DUTCH DISEASE — HOW MUCH SICKNESS, HOW MUCH BOON?

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This paper sets out a very simple neo-classical, small-country, open-economy model with non-tradable goods, tradables other than oil, and oil. Using the comparative static version of the model it is shown that a rise in the world price of oil must, ceteris paribus, cause the price level of non-tradables to rise if a fixed exchange rate is maintained. Using the dynamic version of the model it is shown that the path of the non-tradables price level in response to an oil shock may carry it through substantial overshooting before the final equilibrium is reached. However, it is also shown that the degree of overshooting can be reduced dramatically by the simple expedient of seeing to it that the increase in spending generated by the added revenue takes place gradually through time, rather than precipitously. In this way the rise in the domestic price level caused by the oil shock can be limited (for practical purposes) to approximately the amount dictated by the degree of appreciation of the real exchange rate necessary to restore equilibrium.

1. Introduction

The term 'Dutch disease' was coined to describe the reaction that an economy can have to the emergence of a new major export industry, or, alternatively, to a significant rise in the international price of one or more existing exports.

In the present paper we develop a simple model to analyze the 'export boom' phenomenon. The model, probably the simplest that can be devised to handle the problem, covers all its essential components. Its equations distinguish between 'oil' (the export boom product), the production of tradables other than oil, the demand for tradables other than oil, and the supply and demand for home goods (non-tradables).

*Author's note: This paper was written during August and September, 1981, while I was serving as a consultant to the Ministry of Finance of Indonesia under the auspices of the Harvard Institute of International Development (to both of which institutions I am grateful for permission to publish). The study was done under circumstances and time constraints which precluded any careful examination of the literature. When, later, I attempted to remedy this deficiency, I found the task of distilling and summarizing the existing work on the general topic of Dutch disease, and of relating it to my own contribution, to be more formidable by far than the work that culminated in the present paper. Certainly such a task would merit, at this stage of development of the literature, an independent review article. Under these circumstances, I have decided to include a bibliography of work on Dutch disease and related subjects, containing the contributions that have come to my attention. The large number of papers there listed itself suggests that I have not uncovered all that has been done. I have therefore called it a partial bibliography on Dutch disease and related topics.
In section 2 the simplest version of this model is considered, in which only comparative static solutions emerge. This model is evolved in the context of a fixed exchange rate economy, but this really plays no role in the final solutions for relative prices and real quantities. The use of the assumption of a fixed exchange rate is nothing more than the choice of foreign currency as the 'numeraire' of the system. Other choices of numeraire (e.g., the wage rate or the money supply) would yield the identical results (for real quantities and relative prices).

In section 3 of the paper certain monetary dynamics are explored. Here the assumption of fixed exchange rates is again made, but now it has more substantive content, as there is no reason why the dynamic process under a fixed exchange rate system should match the one that would exist under, say, a flexible rate system. The final equilibria should be the same, but the time paths by which those equilibria are approached can easily differ. Indeed, when the exchange rate is specified to be fixed, many alternative dynamic processes could be compatible with it. In our exercises, we will use processes that we believe to be plausible.

2. The 'real' model

We posit an economy described by the following equations for

**Home Goods Demand:**

\[ H^* = a_0 - a_1(P_x - P_i) + a_2 Y, \]

which depends on the price of home goods \( P_x \) relative to that of tradables \( P_i \) and on the level of real output \( Y \) \textit{(initial prices are calibrated to 1.0}, hence \( P_x - P_i \) approximates the corresponding price ratio, note, too, that \( a_1 \) is defined to be positive).

**Home Goods Supply:**

\[ H^* = b_0 + b_1(P_x - w), \]

which depends on the price of home goods \( P_x \) relative to the level of factor costs or wages \( w \).

**Tradeable Goods Supply:**

\[ T^* = c_0 + c_1(P_i - w), \]

which depends on the price level of tradable goods \( P_i \) relative to the level of factor costs or wages \( w \).

\[ \]

National Real Product Generated by 'Oil' \( O \):

\[ Z = P_0 O, \]

where the oil economy of the country is assumed to have a life of its own. Output is exogenous in the sense that it is the product of past discoveries, and the world price is also taken to be exogenous. The disturbance to be analyzed is a change in real prices.

**Real Output:**

\[ y = H^* + T^* + Z, \]

note that we assume the world price of non-oil tradables is exogenous and constant over the exercise.

**Factor Costs or Wages:**

\[ w = f_1 P_x + (1 - f_1) P_i \]

\[ f_1 = b_1(b_1 + c_1), \]

which is an index of the variable costs that are relevant in the production of \( H^* \) and \( T^* \). As the oil sector is assumed to be able to command the resources it desires, we build in the assumption that sectors \( H \) and \( T \) compete for the remaining resources. Thus \( dH^* = b_1(dp_x - dw) = -dT^* = -c_1(dp_i - dw) \). With \( dp_i = 0 \), this means \( b_1(dp_x - dw) = c_1(dw) \) or \( dw = b_1(dp_x(b_1 + c_1)). \)

**Demand for Tradeables:**

\[ T^* = a_0 + a_1(P_x - P_i) + (1 - a_2) Y, \]

where it is assumed that all income is spent—either consumed or invested—on either tradables or home goods. Hence the coefficient of \( Y \) in the tradeables demand equation is 1 minus its coefficient in the home-goods demand equation. The standard 'Slutsky condition' on compensated price effects requires that \( \partial T^*/\partial P_x = \partial H^*/\partial P_x \). Using \( a_i \) as the coefficient of \( P_x - P_i \) ensures this.

**Balance of Trade:**

\[ B = T^* + Z - T^*, \]

which is usually defined as exports minus imports. This is equal to non-oil exports plus oil exports minus imports. Add to non-oil exports the home costs.
consumption of home-produced exportables and the home consumption of home-produced importables; this is the supply of tradeables. Add the same two items to imports to get the demand for tradeables. Thus the trade balance can be expressed as shown.

**World Price of Tradeables:**

\[ P_t = P_n \]  \hspace{1cm} (9)

which is taken as exogenous, and (implicitly) the exchange rate is taken as given. This equation thus defines the numeraire of the system. Alternatively, a different numeraire could be chosen; \( P_t \) would then be defined as \( P_t = E P_n \) where \( P_t \) is the price of tradeables in world prices and \( E \) is the exchange rate.

**Demand for Money:**

\[ M^d = k w y \]  \hspace{1cm} (10)

which is a version of the 'Cambridge equation' where the price level relevant for money demand is defined to be the level of wages (or unit factor costs).

**Supply of Money:**

\[ M^s = M^f \]  \hspace{1cm} (11)

with a fixed exchange rate, the money supply (in equilibrium) is beyond the control of the monetary authorities, as long as they do not modify the pattern of trade distortions. The dynamic version of the model (see section 3), however, permits transitory divergences of \( M^s \) from \( M^f \).

The solution of this model, starting from an initial situation in which \( P_x = P_y = P_t = w = 1 \), is extraordinarily simple. Given the fact that \( dH^* = -dT^* \) [see under eq. (6)], it follows that \( dP_y = dz \). The fact that \( dP_y \) is zero allows us, from eq. (6), to set \( dP_y = f_y dP_y \). With these two results, we equate \( dH^* \) and \( dH^* \), from eqs. (1) and (2), as follows:

\[ dH^* = -a_y dP_y + a_y dz = b_1 dP_y (1 - f_y) = dH^* \]  \hspace{1cm} (12)

\[ dP_y = \frac{a_y dz}{a_1 + b_1 (1 - f_y)} \]  \hspace{1cm} (13)

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\[ dP_y = \frac{a_y dz}{a_1 + b_1 (1 - f_y)} \]  \hspace{1cm} (13)

This can be converted into more familiar elasticities using the following

subscripts formulas:

- \( \sigma_y \) = income elasticity of demand for home goods = \( \frac{a_y}{H^*} \)
- \( \eta_y \) = price elasticity of demand for home goods = \( \frac{a_y}{H^*} \)
- \( \sigma_y \) = price elasticity of supply of home goods = \( \frac{b_1}{H^*} \)

Eq. (13) then becomes

\[ dP_y = \frac{\sigma_y dZ / y}{\eta_y + \sigma_y (1 - f_y)} \]  \hspace{1cm} (14)

Table 1 shows, for illustrative but plausible values of \( \sigma, \eta, \) and \( c \), the equilibrium change in the price of home goods relative to that of non-oil tradeables. The conclusions are quite clear. In general a rise in world oil price sufficient by itself to increase real national income by 10 percent will necessarily raise home goods prices relative to those of tradeables. But given the magnitude of the shock, the size of the effect on home goods prices is surprisingly modest. Only in two cases out of the fourteen examined is this effect larger than 10 percent.

<table>
<thead>
<tr>
<th>Assumed parameters</th>
<th>Elasticities of demand for home goods</th>
<th>Elasticity of supply price</th>
<th>Weight of home-goods prices in wage index (f_y)</th>
<th>New equilibrium price level after oil shock (P^*_y = 1.00)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>Price</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.75</td>
<td>1.08</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0.75</td>
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</tr>
<tr>
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<td>2</td>
<td>2</td>
<td>0.75</td>
<td>1.04</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0.75</td>
<td>1.044</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0.75</td>
<td>1.088</td>
</tr>
<tr>
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<td>2</td>
<td>2</td>
<td>0.75</td>
<td>1.13</td>
</tr>
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<td>1</td>
<td>0.75</td>
<td>1.16</td>
</tr>
<tr>
<td>0.6</td>
<td>1</td>
<td>2</td>
<td>0.75</td>
<td>1.048</td>
</tr>
<tr>
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<td>2</td>
<td>0.75</td>
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</tr>
<tr>
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</tr>
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</tr>
<tr>
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<td>1</td>
<td>1</td>
<td>0.75</td>
<td>1.078</td>
</tr>
<tr>
<td>0.6</td>
<td>1</td>
<td>1</td>
<td>0.75</td>
<td>1.096</td>
</tr>
</tbody>
</table>
Table 2 explores another effect of interest of students of 'Dutch disease'. Obviously, a rise in home goods prices, relative to those of tradeables, creates an incentive to shift resources out of the production of tradeables and into that of home goods. It was, indeed, the decline in industrial output in the Netherlands that led to the baptism of 'Dutch disease'. The final column of table 2 depicts, for the combinations of parameters given, the amount of those shifts, expressed in percentage points of total initial national product. Here again the results are reassuring, with the resource shift in all cases being the equivalent of 2 percent of national output or less.

Also worthy of note is the fact that the results of table 2 depend only on the relative values of the price elasticities. That is to say, a doubling or halving of all price elasticities leaves the amount of the resource shift unchanged. This is evident once the expression for $\delta_{1}$ is inserted into eq. (2) [using eq. (6)], leading to

$$dH = H^{(F)} \frac{dP_{d}(1-f)}{y} \frac{dP_{d}(1-f)}{y} \frac{dZ}{y}$$

$$dH = \left( \frac{H^{(F)}}{y} \right) \frac{\delta_{1}P_{d}(1-f_{1})}{y} \frac{dZ}{y} y$$

Table 2

<table>
<thead>
<tr>
<th>Elasticiies of demand for home goods</th>
<th>Elasticity of supply price</th>
<th>Weight of home goods prices in wage index</th>
<th>Amount of resources shifted as percentage of initial national product (95 = 60, $\gamma_{1} = 20, \gamma_{2} = 100$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1</td>
<td>1</td>
<td>0.75</td>
<td>1.2</td>
</tr>
<tr>
<td>1 2</td>
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<td>0.75</td>
<td>2.0</td>
</tr>
<tr>
<td>1 3</td>
<td>3</td>
<td>0.75</td>
<td>1.2</td>
</tr>
<tr>
<td>1 1</td>
<td>1</td>
<td>0.75</td>
<td>0.66</td>
</tr>
<tr>
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<td>1</td>
<td>0.75</td>
<td>0.66</td>
</tr>
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</tr>
<tr>
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<td>1</td>
<td>0.75</td>
<td>1.2</td>
</tr>
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</tr>
<tr>
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<td>2</td>
<td>0.75</td>
<td>1.2</td>
</tr>
<tr>
<td>0.6 2</td>
<td>2</td>
<td>0.75</td>
<td>0.72</td>
</tr>
<tr>
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<td>0.75</td>
<td>0.40</td>
</tr>
<tr>
<td>0.6 1</td>
<td>1</td>
<td>0.75</td>
<td>0.40</td>
</tr>
<tr>
<td>0.6 1</td>
<td>1</td>
<td>0.75</td>
<td>1.2</td>
</tr>
<tr>
<td>0.6 1</td>
<td>1</td>
<td>0.75</td>
<td>0.72</td>
</tr>
</tbody>
</table>

3. Adding monetary dynamics to the 'real' model

It takes little adaptation in order to introduce a plausible dynamics into the model of section 2. The principal changes are:

(a) To eliminate the requirement of continuous equality between money demand ($M^{(M)}$) and money supply ($M^{(S)}$). Instead we add terms to the demand equations for home goods and for tradeables; these terms state the increment to the demand for each of the two classes of goods that will take place as a consequence of the existence of a supply of money greater than what people want to hold (and vice versa for a shortfall in the money supply).

(b) To introduce a dynamic equation for the money supply, in which changes in international reserves cause the money supply to change in the same direction. In the simulations presented here, we work with the equation $M_{j} = M_{j-1} + B_{j}$ where $M_{j}$ is the money supply at the end of period $j$ and $B_{j}$ is the balance of trade during period $j$. But with equal ease one can incorporate explicitly a distinction between money on the one hand and the monetary base on the other, with a 'money multiplier' as the link between the two.

(c) To introduce plausible lag patterns in the equations of the basic model. The establishment of specifically "timed" relationships is, of course, essential once a dynamic focus is adopted. The key lagged relationships are:

(i) demand for home goods ($H^{(F)}$) and demand for tradeables ($T^{(F)}$) depend on last period's income ($y_{j-1}$) and on this period's relative prices ($P_{d} - P_{u}$).

(ii) transitory components in the demand for home goods ($H^{(F)}$) for tradeables ($T^{(F)}$) appear whenever ($M^{(F)}_{j} - M^{(F)}_{j-1}$) is different from zero. These transitory components of demand are proportional to ($M^{(F)}_{j} - M^{(F)}_{j-1}$).

(iii) the wage of one period is based on the previous period's price levels of home goods and of tradeables.

The dynamic model is presented explicitly below, with $j$ as the index for the time period.

**Home Goods Demand:**

$$H^{(F)}_{j} = a_{0} - a_{1}(P_{d} - P_{u}^{j}) + a_{2}y_{j-1} + a_{3}(M^{(F)}_{j-1} - M^{(F)}_{j-1})$$

(1)
Home Goods Supply:
\[ H_1^* = b_0 + b_1(P_0 - w) \]  
(2)

Tradeable Goods Supply:
\[ T_1^* = c_0 + c_1(P_0 - w) \]  
(3)

National Product Generated by 'Oil' (G)
\[ Z_1 = P_0 \Phi_p \]  
(4)

Real Output:
\[ y_1 = H_1^* + T_1^* + Z_1 \]  
(5)

Factor Costs or Wages:
\[ w_t = \frac{1}{1 - f_1} P_{k+1} + (1 - f_1) P_{k+1} \]  
(6)

Demand for Tradeables:
\[ T_1^* = c_0 + c_1(P_0 - P_1) + (1 - a_2) y_{k+1} + c_3(M_{k+1} - M_{k+1}) \]  
(7)

Balance of Trade:
\[ B_1 = T_1^* + Z_1 = T_1^* \]  
(8)

World Price of Tradeables:
\[ P_0 = P_1 \]  
(9)

Demand for Money:
\[ M_2^* = k y_t [f_1 P_{k+1} + (1 - f_1) P_{k+1}] \]  
(10)

Supply of Money:
\[ M_2^* = M_{k+1} + B_1 \]  
(11)

There follow a series of simulations in which the dynamics implicit in the above model are worked out under a number of alternative assumptions. Simulations 1, 2, and 3 are all based on the assumption that the elasticities of demand and supply of home goods are equal to one, and that the income elasticities of both goods as well as the supply elasticity of tradeables are also equal to unity. (The demand elasticity for tradeables is 1.5 in these simulations, as determined by the Slutsky condition.)

In Simulation 1, it is posited that when the money supply is greater (less) than what people want to hold, they eliminate the excess (shortfall) in just one period. In Simulation 2, it is assumed that they only eliminate half of the excess or shortfall in the first period; then they eliminate half of any excess or shortfall that remains in the second period, etc.

In the three simulations, 1, 2, and 3, the equilibrium values of all the variables are the same. The dynamic paths of the variables, however, differ as among these simulations, because the speed with which excess money is spent is slower in Simulations 2 and 3 than in Simulation 1, and because the pattern in which excess money is spent differs as between Simulations 2 and 3. In Simulation 1, for example, the price level of home goods (P1) rises to a maximum of 1.125 times the price level of tradeables, before adjusting (in a damped oscillatory process) to its final equilibrium level of 1.08 times P1. In Simulation 2, Ps rises only to a maximum of 1.113 times P1. This is exclusively due to the slower process of working off excess money balances.

Simulation 3 begins a series of experiments in which we make a conscious effort to increase both the response of Ps to the oil shock in the final equilibrium and the degree to which Ps overshoots its final equilibrium level in the process of adjustment. The first experiment (Simulation 3) involves increasing the share of excess money balances which is spent on home goods, and reducing correspondingly the share spent on tradeables. This should have the effect of 'bottling up' excess balances within the economy, and causing a somewhat greater overshoot. This is indeed the case, with Ps reaching 1.123 in Simulation 3 as against 1.114 in Simulation 2, but the magnitude of the effect is obviously not very great.

In Simulation 4 we extend the same sort of adjustment to the marginal proportions in which income is spent (for consumption and investment). These are changed (as against Simulation 3) from 0.6 and 0.4 for home goods and tradeables, respectively, to 0.8 and 0.2, implying a higher elasticity of demand for home goods (in the neighborhood of the initial equilibrium) of 1.33, and an income elasticity of 0.5 for tradeables. This sort of pattern of income elasticities is quite implausible, as in general luxury goods tend to be concentrated among the tradeables. Yet the assumption is made in order to test the sensitivity of the results. In the particular case examined in Simulation 4, the equilibrium level of Ps moves from 1.08 to 1.107, while the maximum point on its time path shifts upward somewhat more sharply, from 1.123 to 1.184.

Simulations 5 and 6 experiment with changing price elasticities. Both are to be compared with Simulation 4. Starting from this base, Simulation 5 cuts
in half all four price elasticities (those of supply and demand for both home goods and tradeables), while Simulation 6 reduces by one half only the two demand elasticities. The effect of cutting price elasticities is much more marked than those of our earlier experiments. In Simulation 5 the equilibrium value of \( P_t \) moves up from 1.107 in Simulation 4 to 1.213, while its maximum value moves from 1.162 to 1.340. Simulation 6 produces an equilibrium value of \( P_t \) equal to 1.178, as compared with 1.107 for Simulation 4. The increase in the maximum value is even sharper—from 1.162 to 1.297. It appears, then, that reducing demand elasticities has stronger effects in generating 'overshooting' than does a corresponding reduction of supply elasticities. [That changes in demand elasticities have a stronger effect on equilibrium values than corresponding changes in supply elasticities is evident from eq. (14). It is not self-evident that this should be true for the degree of overshooting as well, but that is the conclusion suggested by the comparison of Simulations 5 and 6.]

4. Introducing lags in supply response, plus greater long-run elasticity

In this section we try to zero in somewhat more carefully on parameter patterns that are likely to reflect reality. These diverge somewhat from the patterns used in earlier sections, which were intended mainly for the purpose of assessing the sensitivity of our results to changes in the values of particular parameters.

4.1. Income elasticity of demand: 1.25 for tradeables, 0.83 for home goods

These assumptions imply that marginal income is spent half on tradeables and half on home goods. Since the initial average propensities to spend (i.e., consume and invest) on the two classes of goods are 0.4 and 0.6, the stated elasticities emerge from the definition of income elasticity (=marginal propensity divided by average propensity). These figures were chosen because of our conviction that in general (for less developed countries) tradeable goods are somewhat more likely to fall in the luxury (e.g. category than non-tradeables, while at the same time the income elasticities of expenditure on all goods and services have to average to one.

4.2. Price elasticity of demand: 0.6 for tradeables, 0.4 for home goods

These assumptions imply a unitary elasticity of substitution between tradeables and non-tradeables. It is unlikely that the true elasticity is significantly greater than this, if only for the reason that any good that is a close substitute for an import or export commodity would normally be classified with the tradeables. (The relative sizes of the two elasticities are determined by the Slutsky condition; they must be inversely proportional to the budget shares of the two groups of goods, and their sum must be equal to the elasticity of substitution.)

4.3. Price elasticities of supply: Between 2.0 and 5.0 in the long run

We now both from individual industry studies and from simulations that the elasticities of supply of individual industries as well as of large sectors of the economy tend to be significantly greater than unity. (In general, low elasticities appear only when activities are characterized by severe natural resource constraints.) At the same time, we know that there are severe limits to the amount by which the bulk of activities can be expanded within a short time (say, a year or so). Both of these appreciations of reality can be incorporated into our simulations by introducing lagged price terms in the supply function. In what follows we shall use the following lag distributions:

4L 0.25, 0.25, 0.25, 0.25
4D 0.40, 0.30, 0.20, 0.10
6L 0.167, 0.167, 0.167, 0.167, 0.167, 0.165
6D 0.35, 0.25, 0.16, 0.12, 0.08, 0.04

This means that, for 4L, one-fourth of the total long-run effect of the change in price takes place in the first period (which in setting up the dynamics I have thought of as being something like a year); one-half takes place by the end of the second period, three-fourths by the end of the third, and the full effect by the end of the fourth period. For lag pattern 6L, the initial response is one-sixth of the long-run response, and an additional one-sixth is added each period. For the lag pattern 4D, we have 40 percent of the total response in the first period, 70 percent by the end of the second, 90 percent by the end of the third and 100 percent by the end of the fourth. In pattern 6D these cumulative percentages of the total effect are, for successive periods, 35, 60, 76, 88, 96, and 100 percent. We believe that these four response patterns are sufficiently different from each other to give us a good sense of how our results respond to plausible differences in response patterns, while at the same time reflecting our belief that long run supply elasticities are significantly greater than we would infer from the first period response.

4.4. Coefficients of \((M^* - M^0)\) = 0.25, 0.25, or, alternatively, 0.5, 0.5

These coefficients dictate the fraction of 'excess money supply' that will be reflected in spending on each of the two categories of goods within one
period. Thus in the first case it is assumed that one quarter of the excess is spent on home goods, one quarter on tradeables, within one period. If this is the pattern, three-fourths of a given excess supply would be worked off after two periods, seven-eighths after three periods, etc., assuming no intervening or additional disturbances.

The alternative assumption, that all the excess is spent within one period, requires no elaboration.

4.5. The money multiplier (money/international reserves)

The monetary mechanism that is built into our simulations is that of a fixed exchange rate system. The ultimate reserves of such a system are gold and foreign currency, and they are acquired through surpluses in the balance of payments (balance of trade in the case of our model, since we abstract from voluntary capital movements). A money multiplier of unity is implicit in the equation \( M^t = M^{t-1} + B^t \). To introduce a different multiplier, \( \mu \), this is altered to \( M^t = M^{t-1} + \mu B^t \). In table 4 we explore the consequences of changing \( \mu \) from 1.0 to 1.5.

4.6. The oil shock

In each of tables 3 and 4, allowance is made for the possibility of 'spreading' over time the response of the economy to the oil shock. This is accomplished by spending in the first period only a relatively small part of the shock, followed by steadily increasing fractions in subsequent periods, until finally the full effect of the assumed increment of oil prices is reflected. Three alternative patterns are explored:

(a) Full Immediate Impact (20, 30, 30, ...). Here the contribution of oil proceeds, which starts at 20 percent of the national product, goes immediately to 30 percent, and stays there.

(b) Declining Increments (20, 24, 27, 29, 30, ...). Here the path from a 20 percent to a 30 percent contribution of oil is spread out over four years, with successively smaller increments being reflected each year.

(c) Equal Increments (20, 22, 24, 26, 28, 30, ...). Here the shock is spread over a five-year period with equal increments in each.

Obviously, patterns (b) and (c) would entail accumulation of foreign reserves, if the actual oil-price rise was such as to permit pattern (a). The cumulative reserve accumulation under pattern (b) would be equal to 10 percent of GDP; that is, equal in size to one year's contribution of the oil shock itself. In the case of pattern (c) this accumulation of reserves would amount to 20 percent of GDP, or twice the annual contribution of the oil

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Maximum level reached by ( P^t ) during adjustment process; money multiplier = 1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil shock</td>
<td>Supply elasticity = 2</td>
</tr>
<tr>
<td>4L</td>
<td>4D</td>
</tr>
<tr>
<td>Coefficients of ((M^t - M^{t-1}) = 0.25, 0.25)</td>
<td></td>
</tr>
<tr>
<td>20, 30, 30, ...</td>
<td>1.133</td>
</tr>
<tr>
<td>20, 24, 27, 29, 30, ...</td>
<td>1.108</td>
</tr>
<tr>
<td>20, 22, 24, 26, 28, 30, ...</td>
<td>1.114</td>
</tr>
<tr>
<td>Coefficients of ((M^t - M^{t-1}) = 0.5, 0.5)</td>
<td></td>
</tr>
<tr>
<td>20, 30, 30, ...</td>
<td>1.167</td>
</tr>
<tr>
<td>20, 24, 27, 29, 30, ...</td>
<td>1.105</td>
</tr>
<tr>
<td>20, 22, 24, 26, 28, 30, ...</td>
<td>1.115</td>
</tr>
</tbody>
</table>

Steady state = 1.093

Maximum price rise/equilibrium price rise

| Coefficients of \((M^t - M^{t-1}) = 0.25, 0.25\) | | | | |
| 20, 30, 30, ... | 1.46 | 1.32 | 1.65 | 1.44 |
| 20, 24, 27, 29, 30, ... | 1.16 | 1.18 | 1.37 | 1.26 |
| 20, 22, 24, 26, 28, 30, ... | 1.23 | 1.15 | 1.31 | 1.20 |
| Coefficients of \((M^t - M^{t-1}) = 0.5, 0.5\) | | | | |
| 20, 30, 30, ... | 1.79 | 1.39 | 2.19 | 1.49 |
| 20, 24, 27, 29, 30, ... | 1.13 | 1.18 | 1.33 | 1.20 |
| 20, 22, 24, 26, 28, 30, ... | 1.18 | 1.08 | 1.30 | 1.17 |

Supply elasticity = 5

| Oil shock | Lag pattern |
| 4L | 4D | 6L | 6D |
| Coefficients of \((M^t - M^{t-1}) = 0.25, 0.25\) | | | | |
| 20, 30, 30, ... | 1.082 | 1.060 | 1.104 | 1.077 |
| 20, 24, 27, 29, 30, ... | 1.064 | 1.063 | 1.082 | 1.069 |
| 20, 22, 24, 26, 28, 30, ... | 1.064 | 1.060 | 1.072 | 1.065 |
| Coefficients of \((M^t - M^{t-1}) = 0.5, 0.5\) | | | | |
| 20, 30, 30, ... | 1.091 | 1.078 | 1.121 | 1.087 |
| 20, 24, 27, 29, 30, ... | 1.064 | 1.061 | 1.081 | 1.069 |
| 20, 22, 24, 26, 28, 30, ... | 1.063 | 1.059 | 1.068 | 1.062 |

Steady state = 1.051

Maximum price rise/equilibrium price rise

| Coefficients of \((M^t - M^{t-1}) = 0.25, 0.25\) | | | | |
| 20, 30, 30, ... | 1.61 | 1.35 | 2.04 | 1.51 |
| 20, 24, 27, 29, 30, ... | 1.25 | 1.24 | 1.64 | 1.35 |
| 20, 22, 24, 26, 28, 30, ... | 1.25 | 1.18 | 1.41 | 1.27 |
| Coefficients of \((M^t - M^{t-1}) = 0.5, 0.5\) | | | | |
| 20, 30, 30, ... | 1.78 | 1.53 | 2.37 | 1.71 |
| 20, 24, 27, 29, 30, ... | 1.25 | 1.20 | 1.59 | 1.35 |
| 20, 22, 24, 26, 28, 30, ... | 1.24 | 1.16 | 1.33 | 1.22 |
shock. Thus, although the time periods of spreading differ relatively little as between patterns (b) and (c) the effective amount of spreading is substantially greater in the latter case.

4.7. Interpretation of tables 3 and 4

Tables 3 and 4 summarize the results of 96 different simulations. We have focused on the maximum level reached by the price level of home goods during the initial overshoot (which invariably occurs in the cases investigated). The overshoot is, however, substantially more moderate than in the extreme examples of simulations 5 and 6. Moreover, adopting a gradual response to the oil shock succeeds in limiting the overshoot even further.

When a supply elasticity of 2 is used, and 25 percent of excess money holdings is spent on each good in each period, we are placed in the upper panels of tables 3 and 4. With full immediate impact of the oil shock, the biggest overshoot carries \( p_t \) to a maximum of 1.153 in table 3 (lag pattern 6L). This is reduced to 1.127 and 1.122 under gradual response with declining or with equal increments. The overshoots in these cases are very modest indeed, because the steady state level of \( p_t \) is 1.093.

A similar exercise for table 4 yields an overshoot to 1.187 in the full immediate impact case, reduced to 1.133 and 1.124 when a gradual adaptation to the oil shock is imposed.

The story is similar for the other cases examined in tables 3 and 4. Under the 20, 24, 27, 29, 30, ... pattern of gradual response to an oil shock, the maximum level of \( p_t \) never reaches a level as high as 1.127 in the remaining panels of table 1 nor a level as high as 1.133 in the remaining panels of table 2.

When a long-run elasticity of supply of 5.0 is assumed (which I believe to be more plausible than 2.0 in any event), the maximum points on the time path of \( p_t \) are as follows:

**Nature of response to oil shocks**

<table>
<thead>
<tr>
<th>From table 3</th>
<th>From table 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full immediate impact (20, 30, 30, ...)</td>
<td>1.121</td>
</tr>
<tr>
<td>Gradual, declining increments (20, 24, 27, 29, 30, 30, ...)</td>
<td>1.082</td>
</tr>
<tr>
<td>Gradual, equal increments (20, 22, 24, 26, 28, 30, 32, ...)</td>
<td>1.072</td>
</tr>
<tr>
<td>Steady state (for reference)</td>
<td>1.051</td>
</tr>
</tbody>
</table>

The clear conclusion to be drawn from this exercise is that by adopting a gradual pattern of response to an oil shock the extent of overshooting can very likely be kept within modest and easily manageable limits.

5. Some concluding observations

The exercises that we have reported on here cover quite a wide range of possibilities, but obviously not the whole set of potentially interesting cases. In conversations with colleagues, I have found that the greatest interest in alternatives has to do with cases in which the government spends the 'oil money', Z, in a fashion somewhat different from that which our exercises have assumed.

The assumption implicit in our exercises is that the government spends the oil money in substantially the same pattern (as between tradeables and home
goodness}, as consumers would have chosen. This assumption would obviously also hold in the case where the government simply gives the money in to consumers. The results of this an exercise can easily be predicted without actually going through the exercise of a simulation. The key feature is that, in the context of the model, no feedback to the economy is required, or assumptions are made. For example, that all of the oil proceeds were carried over to the following year, or that a government decision made in the first quarter of the year would not have to be reflected in the forecast for the following year.

The allocation of resources at the point where the military were concerned would be different now, with the oil windfall, but in the period while the steel plant was being built, and even in its first year of operation, there would be no serious difference between the two periods. Two variables in the model are concerned.

Now, if instead of the incremental revenues, the corresponding one in tables 3 and 4, the same thing, on tradeables, regardless of where the money is spent on. That is, the availability (v) that is "available to help adjust the balance of payments in tables 4 and 5, half of the proceeds of the oil shock simply disappeared overseas in the form of foreign currency, to bring about the consequent balance-of-payments adjustment. The consequences are far more serious than the time of this exercise. However, the signs are that all the money is spent on, whereas in the exercise, the corresponding one in tables 3 and 4, the same thing, on tradeables. At the same time, the exercise, the corresponding one in tables 3 and 4, the same thing, on tradeables.
References

Partial bibliography on Dutch disease and related topics