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Oil, Disinflation, and Export Competitiveness

A Model of the "Dutch Disease"

Willem H. Buiter and Douglas D. Purvis

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8 Oil, Disinflation, and Export Competitiveness: A Model of the "Dutch Disease"

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The 1970s 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, discoveries of domestic oil reserves, and monetary disinflation. While the main part of the chapter 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 1970s, 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 1970s 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

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which, on standard microeconomic grounds, should have made them better off. More generally, the burden of adjustment 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 chapter 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 nonoil 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 chapter.

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 reserve 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 chapter 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 analysis is also applied to the short run.) Abstracting from service account developments indicates that a resource boom then implies that *net* nonoil exports must fall. The first point to note is that this does not automatically imply a shrinking of gross manufacturing exports or output. For example, 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 nonoil 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], and Djajic [1980]. 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 analyzed, 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 nontraded 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 1960s and 1970s to a substantial public sector revenue increase, a large part of which was allocated to an expansion of the labor-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 can create an excess demand for labor and drive up manufacturing wages. One problem with this result 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 United Kingdom. Nevertheless, the role of the nontraded goods sector is likely an important

Table 8.1
List of symbols[a]

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 nonoil goods (logarithm)
q_b^p	permanent production of oil (logarithm)
μ	$\dot{m}$, rate of growth of the nominal money stock (exogenous)
v	share of non oil production in domestic value added
l	logarithm of real liquidity in terms of the non oil domestic good
c	logarithm of the real exchange rate

a. A dot over a variable indicates a time derivative.

part of the Dutch disease story, but one we shall not address in this chapter; 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 1970s. 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]

8.1 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 relation between current oil production and the permanent income derived therefrom is treated in detail below. There is also a nonoil 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 nonoil good available in infinitely elastic supply; by appropriate choice of units the foreign price of the nonoil import is unity so its domestic price equals the nominal exchange rate. The model is given in equations (1)–(9); the variables are as defined in table 8.1:

$$p = \beta_1 p_H + \beta_2(e + p_b^f) + (1 - \beta_1 - \beta_2)e, \quad 0 \leqslant \beta_1, \beta_2, 1 - \beta_1 - \beta_2 \leqslant 1; \tag{1}$$

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

$$\dot{p}_H = \phi q_H + \mu, \qquad \phi \geqslant 0; \tag{3}$$

$$m - p = ky^p + (1 - k)y - \lambda^{-1} r, \qquad k, \lambda > 0; \tag{4}$$

$$r = r^f + \dot{e}; \tag{5}$$

$$y = vq_H + (1 - v)q_b + (1 - v - \beta_2)p_b^f + (\beta_1 - v)(e - p_H), \quad 0 \leqslant v \leqslant 1; \tag{6}$$

$$y^p = vq_H^p + (1 - v)q_b^p + (1 - v - \beta_2)p_b^f + (\beta_1 - v)(e - p_H); \tag{7}$$

$$c = e - p_H; \tag{8}$$

$$l = m - p_H. \tag{9}$$

The domestic cost of living is a weighted average of the price of domestic nonoil goods, the price of oil, and the price of nonoil imports [equation (1)]. Output of nonoil goods is demand determined and depends on the real interest rate, the relative prices of foreign and domestic goods, and

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

$$\dot{p}_H = \phi q_H + \mu, \qquad \phi \geqslant 0; \tag{3}$$

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The domestic cost of living is a weighted average of the price of domestic nonoil goods, the price of oil, and the price of nonoil imports [equation (1)]. Output of nonoil goods is demand determined and depends on the real interest rate, the relative prices of foreign and domestic goods, and permanent income [equation (2)]. The rate of change of the price of domestic nonoil goods in excess of the underlying trend rate of inflation depends on the excess demand for them [equation (3)];[4] the underlying rate of inflation is proxied by the rate of growth of the nominal money supply, a specification also adopted by Liviatan [1979] and Dornbusch [1980b]. The demand for real money balances depends on permanent income (wealth), actual income (transactions demand), and the nominal interest rate [equation (4)]. 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.[5] Note that $v \equiv P_H Q_H / PY$ is the share of nonoil production in total value added. We use the ratio of the price of nonoil imports to the price of the domestic nonoil manufactured goods as a measure of competitiveness; this ratio, denoted by $c \equiv e - p_H$, 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; changes in either influence demand via their implications for permanent income. While exogenous oil price increases might well be viewed as being permanent, 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 either will change the steady-state terms of trade. For the latter case, 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 an oil discovery leading to an oil flow of *finite* duration will alter the steady-state terms of trade.

Permanent production of nonoil 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

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

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 labor, so that the short-run dynamics in (4) are 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

$$\hat{q}_b(t, s) = \begin{cases} \bar{q}_b & \text{for all } t, s \leqslant 0 \\ q_b(t) & \text{for all } t, s > 0. \end{cases} \tag{11}$$

Permanent income accruing from oil production[6] is given by

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

Figure 8.1 illustrates the behavior of q_b and q_b^p.

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

$$\eta_b \equiv \partial q_H / \partial p_b^f = \gamma_4 + \gamma_3(1 - v - \beta_2); \tag{13}$$

$$\eta_c \equiv \partial q_H / \partial(e - p_H) = (\gamma_2 + \gamma_4) + \gamma_3(\beta_1 - v). \tag{14}$$

In principle, either elasticity could be of either sign. Consider first η_b: The pure substitution term γ_4 could be positive or negative;[7] the income effect could also be positive or negative depending upon whether the share of oil in domestic output $1 - v$ is greater than or smaller than its share in domestic consumption. In what follows we shall consider both positive and negative values for η_b. For η_c we assume that foreign and domestic manufactured goods are sufficiently close substitutes that γ_2 is sufficiently large to ensure that the direct substitution effect $(\gamma_2 + \gamma_4)$ is positive. Note that if β_1 (the share of the home good in consumption) were small relative to v (its share in domestic value added)—a not improbable situation for countries which are significant oil exporters—then the income effect of an increase in p_H would work in the opposite direction to the substitution effect. We assume that γ_2 would still be sufficiently large to ensure also $\eta_c > 0$.

It is also useful at this stage to note the differential effects of a given percentage change in the price and quantity of oil. It is easily seen that $\partial q_H / \partial q_b^p = \gamma_3(1 - v) = \eta_b + \gamma_3\beta_2 - \gamma_4$, which may be greater than or

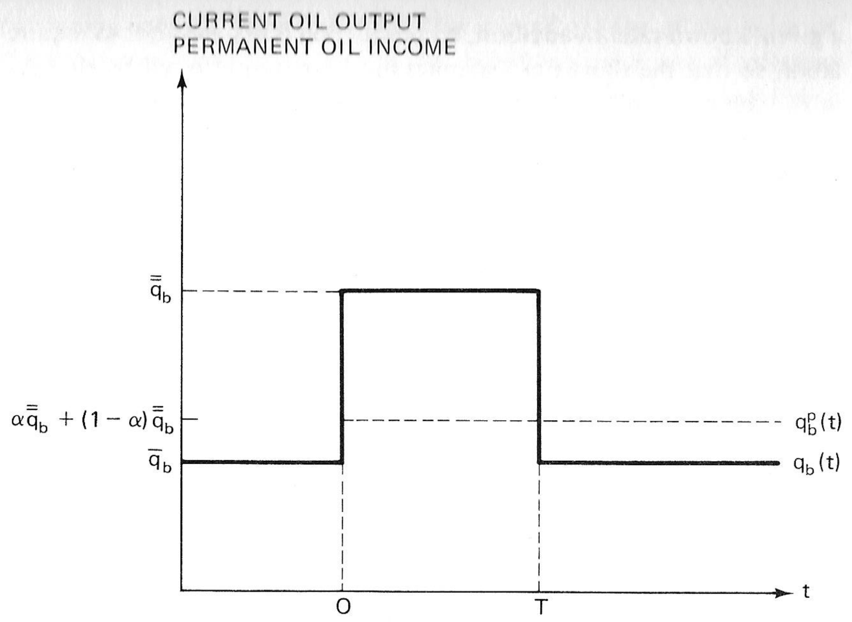

Figure 8.1
Exogenous paths of actual oil output and permanent oil income.

smaller than η_b, depending upon whether the weighted income elasticity $\beta_2\gamma_3$ is greater than or smaller than the price elasticity γ_4.

Using the definitions of p, y^p, and c, we can rewrite the demand for the home good in a semi-reduced form as[8]

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

This is only a semireduced 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 $\dot{l}$ 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 l and the real exchange rate c. Except at those instants when the level of the nominal money supply is altered, l 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):

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

where the elements of the state transition and forcing matrices are given in the appendix.

8.2 Long-Run Comparative Statics

Before examining the dynamics in detail, it is useful to examine the long-run or steady-state equilibrium conditions, characterized by

$$\dot{p}_H = \dot{p} = \dot{e} = \mu; \qquad r = r^f + \mu; \qquad q_H = q_H^p = 0. \tag{16}$$

The last equation ensures that there are no long-run output effects.

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

$$\eta_c c = \gamma_1 r^f - \eta_b p_b^f - \gamma_3(1-\nu)q_b^p, \tag{17}$$

$$l = \lambda(1-\nu)(c + p_b^f + kq_b^p + (1-k)q_b) - (\mu + r^f). \tag{18}$$

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

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

$$l^* = \eta_c^{-1}(1-\nu)\{(\gamma_1 - \delta)r^f - \delta\mu + (\eta_c - \eta_b)p_b^f + (k\eta_c - (1-\nu)\gamma_3)q_b^p + (1-k)\eta_c q_b\}. \tag{20}$$

These are depicted as the intersections of the LIS and LIM curves in figures 8.2–8.4. Note that the LIS curve is independent of l due to the absence 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. The LLM curve is positively sloped, indicating that a fall in the relative price of home goods increases the long-run desired value of money holdings in terms of home goods.[9]

We can use the LIS and LLM curves to analyze the long-run steady-state effects of a change in the exogenous variables μ, p_b^f, and q_b^p.[10] In what follows we continue to assume η_c to be greater than zero; this is

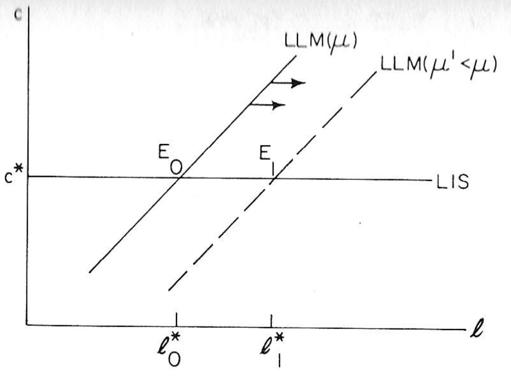

Figure 8.2
Long-run effects of monetary disinflation.

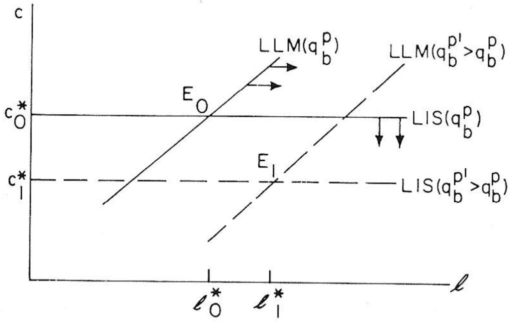

Figure 8.3
Long-run effects of a domestic oil discovery.

simply the condition that an increase in p_H reduce the demand for the home good. As noted in the appendix, we also assume that η_c is sufficiently large to ensure that $a_{21} \equiv \partial \dot{l}/\partial c$ is negative.

8.2.1 Monetary Disinflation

The simplest case is that of the long-run effects of a reduction in the rate of monetary growth μ. 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 l; this is reflected in the fact that the LLM curve shifts to the right, as shown in figure 8.2. While μ thus exerts no long-run effect on c, we shall see below that it does exert important short-run effects.

8.2.2 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 (19) that an increase in q_b^p will cause a fall in competitiveness as measured by c; thus a real appreciation arises since as shown in figure 8.3 the LIS curve shifts down. An increase in the relative price of home goods is required to counter the larger demand arising from the increase in permanent income. As can be seen directly from equation (20), 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 8.3 we illustrate the case in which 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 η_c is relatively large.

8.2.3 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 η_b, and then on the sign of $(\eta_c - \eta_b)$ if the latter is positive. If η_b is negative, a case that arises if the country is a sufficiently large net user of oil that the negative income effect dominates the substitution 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 8.4A, where the LIS curve has shifted up. The LLM curve shifts right, indicating that due to the rise in p_b^f, steady-state liquidity, for a given value of c, must rise. Hence l also rises and 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 η_b is positive, then the LIS curve shifts down and the increase in p_b^f causes a fall in competitiveness as in figure 8.4B. 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 l^* 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 $l = m - p_H$ ambiguous. As can be seen from equation (20), the direction l changes depends upon the sign of $\eta_c - \eta_b$.[11] In figure 8.4B we illustrate the case where $\eta_c - \eta_b > 0$, so l rises and the new equilibrium E_1 lies to the southeast of E_0.[12] However, the case where l falls, so that E_1 is southwest of E_0, is a possibility that will be of interest in the next section.[13]

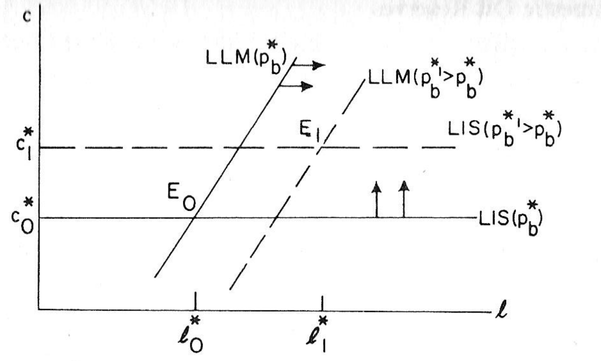

Figure 8.4A
Long-run effects of an increase in p_b^f: real depreciation ($\eta_b < 0$); l must rise.

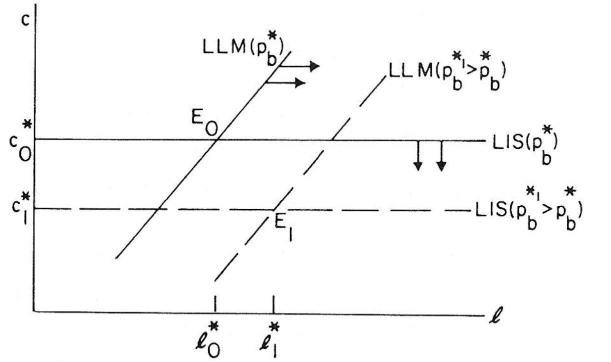

Figure 8.4B
Long-run effects of an increase in p_b^f: real appreciation ($\eta_b > 0$) and l rises $[(\eta_c - \eta_b) > 0]$.

Table 8.2
Long-run comparative statics results

Disturbance		Case	Response of c	Response of l	
Monetary disinflation	($u\downarrow$)	1	0	+	
Foreign oil		2	+	+	if $\eta_b < 0$
price	($p_b^f\uparrow$)	3	−	−	if $\eta_b > 0$ and $\eta_c - \eta_b < 0$
increase		4	−	+	if $\eta_b > 0$ and $\eta_c - \eta_b > 0$
Domestic oil		5	−	+	if $k\eta_c - (1 - v)\gamma_3 > 0$
discovery	($q_b^p\uparrow$)	6	−	−	if $k\eta_c - (1 - v)\gamma_3 < 0$

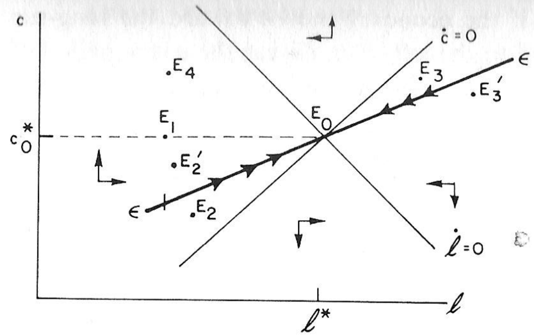

Figure 8.5
Adjustment dynamics—saddle path given by $\varepsilon\varepsilon$.

The six possible results are summarized in table 8.2; the cases are numbered to facilitate reference in the next section.

8.3 Dynamic Adjustment

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

$$A = \begin{bmatrix} + & - \\ - & - \end{bmatrix} \tag{21}$$

(where we have used the assumption of η_c large to ensure $a_{21} < 0$), there is one stable and one unstable root. The phase diagram is given in figure 8.5. The $\dot{l} = 0$ locus is negatively sloped and the $\dot{c} = 0$ locus is positively sloped. The unique saddle path leading to long-run equilibrium e is the upward-sloping line $\varepsilon\varepsilon$; stability requires that, for any predetermined value of l, 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 saddle path $\varepsilon\varepsilon$.[14]

Before turning to the specific case, it is useful now to return to the quasi-reduced form for q_H, rewritten here for convenience as (2″):

$$(q_H^P - q_H) = \eta_c(c^* - c) + \gamma_1\beta_1\dot{c}. \tag{2''}$$

From (2″) it is clear that if the economy moves toward 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 toward E_0 is from the northeast, q_H exceeds q_H^P.

8.3.1 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 $\dot{l} = 0$ loci shift to the right by an equal amount, so that in the new long-run equilibrium, c is unchanged and l rises. This is illustrated in figure 8.5, where only the $\dot{c} = 0$ and $\dot{l} = 0$ loci for the new, lower value of μ are drawn. With the 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 l is predetermined, the reduction in μ 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 8.6.

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 8.6 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.[15]

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 μ. But from (5) this implies a fall in the domestic interest rate and hence an excess demand for money from (1). Hence if c remains 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

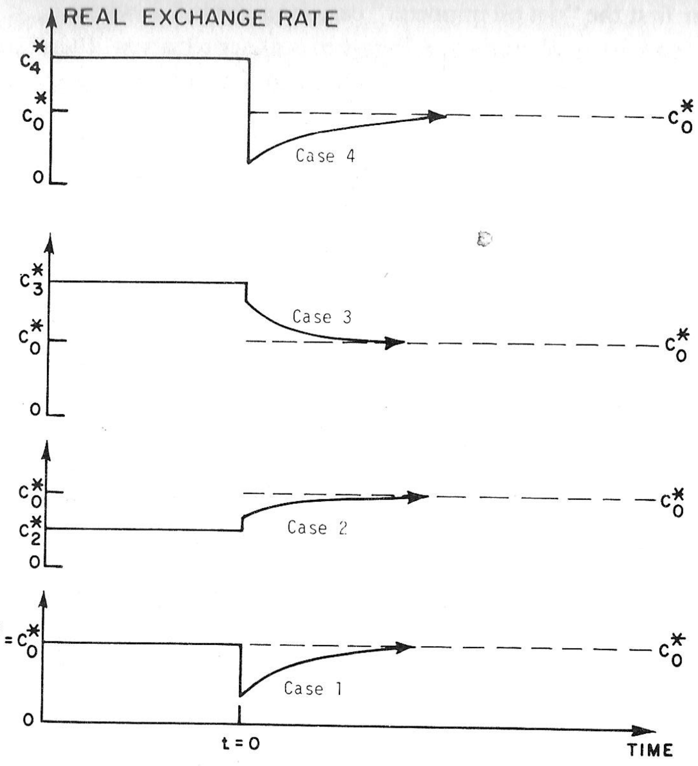

Figure 8.6
Time path of real exchange rate: case 1—monetary disinflation; case 2—oil price shock, net importer; case 3—oil price shock, net exporter (inflationary); case 4—oil price shock, net exporter (Dutch disease).

process is unstable since the long-run value of $\dot{c}$ is zero. The conditions of monetary equilibrium and perfect foresight require that the dynamic path through the initial equilibrium E_1 be positively sloped and that it increase in slope as l increases; hence it is an unstable path. 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.

8.3.2 Increase in the World Price of Oil

As noted above, there are three cases to consider here, depending on the signs of η_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 "net oil importer" case from table 8.2, where $\eta_b < 0$, so that an increase in p_b^f leads to a long-run real depreciation. But l^* also rises, so the old equilibrium must have been to the southeast of the new one. Since the saddle path is positively sloped, the impact effect on c is ambiguous; the initial equilibrium could be either E_2 or E_2' in figure 8.5, and the initial jump in c could be positive or negative. In figure 8.6 we show the time path for c from an initial position like E_2. In either case the impact effect leaves c below its new long-run value, and $\dot{c}$ is positive. Manufacturing output falls at $t = 0$, and the dynamic adjustment involves continuous depreciation and output recovery. A country which is a net oil consumer suffers a transitory loss of manufacturing output as a result of the increase in the price of oil.

Consider now what happens if $\eta_b > 0$, so that the oil price increase leads to a long-run appreciation. The possibility that the manufacturing sector of such a "net oil exporter" declines is of course the focus of one aspect of the "Dutch disease." There are two possibilities here, depending on the sign of $\eta_c - \eta_b$.

In case 3, $\eta_c - \eta_b$ is negative and the new equilibrium involves a fall in both c and l. The initial position could be either E_3 or E_3' in figure 8.5; again the initial jump in c may be either positive or negative. In either case dynamic adjustment involves continuous appreciation; one possible time-path for c is shown in figure 8.6. The impact effect leaves c above its new equilibrium value, $\dot{c}$ is negative, and output is above its steady-state level but falling throughout the adjustment process. This case does not give rise to the "Dutch disease."

In case 4, where $\eta_c - \eta_b$ is positive, the long-run fall in c is accompanied by a rise in l. Hence the new equilibrium must lie to the southeast of the old one; in terms of the phase diagram, figure 8.5, the initial equilibrium must be one like E_4. Again the impact effect is a discrete fall in c to the saddle path $\varepsilon\varepsilon$. Since the saddle path is positively sloped, this initial "jump" appreciation is followed by a continuous real depreciation until E_0 is achieved; that is, the real exchange rate overshoots its long-run value. The time path of the real exchange rate is illustrated in figure 8.6; 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 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 in which $\eta_b > 0$. A prescription that commodities are gross substitutes amounts to a prescription in favor of case 4 over case 3; see note 11.

Case 4 corresponds to the Dutch disease which is a direct result of 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. However, that possibility is ruled out since monetary equilibrium and perfect foresight combine to place that point on an unstable path. For stability, the real exchange rate must overshoot its long-run value. Although the increase in oil prices has a positive direct effect on the demand for the home good ($\eta_b > 0$), this is offset by the indirect reduction in demand due to the real appreciation, and the economy suffers "Dutch disease"-style deindustrialization.

In this model, nonoil output eventually returns to its exogenously given full employment level; that is, in this model there is no long-run run Dutch disease.[16] However, a "transitional" Dutch disease arises in response to an oil price shock if the real exchange rate overshoots its new equilibrium value, that is, 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 attain their new equilibrium values (c^* and 0, respectively) immediately. Nonoil 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.[17] But from (21), the relative change in c^* depends upon the ratio η_b/η_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, on the other hand, $\eta_b > \eta_c$, 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 then require a depreciation relative to c^*, and there would be no overshooting or Dutch disease.

8.3.3 Discovery of Domestic Oil Reserves

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

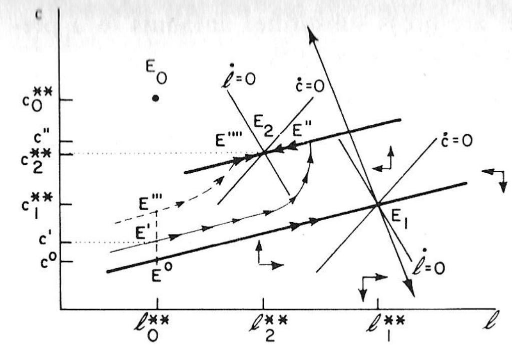

Figure 8.7
The response to a domestic oil discovery.

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.[18] In what follows we treat only case 5, in which l^* rises, abstracting from the possibility discussed earlier that l^* might fall; the time path of c appears qualitatively the same in either case.

The adjustment paths of c and l in case 5 are illustrated in figure 8.7. 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 saddle path 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. Afterward c rises steadily toward 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, that is, at $t = T$. One such "unstable" solution path is given in figure 8.7 by $E'E''$. It crosses the saddle path 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 saddle path to E_2. The time path of c for this

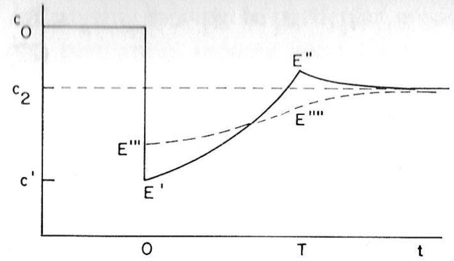

Figure 8.8
Possible paths of real exchange rate.

case is graphed in figure 8.8 as the solid line; for the afficionado, there is "double" overshooting! Alternatively, the initial jump in c could be toward a point like E''' in figure 8.7, with continuous real depreciation from E''' to E_2. At $t = T$ the economy arrives at E'''', on the stable saddle path through E_2, after which c continues to depreciate. This solution is shown in figure 8.8 as the dashed line, where there is only initial overshooting. The reader can confirm that if l^* 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.

8.4 The Exchange Rate and the Current Account

As noted in the introduction, the literature dealing with the Dutch disease often couches the analysis in terms of a balanced trade condition. As the foregoing analysis has, it is hoped, made clear, this is inappropriate. If current account balance is imposed as a long-run condition, any implication for net manufactured exports does not also apply to manufactured output. If, as we have assumed, the oil flow is finite, then the long run or steady state after an oil discovery will be characterized by a trade account deficit. However, that deficit does not mean reduced demand for home goods; rather, it reflects increased *total* demand due to the permanent income effect of the oil discovery; part of that demand is for imports and results in a larger volume of imports; part of that demand is for home goods and results in a higher relative price of home goods.

The trade account deficit D is given by

$$D = A(Y, Y^p, r - \dot{p}) - Y; \qquad 0 < A_1, A_2, \quad A_1 + A_2 < 1, \quad A_3 \leqslant 0, \tag{22}$$

where A denotes private plus public absorption. If $A_1 + A_2 \partial Y^p/\partial Y < 1$, as is ensured in our case, in which the oil discovery is known to be finite so $\partial Y^p/\partial Y < 1$, then the newly oil-rich country will run a larger current account surplus or smaller deficit for as long as the additional oil flows.

Note that this improvement in the trade account can be accompanied by a wide variety of exchange rate dynamics; in this model there is no necessary relation between the trade account and the exchange rate as arises in recent models (see, e.g., Dornbusch and Fischer [1980] or Rodriguez [1980]) which focus on net-wealth accumulation aspects of trade account imbalances.

8.5 Conclusion

We have analyzed the response of a small open economy, with some market power in the world market for its nonoil 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 nonoil tradables. The typical long-run response to an oil discovery is a worsening of the competitive position of the nonoil good. The long-run response to an oil price increase will be a rise in the relative price of nonoil 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 nonoil 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 nonoil 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 focused 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 modeling 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 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 labor, 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 nonoil inputs for oil also become important—for an early analysis of this see Bruno and Sachs [1979].

We referred throughout to the domestically produced nonoil good as "manufactures." This can be taken as shorthand for all domestically produced goods, including (nontraded) services. Our aggregation of domestic nonoil tradables and services yields the commodity structure of part (a) table 8.3. Our conclusions about the effects of an oil discovery on domestic production of, and employment in, nonoil goods applies to this aggregate of traded and nontraded goods. There may be shifts in the composition of domestic nonoil production that our model cannot handle. Such shifts are likely to be out of manufacturing into nontraded services, because both the price of nonoil tradables may be effectively given in the world market (contrary to our model) and the income elasticity of demand for services may be higher. Such a shift of resources

Table 8.3

(a) Commodity structure of the present model		
(1) Oil	Fixed world price	Uses no labor
(2) Domestic nonoil (manufacturers and services or traded and nontraded)	Endogenous world price	Labor intensive Uses oil as input[a]
(3) Imported nonoil	Fixed world price	
(b) Commodity structure of the alternative model		
(1) Oil	Fixed world price	Uses no labor
(2) Domestic nonoil traded (manufacturers)	Fixed world price	Fairly labor intensive, uses oil as input
(3) Domestic nonoil nontraded (services)	Endogenous price	Very labor intensive
(4) Imported nonoil	Fixed world price	

a. Not considered in the formal model.

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 labor mobility, the employment implications should be favorable, since services are more labor intensive than manufactures. This scenario would follow in an alternative model sketched in part (b) of table 8.3. There is assumed to be a fixed world price for the country's nonoil exports and a nontraded good ("services"). The income and wealth increasing effects of an oil discovery raise the price of services relative to all other goods whose world prices are 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 nonoil production would fall.

We assumed in our model that oil production does not compete for resources with nonoil production. This is clearly realistic as regards labor, but is less appropriate as regards capital. In the long run, however, a small country facing a perfect world capital market can accumulate its oil sector capital stock without diminishing the capital stocks of the nonoil 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 focuses on the responses of aggregate demand to various shocks, and it would be straightforward to devise fiscal policies which mitigate those effects. Responding to a rise in the world price of oil with a reduction in the rate of monetary growth will, in the context of the model, intensify the loss of competitiveness and decline in output. The overshooting of the real exchange rate

Table 8.4
Reduced form and dynamic coefficients

$a_{11} = V[\lambda(1-v) + z\eta_c]$	(+)?	$a_{21} = \psi a_{11} - \phi\eta_c$	(−)?
$a_{12} = -V\lambda$	(−)	$a_{22} = \psi a_{12}$	(−)
$b_{11} = V[\lambda(1-v) + z\eta_b]$	(+)?	$b_{21} = \psi b_{11} - \phi\eta_b$	(+)?
$b_{12} = V(1-v)[\lambda k + z\gamma_3]$	(+)	$b_{22} = \psi b_{12} - \phi\gamma_3(1-v)$	(+)?
$b_{13} = V\lambda(1-k)(1-v)$	(+)	$b_{23} = \psi b_{13}$	(+)
$b_{14} = -V$	(−)	$b_{24} = \psi b_{14}$	(−)
$b_{15} = -V(1 + z\gamma_1)$	(−)	$b_{25} = \psi b_{15} + \phi\gamma_1$	(+)
where $V = (1 + \gamma_1\beta_1 z)^{-1}$		(>0 if $z > -(\gamma_1\beta_1)^{-1} < 0$; assumed throughout)	
$z = (1-k)v\lambda - \phi$		($\equiv \partial\dot{c}/\partial q_H$; >0 in Dornbusch case)	
$\psi = \phi\gamma_1\beta_1 > 0$			

Note also: $a_{21} = V[\psi\lambda(1-v) - \phi\eta_c]$

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

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

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

since $(\psi Vz - \phi) = -\phi V$

a. Caution: Rows in equation (15) appear as columns here.

results from the stickiness of the real money supply. Even if the stickiness of the price of domestic output or 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 achieve immediately the new long-run equilibrium, without any need for overshooting. For example, 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 l can be calculated directly from equation (20). 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.

Appendix

Table 8.4 gives the elements of the statetransition and the forcing matrices of equation (15) in the text. In table 8.4 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 8.4 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 8.4, $z \equiv \partial\dot{c}/\partial q_H = (1-k)v\lambda - \phi$. 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 8.4 remain after $V > 0$ has been imposed; for example, with z negative a_{11} could also be negative.

Note that the coefficients of $\dot{l}$ 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 ϕ is small, so that this adjustment does not alter the sign of the relevant coefficient; the one exception is a_{21}, for which case we assume that η_c is sufficiently large to render a_{21} negative even though a_{11} is positive.

Notes

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

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

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.

4. Capacity output of domestic nonoil goods is exogenous and, through choice of units, its logarithm is set equal to zero. Fixing capacity output, of course, precludes any possibility of long-run deindustrialization.

5. The *levels* of current and permanent real income are defined, respectively, by

$$Y = (P_H Q_H + E P_b^f Q_b)/P, \tag{6'}$$

$$Y^p = (P_H Q_H^p + E P_b^f Q_b^p)/P, \tag{7'}$$

where uppercase symbols are the antilogarithms of the corresponding lowercase ones. In what follows we abstract from changes in v occurring as a result of the oil discovery and so treat v 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.

6. Permanent oil production for $t \geqslant 0$ is derived as follows. 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

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

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

7. A negative γ_4 would indicate that either the domestic good is complementary to oil or an increase in p_b^f leads to recession in the country's trading partners, thus reducing export demand.

8. Note that the real interest rate, $r - \dot{p}$, can be written as $r - \beta_1\dot{c}$ using (1) and (9).

9. In (20), δ is defined as $\eta_c/\lambda(1-v)$, so that in the l^* equation the coefficient of μ is λ^{-1}. The term $\eta_c - \eta_b = \gamma_2 - \gamma_3(1-\beta_1-\beta_2)$ takes on significance below.

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

11. 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 re-equilibrate the goods market at full employment if (a) the effect of the real exchange rate on q_H is weak (η_c is small) and (b) the effect of an oil price increase on the demand for domestic nonoil goods is positive and large (η_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.

As Peter Neary has pointed out to us in correspondence, the difference $(\eta_c - \eta_b)$, equal to $\gamma_2 - \gamma_3(1-\beta_1-\beta_2)$, can be interpreted as the gross cross-price elasticity of the demand for home goods with respect to the price of nonoil imports. A presumption that goods are gross substitutes is therefore a presumption that $(\eta_c - \eta_b) > 0$.

12. Note that for a "small" country ($\gamma_2 = \infty$), $dc/dp^f = 0$ and $dl/dp_b^f = (1-v)$, $0 < 1 - v < 1$.

13. 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 nonoil imports whose price remains fixed at

$p^f = 0$. If nonoil 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 l or $e + p_b^f$. If oil price increases were indexed on the price of domestic nonoil 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]).

14. If z were negative, then a_{11} could be negative and the $\dot{c} = 0$ locus would be negatively sloped. As long as it still cuts the $\dot{l} = 0$ locus from above, the analysis in the text holds; in particular, the saddle path would still be positively sloped. Necessary and sufficient for the equilibrium to be a saddle point is that $|A|$ be negative. For anticipated or "preannounced" disturbances the analysis is a little more complicated. This is treated in the context of the oil discovery case below.

15. Note that while our model has a sticky price *level*, the inflation rate is a jump variable. In fact, by equation (3) the initial fall in q_H means that the inflation rate falls immediately by more than the reduction in μ. The model could be extended to allow for inertia in the inflation rate.

16. 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 would be relative to that new value of q_H^p.

17. From (4), a unit fall in c creates an excess supply of money of $1 - v$ while a unit rise in p_b^f creates an equivalent excess demand.

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

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