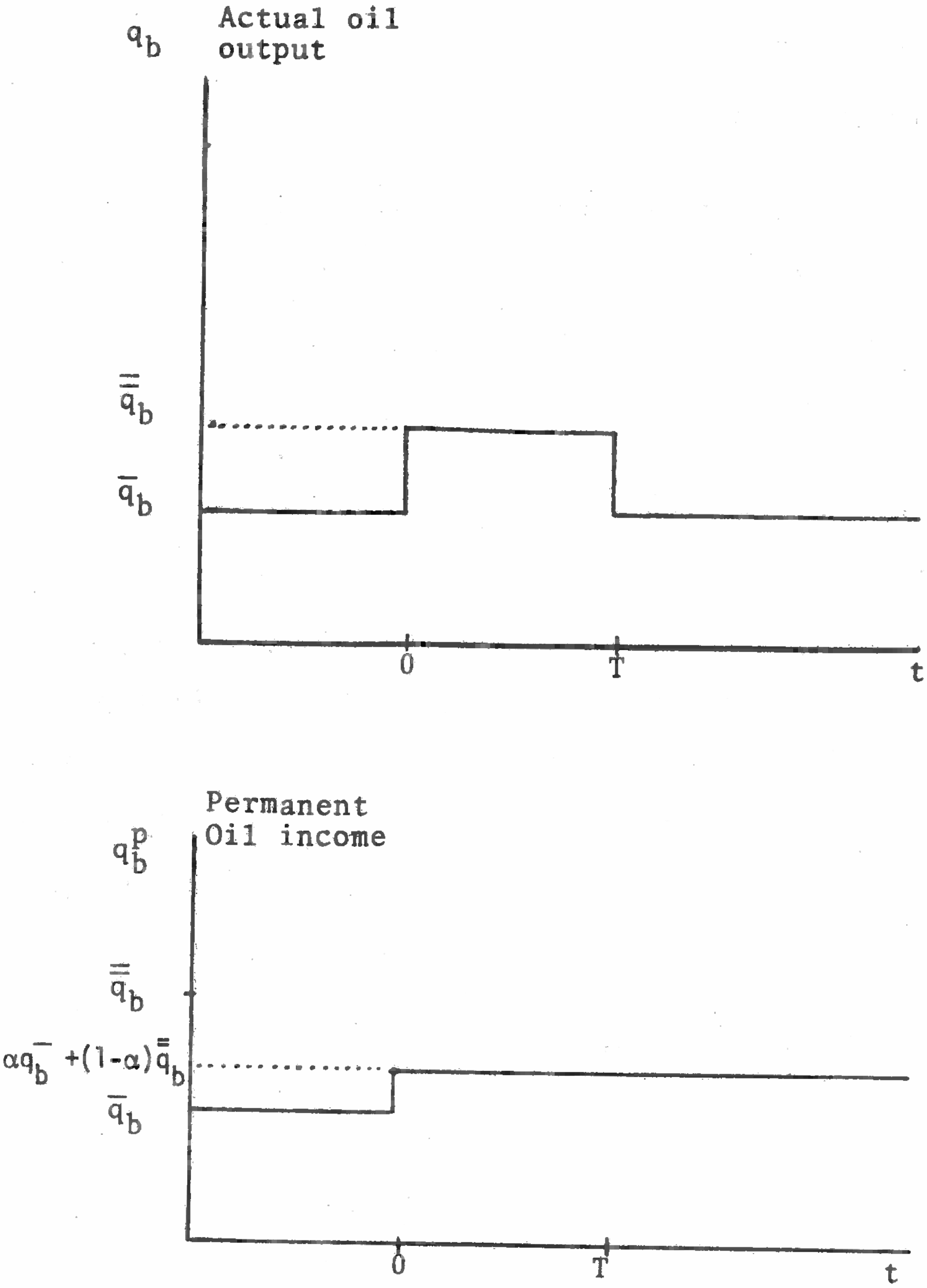
$$\int_0^\infty Q_b^P e^{-r^f t} dt = \int_0^T \bar{\bar{Q}}_b e^{-r^f t} dt + \int_T^\infty \bar{Q}_b e^{-r^f t} dt$$

This yields

$$Q_b^P(t) = \bar{\bar{Q}}_b + e^{-r^f T}[\bar{Q}_b - \bar{\bar{Q}}_b].$$

The log-linear approximation is thus $\alpha\bar{q}_b + (1-\alpha)\bar{\bar{q}}_b$.

Figure 1




EXOGENOUS PATHS OF ACTUAL OIL OUTPUT AND PERMANENT OIL INCOME

(13) $\eta_b \equiv \partial q_H/\partial p_b^f = \gamma_4 + \gamma_3(1-\nu-\beta_2)$

(14) $\eta_c \equiv \partial q_H/\partial(e-p_H) = (\gamma_2+\gamma_4) + \gamma_3(\beta_1-\nu)$

Note that if the share of oil in domestic output $(1-\nu)$ exceeds its share in domestic consumption $(\beta_2)$, a case we shall refer to as that of a net exporter, then an increase in $p_b^f$ increases domestic income, thus reinforcing the substitution effect in favor of home goods and causing $q_H$ to rise. Similarly if the share of the home good in domestic consumption, $\beta_1$, exceeds its share in output, $\nu$, then a fall in its relative price also causes demand for the domestic good to rise.[6] In what follows we shall maintain the assumption that $\eta_c>0$ but we shall consider both possibilities for $\eta_b$. It is also useful at this stage to note the differential effects $q_H$ of a given percentage change in the price and quantity of oil. It is easily seen that $\partial q_H/\partial q_b^p = \gamma_3(1-\nu) = \eta_b + \gamma_3\beta_2 - \gamma_4$ which may be greater than or smaller than $\eta_b$, depending upon whether the weighted income elasticity, $\beta_2\gamma_3$, is greater than or smaller than the price elasticity, $\gamma_4$.[7]

The current account deficit, D, is given by $D = A(Y,Y^P,r-\dot{p}) - Y$;

---

[6] Of course, these are only sufficient conditions for $\eta_b$ and $\eta_c$ to be positive; necessary and sufficient conditions are
$(1-\nu) > \beta_2 - (\gamma_4/\gamma_3)$ and $\beta_1 > \nu - (\gamma_2+\gamma_4)/\gamma_3$ respectively.

[7] The definition could be elaborated to explicitly incorporate the effects of the impact of the increase in $p_b^f$ on the country's trading partners. This would reduce the size of $\gamma_4$, possibly rendering it negative. However, as we will in any event consider positive and negative values of $\eta_b$, we have not added this complication.

$0<A_1, A_2$ ; $A_1 + A_2<1$ ; $A_3\leq 0$ ; where A denotes private plus public absorption. If $A_1 + A_2\ \partial Y^P/\partial Y < 1$, as is insured in our case where the oil discovery is know to be finite so $\partial Y^P/\partial Y < 1$, then the nearly oil-rich country will run a larger current account surplus or smaller deficit for as long as the additional oil flows.

Using the definitions of p, $y^P$, and c, we can rewrite the demand for the home good in a semi-reduced form as

$$(2') \quad q_H = \eta_c c + \eta_b p_b^f + \gamma_3(1-\nu)q_b^p - \gamma_1 r^f - \gamma_1\beta_1\dot{c}$$

This is only a semi-reduced form since c (and $\dot{c}$ outside of long-run equilibrium) are endogenous variables. However, this particular expression will be useful later in evaluating the impact effects of the various shocks under consideration on $q_H$. Recognizing from equations (4) and (9) that $\dot{\ell}$ just equals $-\phi q_H$, we see that the model can be expressed as a system of two dynamic equations in real money balances in terms of the home good, $\ell$, and the real exchange rate, c. Except at those instants when the level of the nominal money supply is altered, $\ell$ is predetermined because $p_H$ is sticky and m evolves according to $\dot{m}=\mu$. However, c is not predetermined because e can take discrete jumps in response to current and anticipated future changes in the values of the parameters or the exogenous variables. The dynamic system is given by equation (15).

$$(15) \quad \begin{bmatrix} \dot{c} \\ \dot{\ell} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} c \\ \ell \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \end{bmatrix} \begin{bmatrix} p_b^f \\ q_b^p \\ q_b \\ \mu \\ r^f \end{bmatrix}$$

where the elements of the state-transition and forcing matrices are given in Table 2.

In Table 2 we also indicate the likely sign pattern of the coefficients; a question mark indicates that the sign is a priori ambiguous while the sign in the brackets indicates the case we treat as the standard one. We assume throughout that the parameter V, the coefficient of $\dot{c}$ that arises when (2') is substituted into (4), is positive. From Table 2 it can be seen that a sufficient condition for V to be positive is that z be positive, where z is defined to be the influence of a change in output of home goods, $q_H$, on the rate of change of competitiveness, $\dot{c}$. From Table 2, $z \equiv \partial\dot{c}/\partial q_H = (1-k)\nu\lambda - \phi$. The first term indicates the influence of $q_H$ on the rate of change of the nominal exchange rate operating through the money market while the second indicates the influence on the rate of change of $p_H$ operating through the home goods market; assuming z to be positive would be following Dornbusch in assuming the short run adjustment in asset markets dominates that in goods markets. In fact we assume only that $z > -(\gamma_1\beta_1)^{-1}$ which is less than zero; this is necessary and sufficient to ensure $V > 0$. The ambiguities indicated in Table 2 remain after $V > 0$ has been imposed; for example, with z negative $a_{11}$ could also be negative.

Note that the coefficients of $\dot{\ell}$ can be represented as simple linear functions of the coefficients of $\dot{c}$; all are adjusted by the multiplicative factor $\psi = \phi\gamma_1\beta_1 > 0$ and four (corresponding to c, $p^f$, $q_b^p$, and $r^f$) also have an additive adjustment of $-\phi$ times the relevant elasticity. We shall usually assume that $\phi$ is small so that this adjustment does not alter the sign of the relevant coefficient; the one exception is $a_{21}$ where we assume that $\eta_c$ is large enough to render $a_{21}$ negative even though $a_{11}$ is positive.

# TABLE 2

## Reduced Form and Dynamic Coefficients

| | | | | | |
|---|---|---|---|---|---|
| $a_{11}$ | $= V[\lambda(1-\nu) + z\eta_c]$ | (+)? | $a_{21}$ | $= \psi a_{11} - \phi\eta_c$ | (-)? |
| $a_{12}$ | $= -V\lambda$ | (-) | $a_{22}$ | $= \psi a_{12}$ | (-) |
| $b_{11}$ | $= V[\lambda(1-\nu) + z\eta_b]$ | (+)? | $b_{21}$ | $= \psi b_{11} - \phi\eta_b$ | (+)? |
| $b_{12}$ | $= V(1-\nu)[\lambda k + z\gamma_3]$ | (+) | $b_{22}$ | $= \psi b_{12} - \phi\gamma_3(1-\nu)$ | (+)? |
| $b_{13}$ | $= V\lambda(1-k)(1-\nu)$ | (+) | $b_{23}$ | $= \psi b_{13}$ | (+) |
| $b_{14}$ | $= -V$ | (-) | $b_{24}$ | $= \psi b_{14}$ | (-) |
| $b_{15}$ | $= -V(1 + z\gamma_1)$ | (-) | $b_{25}$ | $= \psi b_{15} + \phi\gamma_1$ | (+) |

where $V = (1 + \gamma_1\beta_1 z)^{-1}$ (>0 if $z > -(\gamma_1\beta_1)^{-1} < 0$; assumed throughout)

$z = (1-k)\nu\lambda - \phi$ ($\equiv \partial\dot{c}/\partial q_H; > 0$ in Dornbusch case)

$\psi = \phi\gamma_1\beta_1 > 0$

Note also:

$a_{21} = V[\psi\lambda(1-\nu) - \phi\eta_c]$

$b_{21} = V[\psi\lambda(1-\nu) - \phi\eta_b]$

$b_{22} = V(1-\nu)[\psi\lambda k - \phi\gamma_3]$

$b_{25} = V\nu\phi(1-\beta_1) > 0$

Since $(\psi V z - \phi) = -\phi V$

Caution: Rows in equation (15) appear as columns in Table 3.

## III. Long Run Comparative Statics

Before examining the dynamics in detail, it is useful to characterize the long-run equilibrium conditions. Steady state equilibrium is characterized by

(16) $\dot{p}_H = \dot{p} = \dot{e} = \mu$

(17) $r = r^f + \mu$

(18) $q_H = 0$

The last equation of course ensures that there are no output or employment effects in the long run.

The long run goods market equilibrium locus (LIS curve) and money-market or portfolio balance locus (LLM) can be written as

(19) $\eta_c c = \gamma_1 r^f - \eta_b p_b^f - \gamma_3(1-\nu)q_b^p$

(20) $\lambda \ell = \lambda(1-\nu)(c + p_b^f + kq_b^p + (1-k)q_b) - (\mu + r^f)$

The LIS and LLM equations can be solved to yield the following expressions for steady state competitiveness and liquidity

(21) $c^* = \eta_c^{-1}\{\gamma_1 r^f - \gamma_3(1-\nu)q_b^p - \eta_b p_b^f\}$

(22) $\ell^* = \eta_c^{-1}(1-\nu) \{(\gamma_1-\delta)r^f - \delta\mu + (\eta_c-\eta_b)p_b^f$

$+ (k\eta_c - (1-\nu)\gamma_3) q_b^p + (1-k)\eta_c q_b\}$

These are depicted as the interesections of the LIS and LIM curves in Figures 2 and 3 below.[8] Note that the LIS curve is independent of $\ell$ due to the ab-

[8]Recall that permanent oil income, $q_b^p$, equals $\alpha\bar{q}_b + (1-\alpha)\bar{\bar{q}}_b$ where $\bar{q}_b$ is "normal" oil output, $\bar{q}_b = q_b$. When we consider the effect of an increase

sence of a real balance effect in our specification of the expenditure function. If a real balance effect were included, the LIS curve would be downward sloping since a higher relative domestic price would be required to offset the effect of larger real balances.[9]

We can use the LIS and LLM curves to analyse the long-run steady state effects of a change in the exogenous variables $\mu$, $p_b^f$, and $q_b^p$. We consider each in turn; in what follows we continue to assume $\eta_c$ to be greater than zero; this is simply the condition that an increase in $p_H$ reduce the demand for the home good. A sufficient condition to ensure this is that $\beta_1$, the share of the home good in consumption, exceed $\nu$, the share of home good production in total value added, thus ensuring that an increase in $p_H$ reduces real income. If $\beta_1$ were small relative to $\nu$, a not improbable situation for some net oil exporters, the income effect of an increase in $p_H$ would work in the opposite direction to the substitution effect; we assume then that the latter dominates. We assume also that $\eta_c$ is large enough to ensure that $a_{21} \equiv \partial\dot{\ell}/\partial c$ is negative.

Monetary Disinflation

The simplest case is that of the long run effects of a reduction in

---

in $q_b^p$ holding $q_b$ constant, this is equivalent to examining the effect of a "larger" oil discovery; i.e., to examining the effect of an increase in $\bar{\bar{q}}_b$.

[9]In (22), $\delta$ is defined as $\eta_c/\lambda(1-\nu)$ so that in the $\ell^*$ equation, the coefficient of $\mu$ is $\lambda^{-1}$. The term $(\eta_c-\eta_b) = \gamma_2 - \gamma_3(1-\beta_1-\beta_2)$ takes on significance below.

the rate of monetary growth, $\mu$. This has no effect on the real exchange rate in the long run: the LIS does not shift. The lower steady-state nominal interest rate creates an increased demand for real money balances and hence a larger $\ell$; this is reflected in the fact that the LLM curve shifts to the right, as shown in Figure 2. While $\mu$ thus exerts no long-run effect on c, we shall see below that it does exert important short-run effects.

Discovery of Domestic Oil Reserves

Consider next the long run effects of a domestic oil discovery. Given our assumption that $\eta_c>0$, it is easily seen from equation (21) that an increase in $q_b^p$ will cause a fall in competitiveness as measured by c; thus a real appreciation arises in Figure 3 since the LIS curve shifts down. An increase in the relative price of home goods is required to counter the increased demand arising from the increase in permanent income. As can be seen directly from equation (22) the effect on long-run liquidity is ambiguous. The real income effect causes m-p to rise, but since $p_H$-p also rises due to the fall in c, m-$p_H$ can go either way. In Figure 3 we illustrate the case where the increase in permanent oil income increases real liquidity. In what follows, for simplicity we treat only this case; note that it arises when the gross price elasticity $\eta_c$ is relatively large.

Increase in the World Price of Oil

Finally, consider the long run effects of an increase in the world price of oil, $p_b^f$. Here there are three possibilities to consider, depending upon the sign of $\eta_b$, and then on the sign of $(\eta_c-\eta_b)$ if the latter is positive. If $\eta_b$ is negative, a case that arises if the country is a large enough net user of oil that the negative income effect dominates the substitution

Figure 2

Long-Run Effects of Monetary Disinflation

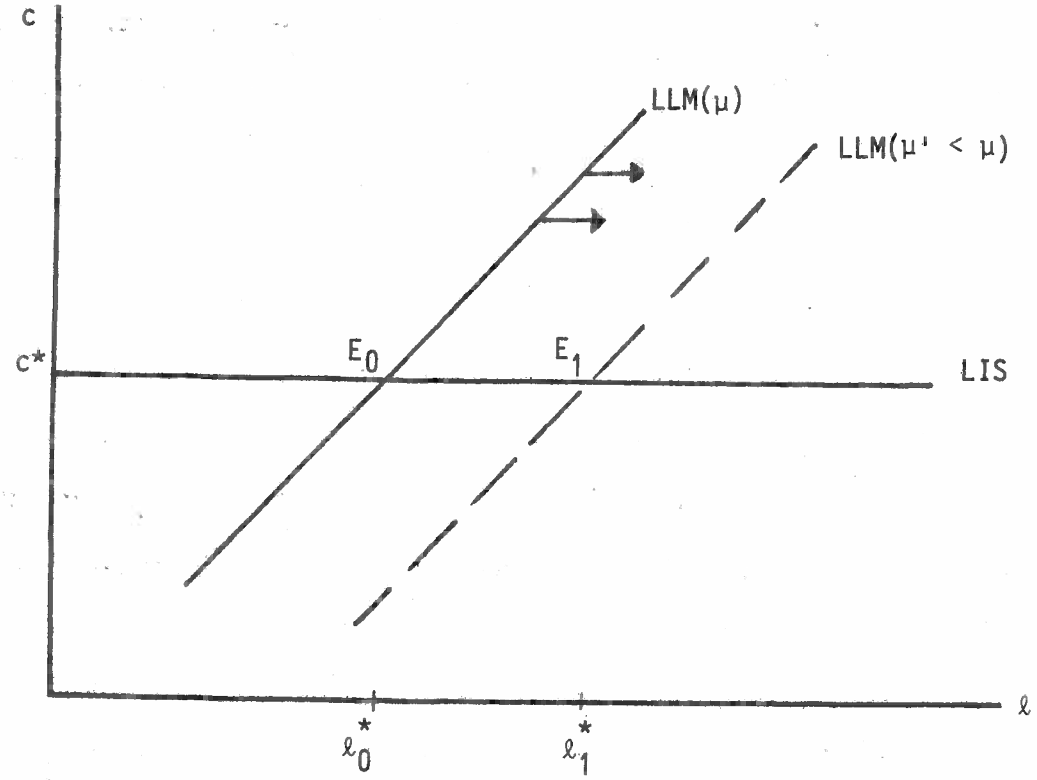
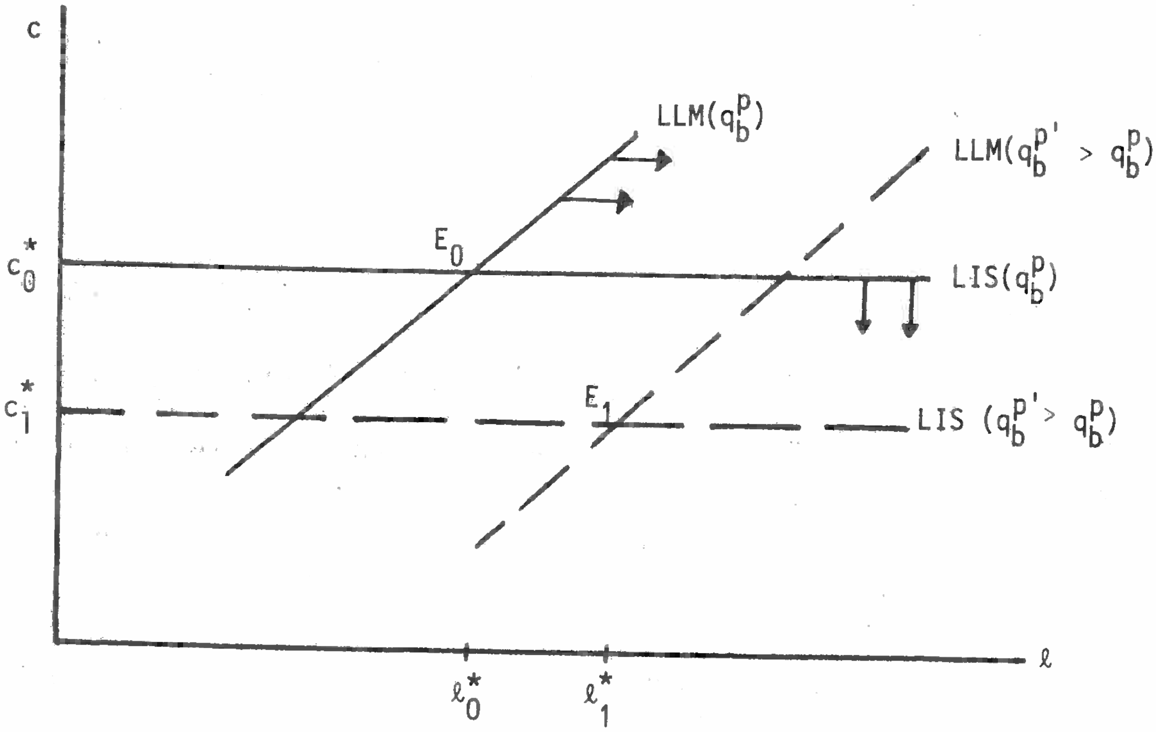



Figure 3

Long-Run Effects of a Domestic Oil Discovery



effect, then it follows that an increase in $p_b^f$ will reduce long run demand for the home good; to equate demand with the fixed long run supply there must ensue a real depreciation. This is illustrated in Figure 4.1 where the LIS curve has shifted up. The LLM curve shifts right and hence $\ell$ must also rise; the new equilibrium is at $E_1$.

If the country is a net producer of oil, or at least only a "small" net user, so that $\eta_b$ is positive, then the LIS curve shifts down and the increase in $p_b^f$ causes a fall in competitiveness as in Figure 4.2. In this case there is an increased demand for the home good which must be offset by a real appreciation. The LLM curve still shifts to the right so that the effect on $\ell^*$ is ambiguous; while the real income effects captured by the change in c will have an unambiguous effect on m-p, the changes in relative prices render the change in $\ell = m - p_H$ ambiguous. As can be seen from equation 22, the direction $\ell$ changes depends upon the sign of $(\eta_c - \eta_b)$.[10] In Figure 4.2 we illustrate the case where $(\eta_c - \eta_b) > 0$ so $\ell$ rises and the new equilibrium $E_1$ lies to the southeast of $E_0$. However the case where $\ell$ falls so that $E_1$ is southwest of $E_0$ is a possibility that will be of interest in the next sec-

---

[10]As m-p increases, $m-p_H$ will only fall if $p_H-p$ increases more than m-p. Therefore, $m-p_H$ will fall only if $c=e-p_H$ falls considerably when $p_b^f$ increases. A large fall in c is required to reequilibrate the goods market at full employment if a) the effect of the real exchange rate on $q_H$ is weak ($\eta_c$ is small) and b) the effect of an oil price increase on the demand for domestic non-oil goods is positive and large ($\eta_b$ is positive and large). The increase in m-p is achieved by a fall in the path of p relative to that of m. Now $p=\beta_1 p_H+(1-\beta_1)e+\beta_2 p_b^f$. If $\eta_c-\eta_b < 0$, the lower path of p is achieved entirely by appreciation of e. $p_b^f$ is higher and the path of $p_H$ has risen relative to that of m.

tion.[11]

The reason there are long-run effects of an increase in the foreign currency price of oil is that this increase in a nominal price also represents an increase in the relative price of oil in terms of non-oil imports whose price remains fixed at $p^f = 0$. If non-oil imports are omitted from the model ($\beta_2 = 1 - \beta_1$ and $\gamma_2 = 0$) there will be no long-run effects of an increase in the nominal foreign price of oil on $\ell$ or $e + p_b^f$.[12]

---

[11]Note that for a "small " country ($\gamma_2 = \infty$), $dc/dp^f = 0$ and $d\ell/dp_b^f = (1-\nu)$, $0 < 1-\nu < 1$.

[12]If oil price increases were indexed on the price of domestic non-oil goods, long-run real effects of an increase in the price of oil would be present even if $\beta_2 = 1 - \beta_1$ and $\gamma_2 = 0$ (see Buiter [1978]).

Figure 4

Long-Run Effects of an Increase in $p_b^f$

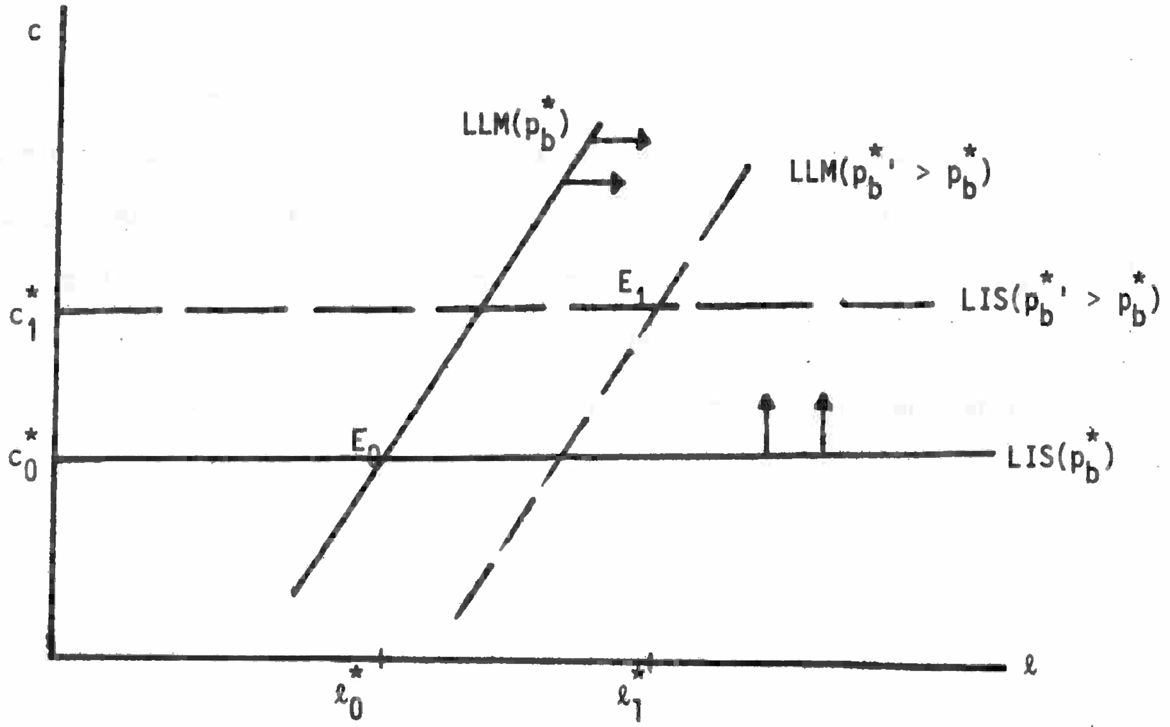



Figure 4.1: Real Depreciation ($\eta_b < 0$); $\ell$ must rise

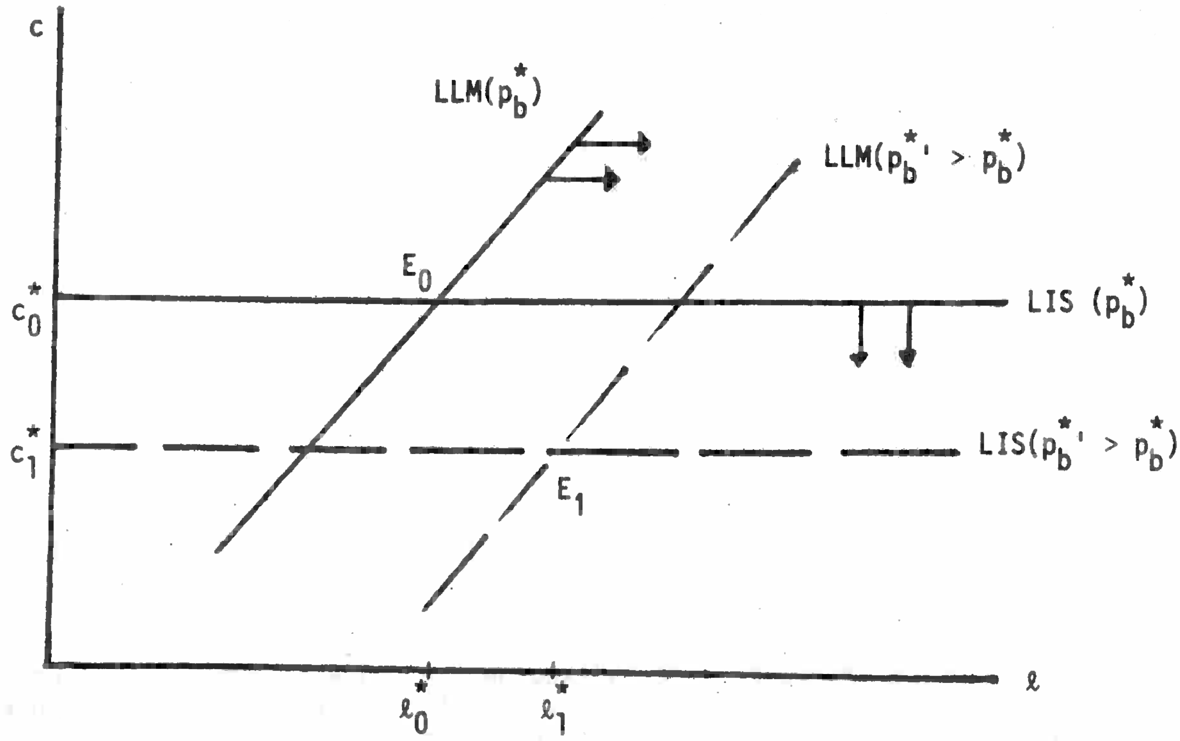



Figure 4.2: Real Appreciation ($\eta_b > 0$) and $\ell$ rises ($(\eta_c - \eta_b) > 0$)

## IV. Dynamic Adjustment

A variety of different dynamic adjustment paths are consistent with our specifications; however we shall only analyse what we consider to be the "standard" case arising with the sign patterns given in Table 2. Given the sign pattern of the state transition matrix A,

$$(23) \qquad A = \begin{bmatrix} + & - \\ - & - \end{bmatrix}$$

(where we have used the assumption of $\eta_c$ large to ensure $a_{21}<0$), there is one stable and one unstable root. The phase diagram is given in Figure 5. The $\dot{\ell} = 0$ locus is negatively sloped and the $\dot{c} = 0$ locus is positively sloped. The unique saddlepath leading to long-run equilibrium e is the upward-sloping line $\varepsilon\varepsilon$; stability requires that, for any predetermined value of $\ell$, the nominal exchange rate "jump" so that c takes on the value required to put the economy on a convergent solution path. In the case of an unanticipated, contemporaneous, permanent shock that changes the long-run equilibrium to $E_0$ from initial positions like $E_1$ or $E_2$, c will have to jump to a point on the saddlepath $\varepsilon\varepsilon$.[13]

Before turning to the specific case, it is useful now to return to

---

[13] If z were negative, than $a_{11}$ could be negative and the $\dot{c}=0$ locus would be negatively sloped. As long as it still cut the $\dot{\ell}=0$ locus from above, the analysis in the text holds; in particular, the saddlepath would still be positively sloped. Necessary and sufficient for the equilibrium to be a saddlepoint is that $|A|$ be negative.

For anticipated or "pre-announced" disturbances the analysis is a little more complicated. This is treated in the context of the oil discovery case below.

the quasi-reduced-form for $q_H$, reproduced here for convenience.

$$(2') \quad q_H = \eta_c c + \eta_b p_b^f + \gamma_3(1-\nu)q_b^p - \gamma_1 r^f - \gamma_1 \beta_1 \dot{c} .$$

From (2') it is clear that if the economy moves towards the long-run equilibrium from below and to the left, then during the entire period of adjustment c is below c* and $\dot{c}$ is positive; hence from equation (2') output of the domestic good is below its long-run value. Similarly, if adjustment towards $E_0$ is from the northeast, $q_H$ exceeds $\bar{q}_H^p$.

Monetary Disinflation

The simplest case concerns the dynamic adjustment to an unanticipated but, once announced, immediately implemented and fully perceived, permanent reduction in the rate of monetary expansion. As our long-run analysis showed, the $\dot{c}=0$ and the $\dot{\ell}=0$ loci shift to the right by an equal amount so that in the new long-run equilibrium c is unchanged and $\ell$ rises. This is illustrated in Figure 5 where only the $\dot{c}=0$ and $\dot{\ell}=0$ loci for the new, lower value of $\mu$ are drawn. With new long-run equilibrium at $E_0$ we know from the long-run analysis above that the initial equilibrium would have been at a point like $E_1$. Initially, since $\ell$ is predetermined, the reduction in $\mu$ causes the real exchange rate to fall so as to place the economy on the saddle-path; the dynamics then involve monotonically improving competitiveness and increasing real liquidity until $E_0$ is achieved. The time path of the real exchange rate is shown in Figure 6.

These results, similar to those presented by Dornbusch [1976, 1980b] and Liviatan [1979], illustrate one of the central problems posed for stabilization policy in an open economy. The exchange rate is an asset price and as such adjusts quickly. As a result, policies such as monetary contractions which are essentially neutral in the long-run can generate systematic responses in relative prices and output in the short run. In Figure 6 the time path of the real exchange rate also depicts the qualitative response of manufacturing output and exports. The initial appreciation results in a sharp fall in activity in the manufacturing sector while the ensuing real depreciation signals a recovery.[14]

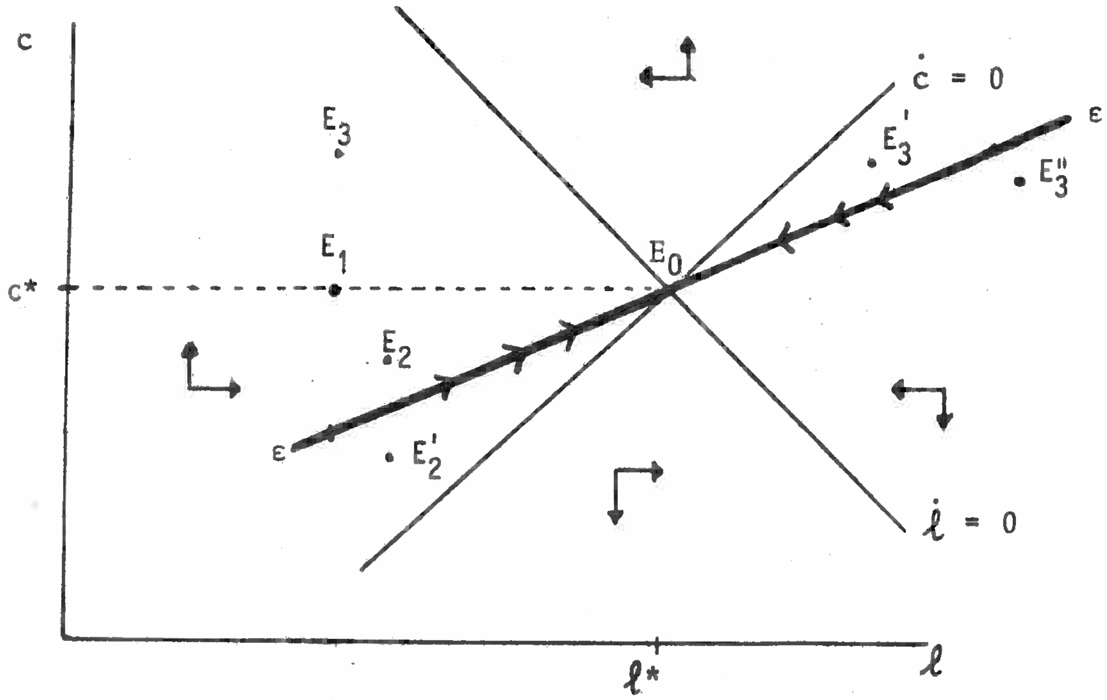
The dynamics underlying this short-run real appreciation warrant further explanation. Suppose instead that c were in fact to stay at its long-run value. If $\dot{c}$ were also to remain at its long-run value (zero) so that (by 2') $q_H$ remained at $q_H^p$, then $\dot{e}$ and $\dot{p}_H$ would adjust to the new value of $\mu$. But from (5) this implies a fall in the domestic interest rate and hence an excess demand for money from (1). Hence if c were to remain at its long-run value, monetary equilibrium requires that $q_H$ fall and $\dot{c}$ rise. But $\dot{c}>0$ implies that at the next instant c is higher and hence on this count $q_H$ will be higher. For monetary equilibrium then, an even higher value of $\dot{c}$ is required; this further increase in $\dot{c}$ of course means that the process is unstable since the long-run value of $\dot{c}$ is zero. For stability, c must fall initially, causing an initial fall in $q_H$ so that the adjustment elicited by positive $\dot{c}$ is consistent with stability; $\dot{c}$ approaches 0 as c approaches c* and $q_H$ approaches $q_H^p$.

---

[14] Note that while our model has a sticky price level, the inflation rate is a jump variable. In fact, by equation (4) the initial fall in $q_H$ means that the inflation rate falls immediately by more than the reduction in $\mu$. The model could be extended to allow for inertia in the inflation rate.

Figure 5

Adjustment Dynamics Saddle Path Given by εε



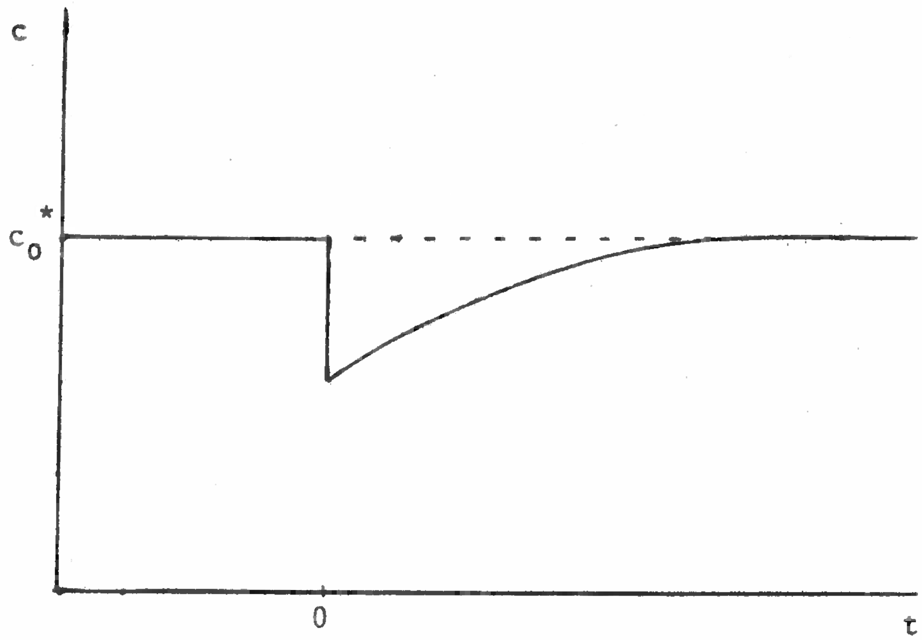




Figure 6

Time Path of Real Exchange Rate in Response to Monetary Disinflation

Increase in the World Price of Oil

As noted above, there are three cases to consider here, depending on the signs of $\eta_b$ and $(\eta_c - \eta_b)$. Although this case involves a taxonomy, the dynamics in each subcase are simpler than those for the oil discovery case; hence we treat the oil price increase case first.

Consider first the case where $\eta_b < 0$, the "net oil importer" case, so that an increase in $p_b^f$ leads to a long-run real depreciation. But $\ell^*$ also rises, so the old equilibrium must have been to the southwest of the new one. Since the saddlepath is positively sloped, the impact effect on c is ambiguous; in Figure 5 the initial equilibrium could be like either $E_2$ or $E_2'$ and hence the real exchange rate may initially rise or fall. However, in either case the dynamic adjustment is one of continuous real depreciation. Two possible time paths of c are plotted in Figure 7.1. Again because c is below its long-run value and $\dot{c}$ is positive, manufacturing output falls at t=0. A country which is a net oil consumer suffers a transitory loss of output as a result of the oil price increase.

Consider now the case where $\eta_b > 0$; the oil price increase leads to a long-run real appreciation. This is the case of a net exporter of oil and the possibility that its manufacturing sector declines is of course the focus of the "Dutch disease". There are two sub-cases here, depending on the sign of $(\eta_c - \eta_b)$.

If $(\eta_c - \eta_b)$ were positive, the long-run fall in c is accompanied by a rise in $\ell$. Hence new equilibrium must lie to the southeast of the old one; in terms of the phase diagram, Figure 5, the initial equilibrium must be one like $E_3$. Again the impact effect is a discrete fall in c to the saddlepath $\varepsilon\varepsilon$. Since the saddlepath is positively sloped, this initial "jump" appreciation is followed by a continuous real depreciation until $E_0$ is achieved; i.e., the real exchange rate overshoots its long-run value. The time path of the exchange rate is illustrated by the solid line in Figure 7.2; it is similar to that generated by monetary disinflation except that now the long-run real exchange rate falls. Although the direct effect of the increase in $p_b^f$ on the demand for the home good is positive with $\eta_b > 0$, the fact that c overshoots means then on balance there is a decline in the demand for the home good; from equation (2') we see that this decline is reinforced by the fact that $\dot{c}$ is positive. Hence the increase in $p_b^f$ results in a drop in manufacturing output even for the case where $\eta_b > 0$.

This is a case of the Dutch disease and is a direct result of the real exchange rate overshooting; if c fell only to its new long-run value, $\dot{c}$ would be zero and there would be no short-run effects on output.

Alternatively, if $(\eta_c - \eta_b)$ were negative so that the new equilibrium were one involving a fall in c and $\ell$, the initial position would have been like $E_3'$ or $E_3''$ in Figure 5. In this case there wouldn't be overshooting. Two possible time paths for c are illustrated in the dashed lines in Figure 7.2; the impact effect on c is ambiguous since both $E_3'$ and $E_3''$ in Figure 5 are possible initial equilibria. The impact effect would leave c above its equilibrium value, $\dot{c}$ would be negative, and output would be above its steady state path throughout the adjustment process.

In this model, non-oil output eventually returns to its exogenously given full employment; i.e., in this model there is no long-

# Figure 7

## Time Path of the Real Exchange Rate in Response to an Increase in the World Price of Oil

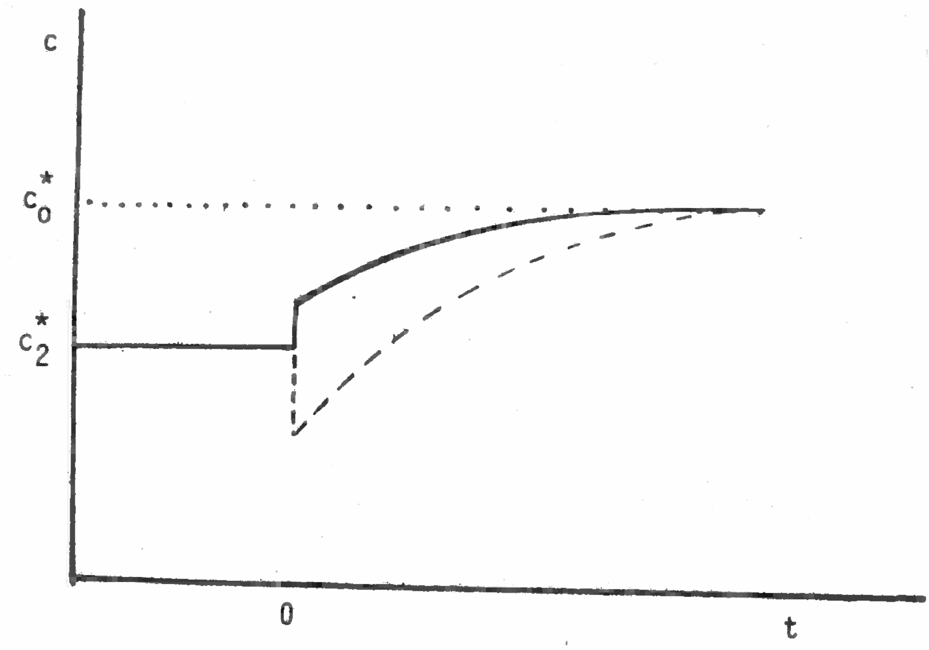



Figure 7.1: Case of Large Net Importer ($\eta_b < 0$)

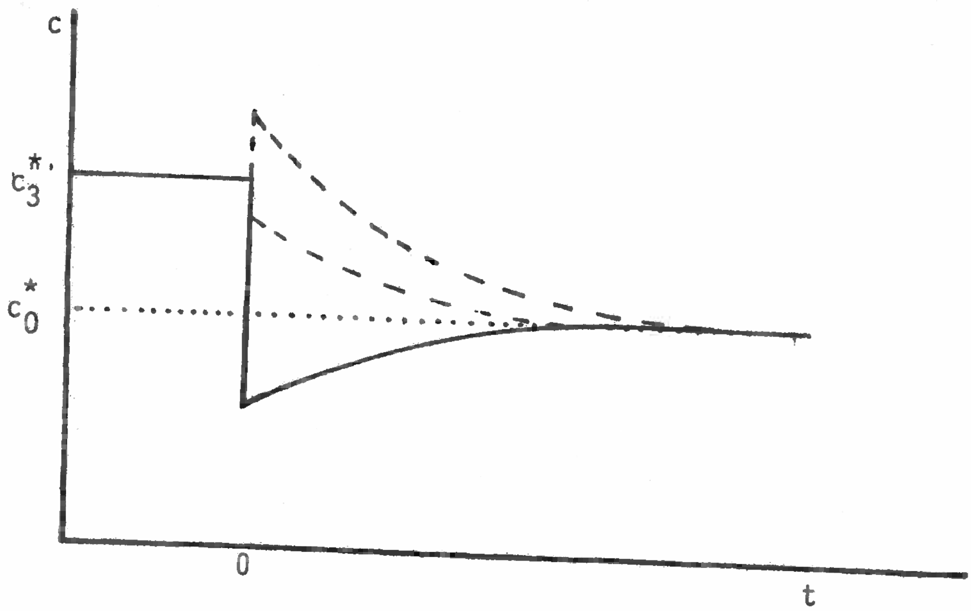



Figure 7.2: Case of Net Producer ($\eta_b > 0$)

run Dutch-disease.[15] However, a "transitional" Dutch-disease arises in response to an oil-price shock if the real exchange rate overshoots its new equilibrium value; i.e., if $\eta_c - \eta_b > 0$. The impact of this variable can be seen by considering what would happen if c and $\dot{c}$ were to immediately attain their new equilibrium values (c* and 0, respectively). Non-oil output would be at $q_H^p$ and r would be unchanged; from (1) we see that the impact in the money market depends on whether c falls proportionately more or less than the initial change in $p_b^f$.[16] But from (21), the relative change in c* depends upon the ratio $\eta_b/\eta_c$. If $\eta_b<\eta_c$, then the fall in c* is less than the initial rise in $p_b^f$; an instantaneous movement to c* with $\dot{c}=0$ would then imply an excess demand for money. The above discussion of the monetary disinflation case would now apply here; monetary equilibrium requires a further real appreciation which, of course, in this case implies overshooting of the real exchange rate. If $\eta_b>\eta_c$, c* changes more than $p_b^f$ and at c* with the initial value of $p_H$ there would be an excess supply of money. Monetary equilibrium and stability would require a depreciation relative to c*, and there would be no overshooting or Dutch-disease.

Discovery of Domestic Oil Reserves

Last, consider the implications of a domestic oil discovery. Although

---

[15] In a more complete model incorporating oil as an intermediate input, long-run real output might be altered. In that case the drop in real output on impact is relative to that new value of $q_H^p$.

[16] From (1), a unit fall in c creates an excess supply of money of $(1-\nu)$ while a unit rise in $p_b^f$ creates an equilvalent excess demand.

the long-run equilibrium is relatively easy to access (the increased demand for the home good necessitating a real appreciation), the dynamics are complicated by the fact that the oil production disturbance is known to be of finite duration. We treat the unanticipated but fully perceived discovery of oil at t = 0 as the combination of two disturbances; a permanent unanticipated increase in oil output effective immediately, and the perception and therefore anticipation of an equal permanent fall in oil output occurring at some known future time T.[17] In what follows we treat only the case where $\ell^*$ rises, abstracting from the possibility discussed earlier that $\ell^*$ might fall; the time-path of c appears qualitatively the same in either case.

The adjustment paths of c and $\ell$ after an unexpected discovery of oil at t = 0 when oil production is known, at t = 0, to fall back to its original level at t = T > 0, is illustrated in Figure 8. $E_0$ is the original long-run equilibrium. $E_1$ is the long-run equilibrium if the unanticipated increase in oil production is permanent; $E_2$ is the long-run equilibrium when there is a temporary increase in oil production.

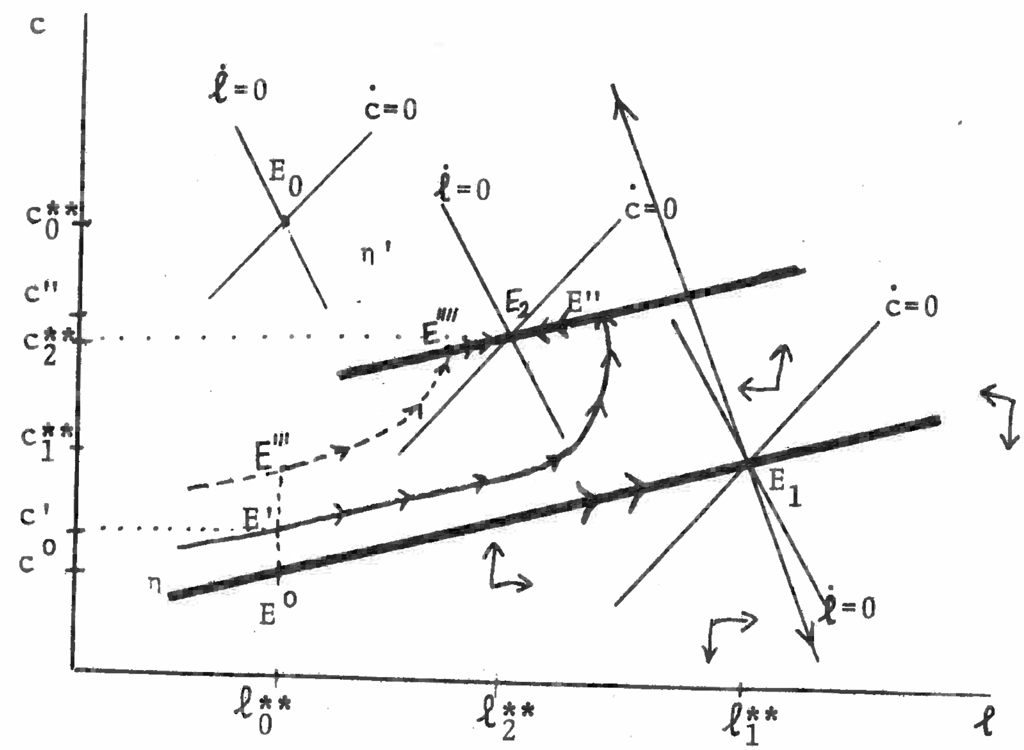
If the unanticipated increase in oil production were permanent, the real exchange rate would immediately jump to $c^0$ putting the economy at $E^0$ on the saddlepath converging to $E_1$. The unanticipated increase in real income (actual and permanent) increases the demand for money; with both m and $p_H$ predetermined monetary equilibrium is restored by a fall in $q_H$ and a rise in r. This in turn is brought about by a jump in the real exchange rate. After-

---

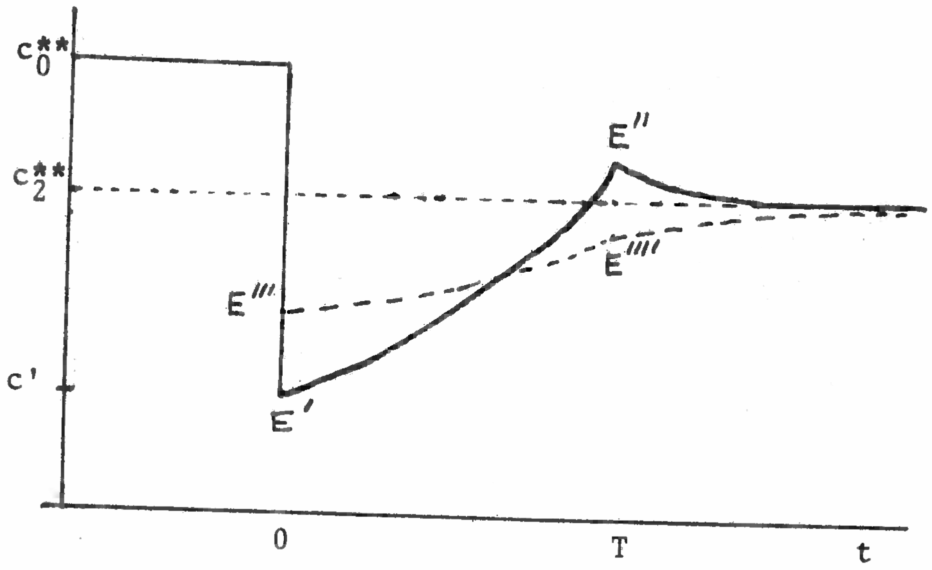
[17] See Wilson [1979] for an early analysis of the dynamics of anticipated future disturbances.

Figure 8

The Response to a Domestic Oil Discovery




8.1 Dynamics of Adjustment




8,2 Time Path of Real Exchange Rate

wards c rises steadily towards $E_1$.

If the increase in oil production is temporary, the rise in permanent income is correspondingly smaller. c still jumps downward, but to a position above $E^0$ such as $E'$ with c equal to $c'$. This position is defined by the requirement that $E'$ be on the unstable solution path (drawn with reference to the eigenvectors of $E_1$) that crosses the unique stable path through $E_2$ at the moment that oil production falls back to its lower level; i.e., at t = T. One such "unstable" solution path is given in Figure 8.1 by E'E". It crosses the saddlepath through $E_2$ at E". At time T (i.e., at E"), the real depreciation is reversed and there is then continuous real appreciation along the new saddlepath to $E_2$. The time path of c for this case is graphed in Figure 8.2 as the solid line; for the afficionado, there is "double" overshooting! Alternatively, the initial jump in c could be towards a point like E"' in Figure 8.1, with continuous real depreciation from E"' to $E_2$. At t = T the economy arrives at E"", on the stable saddlepath through $E_2$ after which c continues to depreciate. This solution is shown in Figure 8.2 as the dashed line, where there is only initial overshooting. The reader can confirm that if $\ell^*$ falls, there might not be any overshooting. The reader can also readily see that there is a rich variety of possible time paths for real output, with a possibility of as many as two "turning points" and with output rising, falling, or both during the adjustment process.

## V. Conclusion

We have analysed the response of a small open economy, with some market power in the world market for its non-oil good, to two kinds of oil shocks and to a monetary policy shock. Both oil shocks -- the unanticipated change in the world price of oil and the unanticipated discovery of domestic oil -- require an adjustment in the long run relative price of non-oil tradables. The typical long-run response to an oil discovery is a worsening of the competitive position of the non-oil good. The long-run response to an oil price increase will be a rise in the relative price of non-oil goods if the country is a net exporter of oil, a fall if it is a significant net importer. A reduction in the rate of growth of the nominal money stock does not alter long-run competitiveness but will raise the steady-state level of real money balances.

A perhaps surprising result is that even in the context of our model which fixes steady state non-oil output, increases in the price of oil or in known domestic oil reserves can have a transitional negative effect on manufacturing output, even for a net oil exporter. This negative output response was seen to be intrinsically linked to the possibility that the real exchange rate overshoots its long-run value. This overshooting results from our assumption that the price of non-oil goods is predetermined and responds only sluggishly to excess demand or supply while the nominal exchange rate (and hence the domestic price of the imported manufactured good) adjusts immediately to maintain equilibrium in the asset markets.

The model focussed on the role of oil prices and oil production in influencing income. In particular, we argued that the relevant concept was the permanent income accruing from current oil production. One implication of modelling demand in terms of permanent income is that in the period during which there is the increased oil production, actual income will be above permanent income. An implication of this is that the full employment current account can be expected to be in surplus because current income is high relative to current consumption, not simply because oil exports are larger. More precisely, the excess of current over permanent income means that the sum (I + X - M) will increase, where I stands for total private and public capital formation. The economy must allocate this increase in domestic saving between domestic capital formation and net foreign investment. When the oil runs out, consumption is maintained via the returns from past domestic and foreign investment. Current account balance and a trade account deficit are reconciled via increased interest and dividends from abroad.

There are a number of extensions to the model that suggest themselves, including elaboration on the production side to incorporate the role of oil as an intermediate good and to thus allow a distinction between domestic costs and prices. To the extent that oil is an intermediate input into the production process, and to the extent that oil is consumed directly by workers so that changes in its price can alter workers' real supply price of labour, then from the point of view of the manufacturing sector an increase in the price of oil entails a significant supply shock. In terms of our model, one consequence of having oil as an intermediate input is that a negative real income effect of an oil price increase is more likely. Adverse supply effects and substitution of non-oil inputs for oil also become important - for an early analysis of this see Bruno and Sachs [1979].

We referred throughout to the domestically produced non-oil good as "manufacture s." This can be taken as short-hand for all domestically produced goods, including (non-traded) services. Our aggregation of domestic non-oil tradables and services yields the commodity structure of Table 3a. The conclusion that an oil discovery should if anything expand domestic production of and employment in non-oil goods applies to this aggregate of traded and non-traded goods. There may be shifts in the composition of domestic non-oil production that our model cannot handle. Such shifts are likely to be out of manufacturing into non-traded services, both because the price of non-oil tradables may be effectively given in the world market (contrary to our model) and because the income elasticity of demand for services may be higher. Such a shift of resources from manufacturing into services may be described by the term "de-industrialization" but it certainly should not be a source of concern. Also, except for problems of short-run intersectoral labour mobility, the employment implications should be favourable, since services are more labour intensive than manufacturers. This scenario would follow in an alternative model sketched in Table 3b. There is assumed to be a fixed world price for the country's non-oil exports and a non-traded good ('services'). The income and wealth increasing effects of an oil discovery raise the price of services relative to all other goods whose world price is given. Resources flow from manufacturing into services. As in our model, there is no reason for believing that total employment and the value of total non-oil production would fall.

We assumed in our model that oil production does not compete for resources with non-oil production. This is clearly realistic as regards labour but is less appropriate as regards capital. In the long-run, however, a small

TABLE 3

a) Commodity structure of the present model:

| | | |
|---|---|---|
| 1) oil | ; fixed world price | ; uses no labour |
| 2) domestic non-oil (manufacturers and services or traded and non-traded) | ; endogenous world price | ; labour intensive<br>; uses oil as input* |
| 3) imported non-oil | ; fixed world price | |

b) Commodity structure of the alternative model:

| | | |
|---|---|---|
| 1) oil | ; fixed world price | ; uses no labour |
| 2) domestic non-oil traded (manufacturers) | ; fixed world price | ; fairly labour intensive<br>; uses oil as input |
| 3) domestic non-oil non-traded (services) | ; endogenous price | ; very labour intensive |
| 4) imported non-oil | ; fixed world price | |

* Not considered in the formal model.

country facing a perfect world capital market can accumulate its oil sector capital stock without diminishing the capital stocks of the non-oil sectors.

The model as it stands does permit some insights into the policy problems created by the divergent speeds of adjustment in goods and asset markets in an open economy. Our model focusses on the responses of aggregate demand to various shocks, and it would be straightforward to devise fiscal policies which mitigate those effects. Further, responding to a rise in the world price of oil with a reduction in monetary growth, as appears to have happened in the U.K., does not seem sensible in such a world. The overshooting of the real exchange rate results from the stickiness of the real money supply. Even if the stickiness of the price of domestic output or of domestic wages is taken as an unalterable institutional constraint, the real money supply can be made flexible by permitting finite responses in the level of the nominal money stock. This would remove the need for the sticky domestic price to do any adjusting. If the parameters of the model were known with certainty the level of the nominal money stock could be adjusted in such a way as to immediately achieve the new long-run equilibrium, without any need for overshooting. E.G., in the case of an oil discovery shock, the increase in the nominal money stock that permits the immediate achievement of the new steady-state values of $c$ and $\ell$ can be calculated directly from equation (22). It can therefore be argued that it is sticky nominal money as much as sticky domestic costs that is responsible for the short-run overshooting of the real exchange rate.

## References

Blinder, A. (1980) *Government Policy and the Great Stagflation* (Academic Press).

Branson, W.H. and J. Rothenburg (1980) "International Adjustments with Wage Rigidity," *European Economic Journal* 13, 309-342.

Bruno, M. and J. Sachs (1979) "Macroeconomic Adjustment with Import Price Shocks: Real and Monetary Aspects," mimeo.

Buiter, W. (1978) "Short-Run and Long-Run Effects of External Disturbances Under a Floating Exchange Rate," *Economica* 45, 251-272.

Corden, M. and P. Neary (1980) "Booming Sector and De-Industrialization in a Small Open Economy," unpublished.

Djajic, S. (1980) "Intermediate Inputs and International Trade: An Analysis of Real and Monetary Effects of an Oil Price Shock", unpublished.

Dornbusch, R. (1976) "Expectations and Exchange Rate Dynamics," *Journal of Political Economy* 84, 1161-1176.

Dornbusch, R. (1980a) "Exchange Rate Economics: Where Do We Stand?", *Brookings Papers on Economic Activity*, 143-186.

Dornbusch, R. (1980b) "Monetary Stabilization, Intervention and Real Appreciation," National Bureau of Economic Research Working Paper No. 472, April.

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

Liviatan, N. (1979) "Neutral Monetary Policy and the Capital Import Tax," unpublished.

Purvis, D. (1979) "Wage Responsiveness and the Insulation Properties of a Flexible Exchange Rate," in A. Lindbeck (Editor) *Inflation and Employment in Open Economies* (North Holland).

Wilson, C. (1979) "Anticipated Shocks and Exchange Rate Dynamics," *Journal of Political Economy* 87, 639-47.