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SUPPLY VERSUS DEMAND APPROACHES TO THE PROBLEM OF STAGFLATION

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Supply Versus Demand Approaches to the Problem of Stagflation

ABSTRACT

We develop a model of aggregate supply and demand in the open economy to explain the important characteristics of international macroeconomic adjustment in the 1970s. Traditional demand-oriented models cannot account for the worldwide phenomenon of rising inflation and unemployment in the mid-70s, or for the failure of most industrialized economies to recover from the deep recession of 1974-75. When aggregate supply is carefully treated, it is found that much of the inflation and sluggish output performance may be attributed to the jump in the real costs of intermediate inputs and the failure of real wages to adjust downward after the input price shock. A simulation model shows that fuel inputs are sufficiently important in production that a large part of the worldwide recession may be attributed to the change in the relative price of oil since 1973. In an empirical section, it is suggested that countries differ in their response to supply shocks and macro-policies because of differences in key stuctural relationships, particularly in wage determination.

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SUPPLY VERSUS DEMAND APPROACHES TO THE PROBLEM OF STAGFLATION*

INTRODUCTION

This paper deals with the co-existence of inflation and unemployment in industrial countries in the 1970s. The period since 1972 marks a departure from the previous decade in more than one important respect. It began with an extraordinary spurt of inflation that in many countries is only now receding. The inflation has been marked by great divergences in rates between countries. It seems to be generally agreed that the oil crisis and related events had a lot to do with this upsurge in prices and that the breakdown of the Bretton Woods system of pegged rates had a lot to do with the subsequent divergence of inflation rates. What is much more marked and less well understood is the pronounced decline in output growth which started with the worldwide recession of 1974-75. The GNP growth of the OECD countries came down to an annual average of 3 per cent during 1973-78, compared with about 5 per cent in the preceding decade. Productivity growth rates came down even more, capital accumulation is still lagging, and above all, unemployment rates, which more or less doubled since the 1960s, are on average still as high to-day as they were in 1974-75.

A prerequisite for enlightened economic policy discussion is a

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reasonable understanding of the recent past, not only because past events might recur, but because it seems as if the industrial world has not yet recovered from the 1974-75 episode. The most natural reaction to persistent unemployment, for a world brought up on Keynes, is to think of it purely in terms of a shortfall in aggregate demand. The oil price hike, under such a view, can be looked upon as an excise levied by OPEC on the industrial world, not enough of which has been spent to keep economic activity at earlier levels. According to this view the slack may be fully eliminated with a sufficient boost to demand on a co-ordinated world scale (leaving aside special problems such as the unemployment of the young or other particular social groups). Inflation persists because of strong inflationary expectations following the commodity boom, but the inflation-unemployment trade-off of the Phillips curve must, in this view, bring inflation down. A more monetarist point of view, according to which there is no such policy trade-off, gives a reasonably good account of divergences in inflation rates between countries but is hard put to explain persistent unemployment.

In our view, stagflation cannot be understood only in aggregate demand or purely monetary terms. Accelerating goods prices and increasing unemployment suggest the co-existence of demand pressure in the commodity market and excess supply in the labour market.[1] This is precisely the nature of a real supply

[1] Stagflation could be defined in terms of alternative combinations of either increasing or persistently high levels of unemployment and inflation (see Blinder, 1979). Rather than sticking to a specific definition we prefer to state the events we are trying to account for: during 1973-75 both unemployment and the rate of inflation increased simultaneously; since 1975 inflation has been tapering off while unemployment remains high.

shock, such as was caused by the rise in oil and raw materials prices in 1972-74.[2] An increase in the price of a variable factor of production, such as oil, may reduce profits, output, and the input of other variable factors, such as labour, unless their relative price adjusts downwards. If real wages are sticky, which, by and large, they have been, unemployment will result.

Such a recession can further be exacerbated by restrictive domestic demand management, which may be required to combat inflation and rising current-account deficits, and by the accompanying fall in investment demand. It is precisely because of the existence of demand-induced elements that it is all too easy to attribute all of the unemployment to Keynesian factors, although a large part it is really of a 'classical' nature. That part can only be eliminated by a fall in real wages or increased capital accumulation, neither of which is likely to occur in the short run.

Because supply shocks are a fairly complex and new problem a large part of our paper (Section I) is devoted to a theoretical discussion of the effect of supply and demand shocks in a representative open economy and the various policy responses to them.[3] This is done by means of a diagrammatic exposition of a model presented in greater technical detail elsewhere. It is followed in Section II by a brief study of global considerations and multi-country interactions.

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[2] The relative prices of raw materials have since dropped back to their previous level, but the higher level of relative oil prices has so far persisted (see Table 5 in Section III).

[3] For earlier studies of the problem in a closed-economy context, see Gordon (1975), Phelps (1978), and Solow (1978).

One may believe that a supply shock will reduce output in the short run without being convinced that the 1973 oil-price rise played a major role in the world recession that followed. The quantitative evidence of Section III argues that it did. There we present a realistic simulation model (for a representative economy and for a two-country world) and some econometric estimates of important relationships (labour market behaviour, investment demand, etc.) for seven major industrial economies.[4] It is important to stress that countries will differ in their response to supply shocks and macro policies precisely because of differences in one or more of these key structural relationships.[5]

The analysis in this paper is almost exclusively short-run in nature. An important issue, the long-term repercussions on capital accumulation, is only mentioned in passing. Likewise the long-run effects of current-account imbalances and the important structural effects on developed economies of LDC industrialization are left out of the present paper.

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[4] Both Mork and Hall (1978) and Hudson and Jorgenson (1978) have found substantial real effects of energy price changes for the United States. Separate studies by the authors of this paper (Bruno, 1979, and Sachs, 1978) have dealt with aspects of these relationships in other OECD countries.

[5] For example, the United States may be characterized by nominal wage rigidity and may therefore be more output-responsive to monetary policy. Many European countries would be better described in terms of real wage rigidity and are therefore more likely to translate money growth into an immediate price rise. It is certainly a mistake to base one's views on observations of only one country.

I. THE REPRESENTATIVE OPEN ECONOMY

An understanding of stagflation necessitates a careful specification of at least two markets, the market for final domestic goods and the labour market. Our analysis here is based on a model that was laid out and discussed in much greater detail elsewhere (Bruno and Sachs, 1979, henceforth MEA). We shall concentrate mainly on a simplified diagrammatic exposition, leaving the algebra and a quantitative amplification to Section III.

While discussing the individual economy it is easiest to consider external market conditions as exogenously given; this assumption is relaxed in Section II. We distinguish between two exogenous commodity prices, the foreign price of intermediate goods, later to be represented by energy, and the foreign price of final goods. These prices, in logarithmic form, will be denoted by p_n^* and p^*, respectively. The relative price will be denoted by π_n $(= p_n^* - p^*)$.[6] Intermediate goods are used as a major input (n) in the domestic production of final goods (q), together with labour (ℓ) and capital (k). Intermediate goods may also be produced domestically

[6] We shall use lower-case letters to denote logarithms of upper-case variables. Thus p_n^* is the log of the price level P_n^* and π_n is the log of $\Pi_n = P_n^*/P^*$, etc. The time derivative of a log variable will thus be the proportional rate of change of the underlying original variable [e.g., $\dot{p} = (dP/dt)/P$ = rate of inflation].

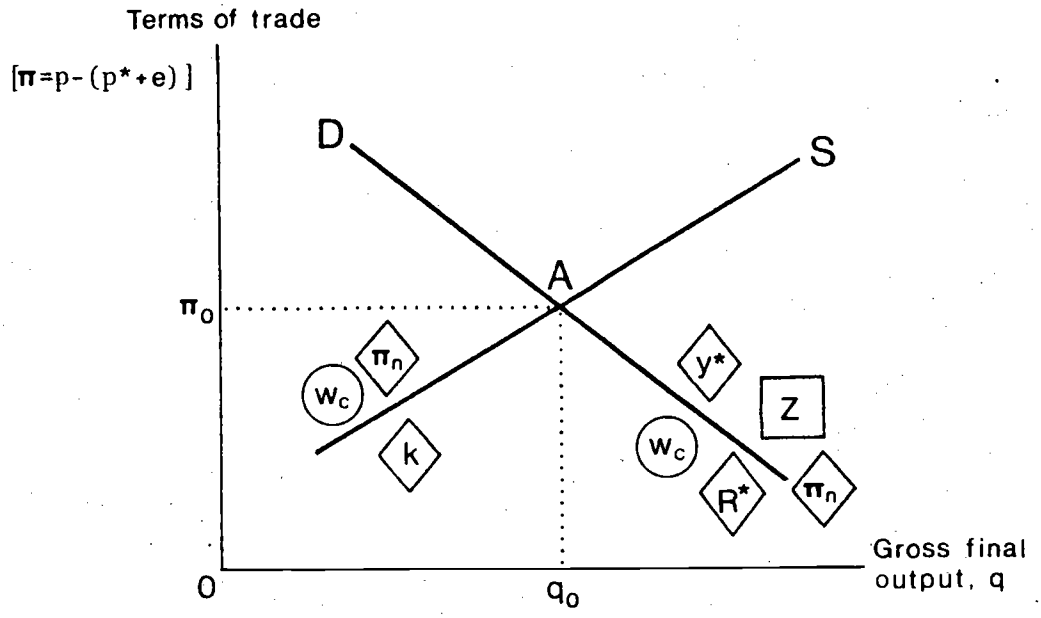
at the given world price and such import substitution (or even net export) may provide one source of international differences in industrial structure. The single domestic final good, q, whose price is p, will be an imperfect substitute for the foreign final good in both consumption and exports. The domestic price of the foreign good is $(p^* + e)$, where e is the exchange rate in domestic currency per unit of foreign exchange. The relative price of the final good ($\pi = p - p^* - e$), or the terms of trade, will be one important endogenous variable to be determined in the commodity market.

The Commodity Market

The analysis of the domestic final goods market (Figure 1) is best conducted in terms of the quantity supplied and demanded of the final good, q, and its relative price, π, as defined above. Determination of π $(= p - e - p^*)$ is tantamount to the determination of the real exchange rate $(e - p)$. In order to conclude something about the behaviour of the absolute price level, p, we still need a theory to determine the *nominal* exchange rate, e. Under a fixed exchange-rate regime it can be considered exogenous while under a float it will be determined by money and an asset market and therefore outside the commodity market. This will be discussed separately. For the moment we only have to remember that $p = \pi + p^* + e$ and that for given final goods price (p^*) and given exchange rate (e) any change in the terms of trade (π) implies an equal change in the price level (p). It is analytical convenience that suggests using π and q, rather than p and q, on the two axes in Figure 1.

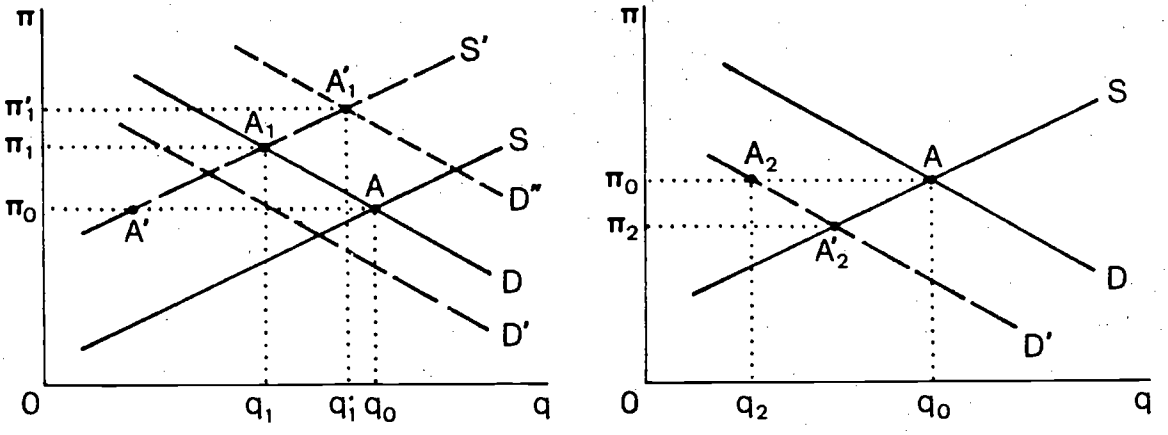
Next we note that in looking at the commodity market we take the real

Figure 1. The Final Goods Market[a]



1a: Import price shock

1b: Pure demand shock



[a] In this and subsequent diagrams we adopt the following conventions: A parameter will be written on the side of a curve according to the direction in which a positive change in it will shift the curve. A variable enclosed in a diamond is exogenous (at least in the short run), in a rectangle it is directly determined by policy, and in a circle, it is endogenous for the model as a whole. Thus, w_c is in a circle because it is endogenously determined by the dynamics of the labour market.

wage (w_c)[7] to represent the labour market as a given parameter. The real wage may be considered the equilibrating variable when the labour market is in disequilibrium, but it is usually characterized by downward rigidity. Its relatively slow speed of adjustment justifies using it as a given parameter in drawing an aggregate short-run supply curve for the commodity market, rather than assuming labour market clearance.[8]

Given a three-factor aggregate production function[9] $q(n, \ell, k)$ and assuming that firms minimize costs, one can deduce a short-run marginal cost schedule which is linearly homogeneous in the prices of the variable factors (w and p_n) and is a negative function of the quantity of capital (k), which is fixed in the short run. Assuming prices (p) to be proportional to marginal costs and making suitable transformations in terms of the relative prices π, π_n, and w_c, we can draw the commodity supply schedule in the π-q space.

The curve marked S in Figure 1 indicates the aggregate supply of final goods. In the short run, with capital, k, held fixed, it should in principle be upward sloping but one would expect it to be reasonably flat

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[7] This is here defined as the nominal wage, w, divided by the price of a consumption basket which consists of both imported and domestically produced final goods, which in log terms is $w_c = w - [\lambda p + (1 - \lambda)(p^* + e)]$ (for details see MEA).

[8] An alternative, which for the purposes of the present diagrammatic exposition would not be very different, is to consider the *nominal* wage as the given parameter (the meaning of the commodity supply curve will alter accordingly). In Section III below we shall make the corresponding empirical distinction between wage-wage and wage-price linkage.

[9] This will be further specified as a two-level CES function (see Section III).

when the economy operates below capacity. As indicated earlier the supply curve is here drawn with the relative price of the intermediate good ($\pi_n = p_n^* - p^*$) and the real wage (w_c) as given parameters. Any increase in one of these raises variable production costs and therefore shifts the S curve up and to the left, while any increase in the capital stock will shift the curve down and to the right.

Let us next briefly summarize the demand side of the model. Consider the main components of final demand: private and public consumption, investment, and exports. Private consumption of the domestic good is considered a positive function of real disposable income and a negative function of the terms of trade ($\pi = p - e - p^*$). Exports are similarly a positive function of world income (y^*) and a negative function of π. Investment is considered a negative function of the externally given real interest rate, R^*, and a positive function of the rate of profit.[10]

Once this subsystem is solved out it can be summarized in the form of a demand schedule, drawn in Figure 1 as a downward sloping curve D for a given set of parameters. This curve will be shifted up and to the right by an increase in external demand (y^*), or by domestic fiscal policy (Z).[11] Similarly a shift down and to the left may be caused by an increase in the real interest rate (R^*) or by an increase in the real wage (w_c). The assumed sign of the latter in the demand curve comes from its supply effect on the production and use of intermediate goods and through

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[10] Money might also affect the system through the investment channel. More on this in Section III.

[11] The fiscal variable is expressed in terms of the combined relative effect of government expenditure and taxes.

investment demand.[12]

The role of the relative foreign price of intermediate goods is ambiguous, because of conflicting forces at work. A rise in π_n at a given production level of intermediate goods will depress the real income and consumption of a net importer of these goods while the substitution effect and a possible increase in the domestic production of intermediate goods will work in the other direction. For a net importer of intermediate goods and with a low degree of substitutability, the demand curve is thus likely to shift to the left with an increase in π_n. For a net exporter of intermediate goods or for an economy in which there is considerable domestic substitutability the shift may go in the other direction.[13] For most OECD countries the first is the more likely.

Consider now the effect of two kinds of possible changes in the system. An import price shock, involving an increase in the relative price π_n, shifts the supply curve unambiguously to the left (see the shift from S to S' in Figure 1a), leading to excess demand of the amount AA' at the initial price π_0. If, as was suggested, demand also contracts as a direct effect of the rise in π_n, excess demand will be reduced, but the new equilibrium at point A_1 will in any case involve a reduction in output. What will happen to the relative price π is not clear; if, as is likely, the supply curve is relatively flat and the effect on the supply curve

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[12] If there are marked differences between the propensities to consume out of wages and out of profits the direction might be reversed. This possibility is ignored here.

[13] For the same reasons the demand curve may itself be upward-sloping (see MEA).

dominates the demand shift, π will rise;[14] in the opposite (and for an OECD economy less likely) case, where import prices are demand-expanding, the terms of trade will obviously rise but the net effect on output is ambiguous.

Consider the importance of the degree of real wage stickiness in this analysis. While we have not yet considered the labour market, it is clear that unless there is a strong substitution effect, an output contraction will reduce labour demand and press downward on real wages. Assume now that nominal wages are downward flexible or that the unexpected price shock causes a momentary reduction in *real* wages. In that case there will be a force working in the commodity market in exactly the opposite direction to that of the import price shock (consider the signs attached in Figure 1 to shifts in w_c). One would obviously expect to find different patterns of real wage response to the import price shock in different countries (see Section III).

It is important to point out that this analysis of the effect of a rise in import prices is confined to the short-run implications. For example, a fall in the rate of profit and a contraction in output, in addition to their immediate effect on investment demand (see below), may eventually cause a fall in the capital stock, k. Also, changes in the current account may have repercussions on domestic real wealth, thereby affecting the demand curve. These are ignored here.

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[14] We should remember that the absolute price level, p, may rise even when the relative price, π, falls, provided the domestic price of the final export (import) good, $p^* + e$, rises sufficiently (which has certainly happened in all OECD countries in the 1970s).

The commodity market representation of the effect of a supply shock is the key to an understanding of the difference between stagflationary effects of the kind that affected OECD economies in the early 1970s and the more conventional business-cycle demand fluctuations which are either inflationary *or* deflationary in both commodity and labour markets. A rightward shift in the demand curve will by itself raise prices (unless we are in a flat section of the supply curve) as well as final output and employment (unless we are hitting a full employment ceiling). But consider now the more relevant case of a demand contraction coming from either domestic demand restraint (Z) or from a contraction in world demand (y^*). In Figure 1b this is represented as a shift of the demand curve from D to D' causing excess supply of the amount A_2A at the given initial price ratio π_0.

If prices are downward flexible the relative price would fall to π_2, with equilibrium at A_2'. But suppose prices (p) are rigid so that at given p^* and e, the relative price stays temporarily at π_0. In that case output would be constrained by demand and would fall from q_0 to q_2, with unemployment of the conventional Keynesian kind resulting (see further discussion below in the labour-market context). Firms would like to sell more but are unable to do so. At point A_2 (Figure 1b) they are, at least temporarily, not on their supply curves. This is in marked contrast with the previous case where output contraction originates from a supply shock.

During the 1974-75 recession there was clearly a combination of a supply shock with a concomitant demand contraction coming from the cumulative income reduction in all OECD countries. This was compounded by a fall in investment and in some countries (notably the United States)

by domestic fiscal and monetary restraint as well. For this reason it is easy to fall into the trap of attributing *all* of the unemployment to a more conventional demand contraction combined with downward price rigidity. As pointed out by Malinvaud (1977), until recently the experience of the industrial countries has been confined to alternations between situations of Keynesian unemployment or inflation. The developments of 1973-75 mark a departure from this pattern.

An import price shock, as we have seen, is most likely to cause a rise in the relative domestic price level $p - e - p^*$. For a given e and p^*, the *nominal* domestic price level will rise. However, it is important to note that neither the observed price rise nor the intercountry differences in inflation rates since 1973 can be explained without recourse to the monetary mechanism and exchange-rate behaviour under a flexible rate regime. For the determination of e, attention must focus on the asset markets, to which we turn briefly.

Current theory and available evidence stress that the exchange rate is the relative price of national moneys. One important element of exchange-rate determination is then the relative growth rates of money stocks. Our model, like most, has the characteristic that a money supply increase in one country leads in the long run to an equiproportional depreciation of its exchange rate and a rise in its domestic prices. Since p and e rise by the same amount, $p - e - p^*$ and output are unaffected in the long run by the money supply increase.

In the short run, though, the determination of domestic prices and the exchange rate is more complicated. Let us trace through the effect of a one-shot increase in the domestic money supply. Initially, domestic interest

rates tend to fall. But given world capital mobility, there is an attempt to transfer funds to world assets, which have a temporarily higher rate of return. With floating rates, the exchange rate depreciates (e rises); in fact, e continues to rise until the expected returns of domestic and foreign assets are again equalized.

As e rises, import prices and the consumer price level rise. If nominal wages are sticky, $w - p_c$ falls and the terms of trade worsen, i.e., $p - e - p^*$ falls. Domestic prices do not immediately rise in equal proportion to e. As real wages are restored, w increases, pushing up the domestic price level in the process. Eventually, p and e rise in the same proportion as the original money supply change. If the real wage is fixed in the *short run*, then the domestic price level almost immediately rises in proportion to the depreciation. This is, of course, the familiar vicious circle of depreciation and domestic inflation.

Once it is recognized that a significant part of the recession was classical and supply-determined, i.e., directly tied to too high real wages, the inflationary consequences of expansionary monetary policy are highlighted. It is important to remember, though, that expansionary monetary policy may have some effect on output in the short run, and that for countries like Canada and the United States, with sluggish nominal wage change (see Section III), the inflationary effects of the money expansion might initially be small.

The three kinds of shift discussed here (import price shock, exchange rate adjustments and demand contraction) go quite a long way in explaining both the deep recession of 1974-75 and the intercountry differences in rates of inflation. But before turning back to these let us consider the

implications for the labour market, which in many ways mirrors the effects already considered in the commodity market.

The Labour Market

The curve L^d in Figure 2 represents the usual downward sloping marginal product curve here expressed in terms of the real consumption wage (w_c) rather than the real product wage ($w - p$).[15] The curve is derived from the commodity supply schedule. The direction of the shift caused by changes in the relative price π_n is again ambiguous because of the conflicting income and substitution effects. It should be noted, however, that final goods production may fall with a rise in π_n and yet labour demand may rise if the substitution effect is strong enough (see, for example, Hudson and Jorgenson, 1978). However, the most likely case for an OECD country with low elasticity of energy substitution is an unambiguous leftward shift in the demand curve for labour. In Figure 2a, which illustrates such a shift, the result is excess supply (unemployment) of the amount B_1B at the initial level of real wage w_{c_0}.

A new equilibrium full employment at B'_1 could be reached after a process of downward real wage adjustment. Alternatively, if capital is a complementary limiting factor, capital accumulation might eventually help to shift the labour demand curve back and thus reduce unemployment. It is doubtful whether such a corrective mechanism would come about by itself,

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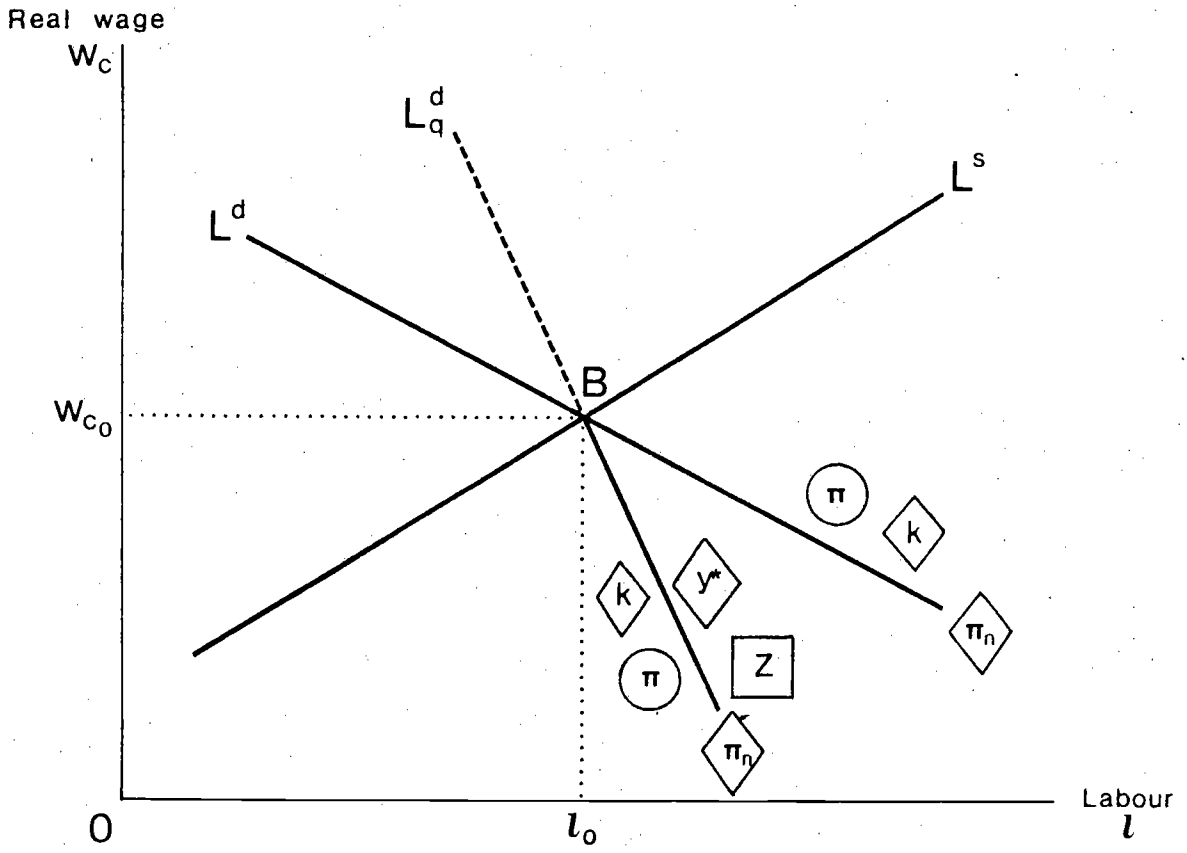
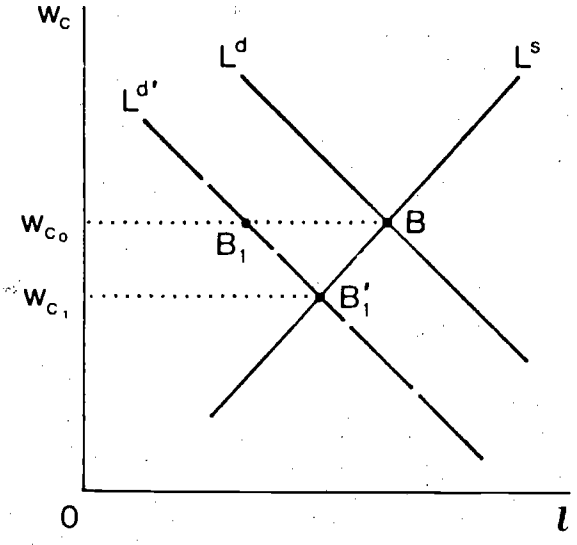
[15] This is done to conform to the concept of real wages that is most appropriate from the point of view of labour supply behaviour (see curve L^s in Figure 2) and the dynamic adjustment process.

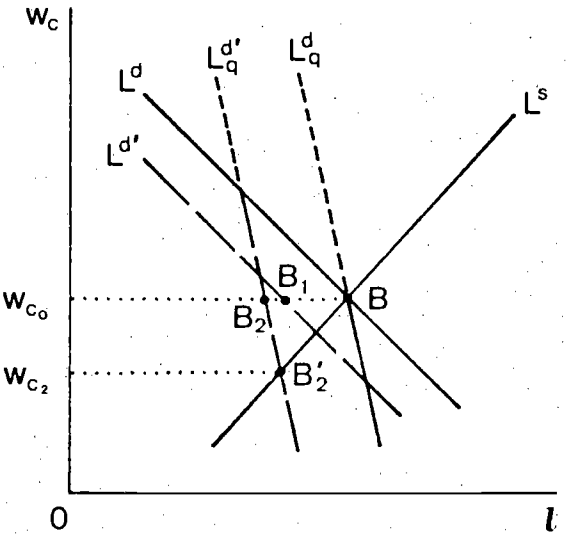
Figure 2. The Labour Market



2a: Classical unemployment



2b: Keynesian unemployment



and in any case either adjustment process would be slow to come about.[16] Another option for a single country, at least in theory, would seem to be the adoption of an expansionary fiscal policy. In the commodity market this is represented by a rightward shift of the demand curve leading to an increase in both output (q) and prices (π and therefore p). As the final goods price also appears as a parameter of the labour demand curve (see Figure 2), this expresses itself as a shift back to the right of the L^d curve and a reduction in unemployment. The implied cost in higher prices and a greater current-account deficit makes this an unlikely policy to follow for any length of time. Besides, as we shall see below (Section II) it cannot be adopted by all supply-shocked countries simultaneously; when the relative price, π, rises in one country it must fall in the rest of the world.

If output in the commodity market happens to be temporarily constrained on the demand (and not on the supply) side, which is the Keynesian case, producers will not be on their supply curve and the relevant demand schedule for labour will be represented by the steeper curve marked L_q^d in Figure 2, whose position will be determined mainly by the demand variables (y^*, Z).[17]

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[16] As far as capital accumulation is concerned, the movement was, if anything, in the opposite direction (see Section III).

[17] The capital stock, k, and the relative price, π, now appear as leftward shifting variables while π_n is again ambiguous but more likely to shift the curve to the left. The relative slopes of the curves L_q^d and L^d are implied by the assumption that the positive response of output supply to a fall in real wages dominates the response of output demand.

The case of a pure demand shock (see the shift from L_q^d to $L_q^{d'}$ in Figure 2b), with rigid real wage, brings about *Keynesian* unemployment of the amount B_2B, if L^d stays put. The case represented in Figure 2a may more appropriately be termed *classical* unemployment, having been caused by a shift in the whole marginal product schedule. With both types of shocks present in the 1974-75 recession it is, of course, difficult to assess how much of the unemployment at any point in time or in any specific country may have been Keynesian or classical,[18] but it is important to stress that given the existence of a supply shock, unemployment cannot be cured only in a Keynesian fashion, for reasons that have already been mentioned and to which we shall return later.

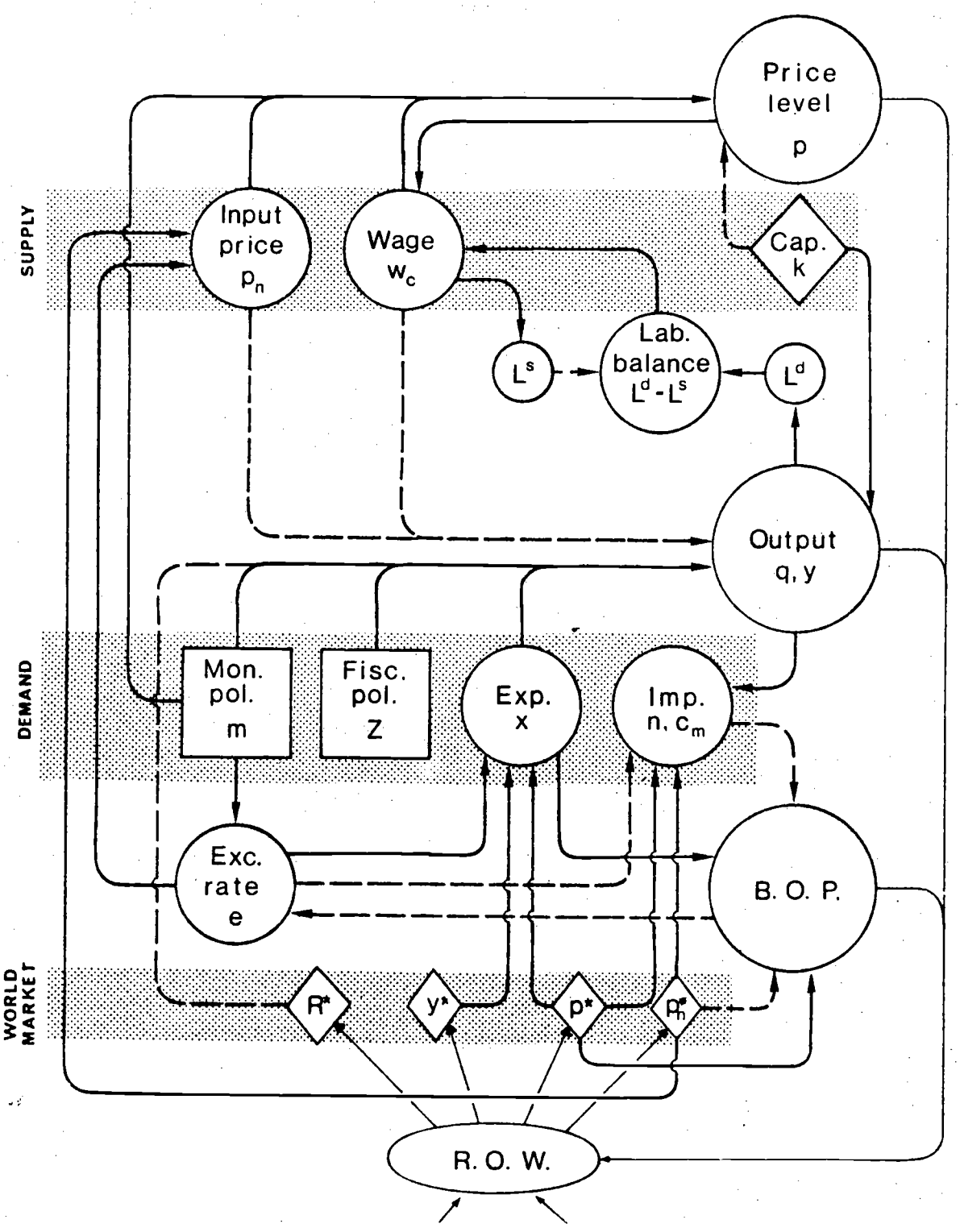
General Equilibrium

The determinants of the exchange rate and the concomitant development of the balance of payments have been described only briefly. In MEA we model the determinants of the exchange rate under the assumption of perfect capital mobility.

To get a better idea of how the various parts of the system are linked, consider a simplified flow-chart of our representative open economy (see Figure 3). The top part of the chart shows the main links from the costs of production (raw materials and labour) to the price level (positively) and the level of output (negatively). Output in turn affects the demand for labour and imports. Both the demand for and the supply of labour are affected by the (real) wage rate which in turn is adjusted in

[18] In the example of Figure 2b there is Keynesian unemployment B_2B_1 over and above the classical unemployment B_1B.

Figure 3. Major Linkages in the Open Economy [a]



[a] Dashed lines – – – indicate negative effect.

a dynamic process by the resulting disequilibrium in the labour market as well as by the extent of price-wage linkages. Lower down, the chart indicates the main links from the demand side (fiscal and monetary policy, exports) to output. The direct link to prices is likely to be weaker if the supply schedule is relatively flat. The foreign sector is represented by the components of demand for real imports[19] and exports; these are domestic or world income as well as the real exchange rate and foreign prices.[20]

The exchange rate, in turn, may in principle be affected by both the balance of payments (capital flows are not directly shown) as well as by monetary policy, in case of a float.

The 1973-75 story can be started from an exogenous increase in external import prices (see the bottom part of the chart). Domestic import prices, which are also determined by changes in the exchange rate, affected the price-wage-price system and led to an output reduction. The latter was exacerbated by an accompanying demand shock largely caused by a contraction in the world market. Countries differed in their response because of differences in three major areas: the nature of the price-wage linkages, the effects on the current-account balance and the closely related monetary policy and exchange rate response. The latter accounts for a substantial part of intercountry differences in inflation rates.

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[19] No separation into intermediate and final imports is shown here nor is the link from the domestic price level shown.

[20] The link from the current account to the exchange rate has not yet been modelled in our empirical study. This has so far been confined to the case of perfect capital mobility.

Empirical Preview

A flow-chart such as Figure 3, though simplified, may still obscure the most important issues. The feeling of not being able to see the wood for the trees may intensify as we proceed, in the next section, to discuss a quantitative simulation model. One may sometimes get a nutshell description of what has been happening even with the aid of one curve and a very small reduced-form model, albeit at the cost of considerable oversimplification. Before we plunge into detail let us therefore consider a summary figure with a familiar pair of axes--average inflation rates and rates of deviation of manufacturing output from capacity growth. Figure 4 traces the main average developments for six major OECD countries, excluding the United States[21] (Canada, Japan, France, Germany, Italy, and the United Kingdom). As is well known, the points followed what looked like a reasonably well-behaved Phillips curve in the 1960s; the plot starts curving back in 1969, with a fairly flat upward drift in both inflation and output deviation. From 1972-73 on one obtains the perverse bell-shaped curve, which is familiar from the experience of so many countries.[22]

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[21] The U.S. data, taken by themselves, also show a very similar general pattern. The following analysis is based on Bruno (1979). Capacity estimates are based on Artus (1977).

[22] A diagram of exactly this kind, averaging the figures of seven major countries, as well as individual country pictures appeared in the McCracken Report (OECD, 1977). It is worth noting that the Report had the figure drawn only up to 1976, with an arrow (and a question mark) pointing in a clear southwest direction signifying the hoped-for move "towards price stability and full employment." Subsequent developments in 1977 and 1978 have not exactly fulfilled that promise.

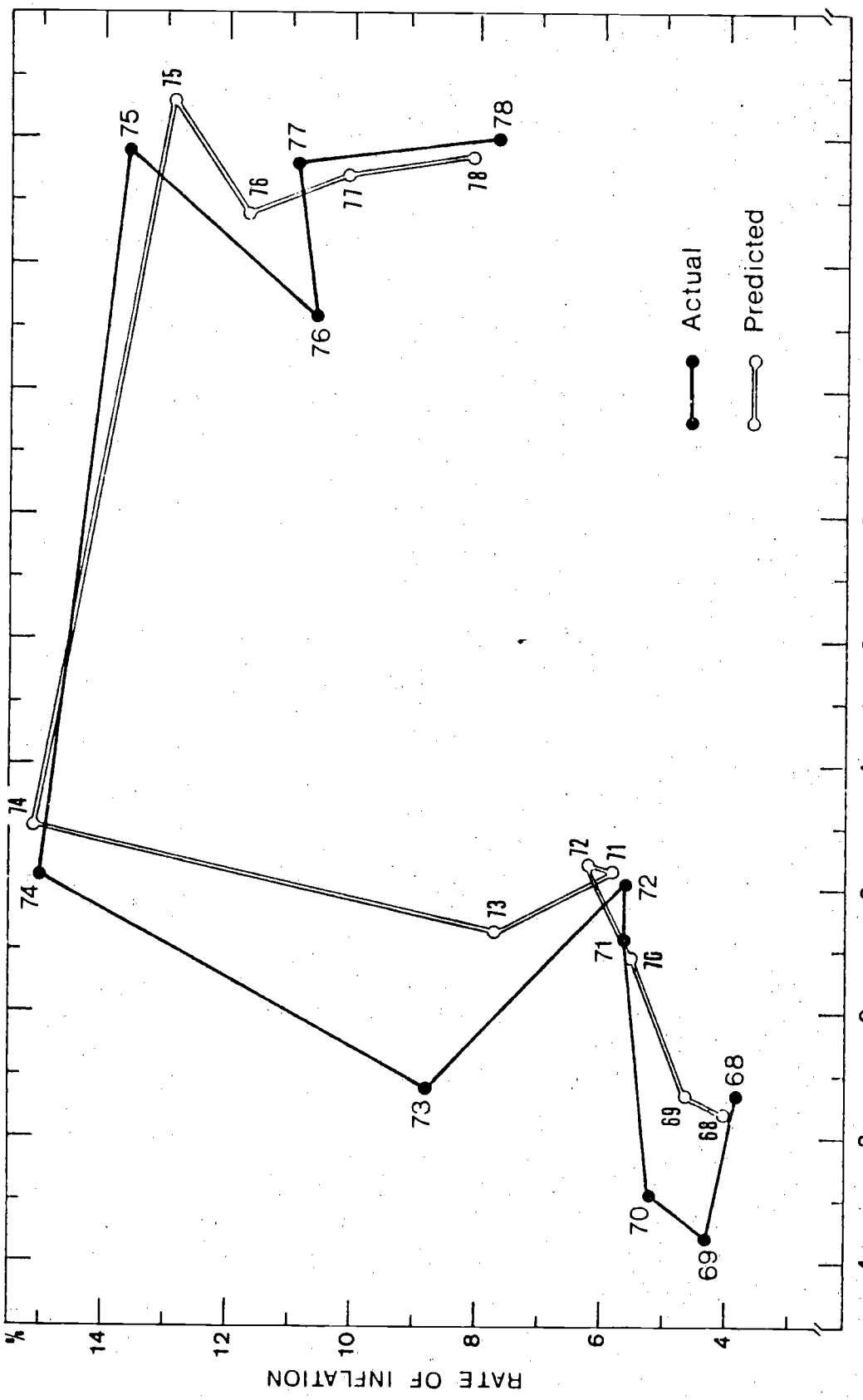

Figure 4. Inflation and Rate of Deviation from Capacity (six major industrial countries)

By 1978 the average rate of inflation had receded to just below the 1973 rate, having reached a 15 per cent peak (with a fairly wide range of amplitudes, e.g., 25 per cent for Japan, Italy, and the United Kingdom and only 7-8 per cent for Germany). However, average unemployment (here represented in terms of the rate of output deviation from capacity) is still as high as in 1975.

What is the simplest kind of model that can explain such unusual behaviour? The broken line in Figure 4 is a prediction based on a simple two-equation semi-reduced-form model estimated on the basis of a pooled regression of 60 observations of rates of change (six countries over the ten-year period 1967-77).

The price equation is

$$\dot{p}_c = \underset{0.01}{0.01} + \underset{0.06}{0.58}\dot{p}_{c_{-1}} + \underset{0.02}{0.17}\dot{p}_n^* + \underset{0.04}{0.18}\dot{e} + \underset{0.05}{0.09}\dot{m} \qquad (R^2 = 0.82)$$

and the output equation

$$\dot{q} = \underset{0.01}{0.01} - \underset{0.05}{0.17}(\dot{p}_n - \dot{p}_c)_{-1} + \underset{0.46}{0.92}\dot{Z}_{-1} + \underset{0.08}{0.16}(\dot{m} - \dot{p}_c)_{-1} + \underset{0.08}{0.32}\dot{x}$$

$$(R^2 = 0.67).$$

Small numerals are standard errors. The variables as measured are p_c = consumer prices ($p_{c_{-1}}$ is lagged one year), p_n^* = dollar import prices,[23] e = exchange rate, m = money supply (M_1), q = manufacturing output, $p_n = p_n^* + e$ = domestic import prices, Z = share of government deficit in GNP, x = total exports (all variables except Z are in logarithms).

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[23] Here no distinction is made between imports of intermediate and final goods.

The price equation can be derived from a straightforward price-adjustment relationship with price expectations and a wage-adjustment equation built into it.[24] The output equation is based on the output-adjustment relation involving both the negative import cost-push[25] and the various demand-pull elements (fiscal and monetary policy, export demand). The model is highly simplified and suffers from some obvious statistical deficiencies (one serious problem is that of pooling different countries' observations into one regression).[26] However, it does give quite good tracking of the curve in Figure 4. It should also be noted that the 1978 prediction is a true prediction lying outside the sample period.[27]

Suppose there is no change in import prices and exchange rates ($\dot{p}_n = \dot{p}_n^* = \dot{e} = 0$). In that case the pair of price and output equations

[24] The above pair of equations was selected from a preliminary empirical study (Bruno, 1979) in which a number of alternative equations were estimated for prices, output, wages, and the exchange rate. When a money-determined exchange-rate equation is substituted for the exchange rate in the price equation during the floating period (after 1972), the end results are similar. An attempt to put in separate demand elements (Z) into the price equation failed. Even money by itself is barely significant. Its main role after 1972 seems to come via the exchange rate effect on import prices.

[25] Real wages came out negative but statistically nonsignificant and were therefore deleted from the equation.

[26] The study attempts to deal with this by introducing dummy intercepts or, in some cases, allowing for different slopes. The best alternative, which we have followed here, is to look in greater detail into the experience of individual countries.

[27] The model was also used to 'explain' price and output developments in the United States, which have followed a similar pattern.

should trace patterns that would look more or less like conventional Phillips curve behaviour. The main driving force behind the system in the 1970s was import prices,[28] which are the important missing third dimension in Figure 4. Their sharp movements have pushed prices up and output growth down, with lagged wage and price adjustments delaying the exit from accelerated inflation.

It can be seen from the output equation that a change in the relative price (p_n/p_c) of the order of 30-40 per cent as in 1973-74 induces a 5-7 per cent drop in q. This accounts for between 40 and 60 per cent of the reduction in manufacturing growth in these countries in the 1970s, with world demand and domestic fiscal and monetary restraint making up varying amounts of the rest. The rise in the relative price of at least one major input, energy, has not been reversed since 1974. This explains, at least partly, that while inflation rates were back at pre-1973 levels by 1978, considerable unemployment remains in the system. It is a 'real' structural phenomenon, not one that can be explained, or cured, by purely monetary or even fiscal means. In Section III we present a more detailed quantitative attempt to trace the dynamics of a macro system under alternative external shocks. But before that we have to extend the analysis to the many-country case.

[28] With the exchange rate providing a major source of the intercountry differences in inflation rates.

II. THE INDUSTRIAL WORLD AND MULTI-COUNTRY INTERACTIONS

Once we move from a single economy to the whole industrial world neither the world price level nor world income can be assumed to remain exogenous. Countries can no longer be assumed to determine their terms of trade and real incomes independently of each other. In what sense then, if at all, can one aggregate the effects of exogenous shocks across countries?

Before considering multi-country interactions it is helpful to discuss a highly abstract model in which the whole industrial world is aggregated into one consolidated economy producing a single final good q at price p, and trading with a single 'OPEC' which is assumed to command sufficient monopoly power[29] to determine the relative price ($\pi_n = p_n - p$) of its only export, the intermediate good.[30]

Since there is no distinction between domestic and traded final goods the real product wage $(w - p)$ is now the same as the real consumption wage w_c and the world final-goods supply schedule can be represented as a function of the real wage (w_c), the relative intermediate goods price (π_n) and the exogenous capital stock (k).[31] If OPEC can fix π_n and the real

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[29] This assumption is crucial for what follows, and it seems to be realistic as far as oil prices are concerned.

[30] All nominal variables will be expressed in units of the single industrial world currency (SDRs, say) so that in terms of the previous model we can write $e = 0$, $p = p^*$. We ignore the existence of other LDCs.

[31] In the log-linear case which forms the basis for the underlying quantitative model one can write the supply curve in the form: $q^s = -b(p_n - p) - c(w - p) + k$. In the present simple world model this can also be written as $q^s = -b\pi_n - cw_c + k$.

wage is rigid, aggregate supply is unambiguously determined. The aggregate supply curve can be drawn as a vertical line in a price-quantity diagram (see curve S in Figure 5). Note that it is the absolute world price level that now appears on the vertical axis.

To obtain an aggregate demand curve we follow logic similar to that applied earlier to the single country case, but, with some modifications. Instead of taking the real world interest rate (R) as given in the investment function we can write $R = i - \dot{p}^e$, where i is the nominal interest rate and $\dot{p}^e$ are inflationary expectations. Next we solve for the nominal interest rate by appealing to a money-market equilibrium condition.[32] After substituting in the investment function and using a Keynesian aggregate demand framework the quantity demanded can finally be written as a negative function of real import prices (π_n) and the real wage (w_c) and as a positive function of the various demand shifting elements: fiscal policy (Z), exports to OPEC (x), the real money stock (m - p) and price expectations ($\dot{p}^e$). In the p-q diagram this will be a downward sloping curve D with nominal (m) rather than real (m - p) money as one of the parameters.[33]

Consider now an exogenous increase in the relative import price π_n. The supply curve shifts leftward from S to S', while the demand curve will most probably also shift to the left (from D to D'). The extent of the shift depends on the real wage response, as before. The equilibrium point will move from A (q_0, p_0) to B (q_1, p_1).

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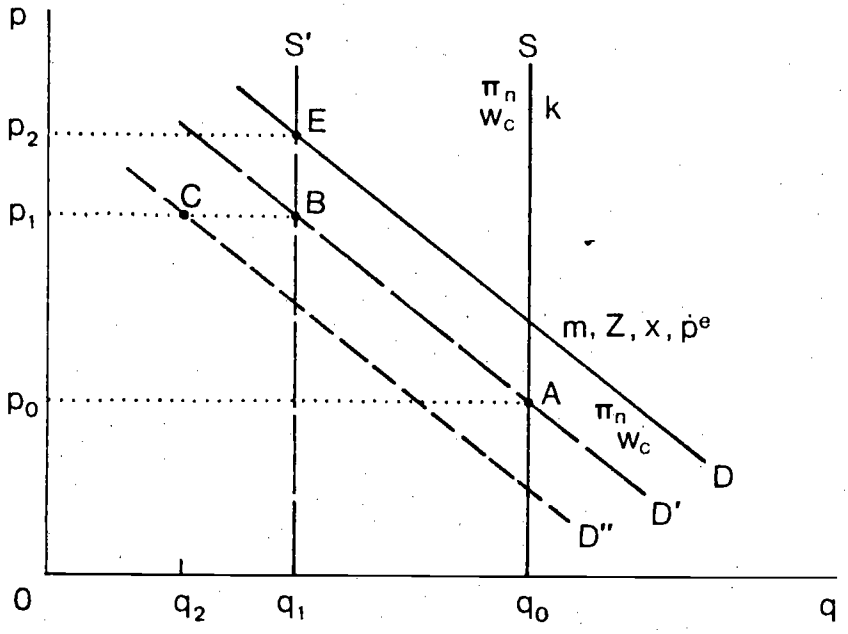
[32] This can be written in the form $m - p = \theta_1 q - \theta_2 i$.

[33] A similar closed-economy framework was recently used by Phelps (1978) to analyse the implications for monetary policy of an exogenous productivity change.

Figure 5. Global Framework



There are a number of important points to note. Consider first the unambiguous contractionary effect on output which is wholly supply-determined, given real wage rigidity. The effect on the price level is more ambiguous since it depends on the relative strength of the impact effect on real income and demand as against its effect on supply.[34]

With the new equilibrium at B, what will happen if an attempt is made to boost demand? An accomodating monetary policy can be represented as an increase in m shifting the demand curve back to D. All that would happen in this case is a further rise in the price level to the full amount of the increase in the money supply (see the move from B to E in Figure 5, with prices rising to p_2). Fiscal policy (Z) will likewise raise interest rates and force up prices by a crowding-out process. Finally, greater recycling of OPEC surpluses can here be represented by an increase in x, again with no expansionary effect on output. If the industrial world is on its supply schedule, an increase in output can come about only as a result of a fall in real wages or a rise in the capital stock.

Is this a realistic description of the main factors underlying the recent world recession? Let us repeat two qualifications. First, note that to the extent that there is *nominal* wage rigidity monetary policy may cause real wages to fall, through a price rise, and thus have an expansionary effect. The second, more important, point is that there could be a Keynesian recession on top of a classical one. Suppose, for example, that the leftward shift of the demand curve takes the form of a further move to D'' (because the effect of the supply shock on real income is stronger or

[34] It also depends on what happens to the expectations term ($\dot{p}^e$) and exports (x).

because of excessive contractionary policy). With prices rigid at p_1, say, the extra fall in output from q_1 to q_2 marks a Keynesian type of demand deficiency with more unemployment in the labour market. It is only the BC $(q_1 - q_2)$ portion of output slack in Figure 5 that could be taken up by non-inflationary expansion of demand. Again there is a hard core $(q_0 - q_1)$ that cannot be eliminated.

Looking at the industrial world as one country obviously precludes discussion of some important questions relating to the interactions between different industrial economies. Short of specifying a more elaborate multi-country model we shall consider briefly the case of two interacting industrial countries of the kind discussed in Section I.[35]

Suppose now that relative prices are defined in relation to a world final-goods price p^*, measured in some unit of account (e.g., SDR). Assume also that the world final-goods price level is defined as a weighted average [log-linear with weights γ and $(1 - \gamma)$] of the two country export prices, so that we can write $p^* = \gamma(p_1 - e_1) + (1 - \gamma)(p_2 - e_2)$. We thus have $\pi_n = p_n^* - p^*$, $\pi_1 = p_1 - e_1 - p^*$, and $\pi_2 = p_2 - e_2 - p^*$ (where e_1 and e_2 are the two exchange rates).[36] It follows that the two relative

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[35] A simulation model based on such a framework is further discussed in Section III. The two supply curves can be written as

$$q_1 = a_1\pi_1 - b_1\pi_n - c_1 w_{c_1} + k_1$$

and

$$q_2 = a_2\pi_2 - b_2\pi_n - c_2 w_{c_2} + k_2.$$

[36] An alternative definition of the terms of trade of country 1 would be in relation to the other country's export price: $\pi' = (p_1 - e_1) - (p_2 - e_2)$. It is easy to transform one definition into the other by noting that $\pi_1 = (1 - \gamma)\pi_1'$. It is π_1' that is the measure used in our empirical study.

final-goods prices π_1 and π_2 are constrained by the relation $\gamma\pi_1 + (1 - \gamma)\pi_2 = 0$. Consider the case in which the two countries are the same size. We get: $\pi_1 + \pi_2 = 0$ or $\pi_1 = -\pi_2$. We can now go back to the two separate supply curves and by substitution obtain a two-country real output frontier,[37] marked TS in Figure 6.

This curve differs from a conventional production possibility frontier in that the real costs of labour (w_{c_1}, w_{c_2}) and the real cost of imports (π_n) rather than their quantities appear as parameters. A rise in π_n shifts the curve inwards from TS to TS' if the two real wage levels are downward rigid. Suppose the original world equilibrium was at point A on the curve TS (for determination of the demand side see below) and as a result of an import price shock is now at A' on TS' after a contraction of output in both countries. But suppose the second country now attempts to regain its previous output level (q_{2_0}) by boosting its domestic demand. Quite independently of any balance of payments problems (to which we turn later) this can only take place at the expense of the first country's output since a gain in one country's terms of trade must be the other country's loss (shift from A' to B in Figure 6).

This highly simplified argument again shows the fundamental difference between a supply shock which affects the structure of the industrial world and between demand shifts which, except for temporary Keynesian situations, can ultimately be no more than beggar-my-neighbour cures. Given the rise

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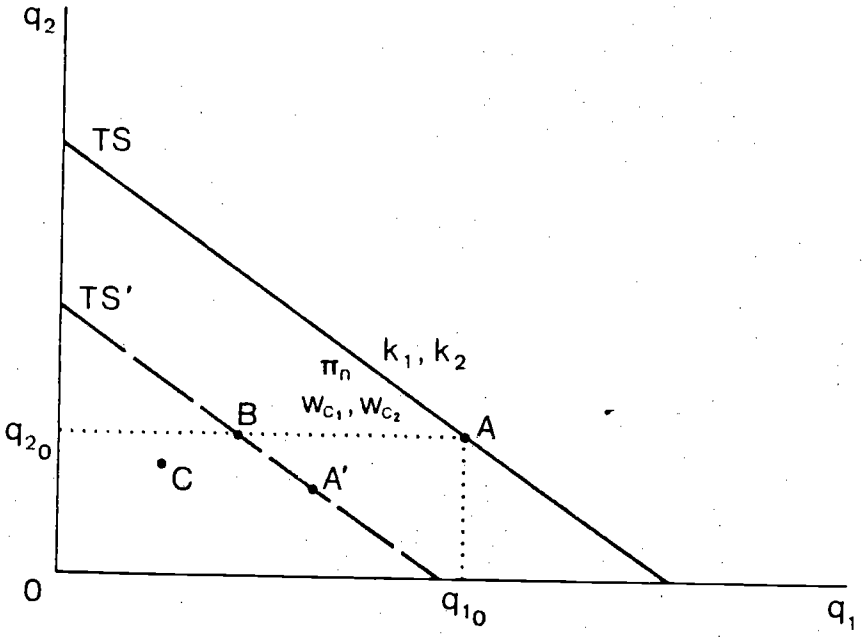
[37] The following equation is obtained from the two in note 35:

$$a_2 q_1 + a_1 q_2 = -(a_2 b_1 + a_1 b_2)\pi_n - (a_2 c_1 w_{c_1} + a_1 c_2 w_{c_2}) + a_2 k_1 + a_1 k_2.$$

Figure 6. Two-Country Model



in π_n, a shift back of the TS curve can only be brought about by a downward adjustment in the real wage in at least one of the countries or by capital accumulation.

Is there any point in co-ordinated world expansion except to prevent beggar-my-neighbour results? Again the answer is that when a supply shock is accompanied by demand contraction, the system may well find itself, temporarily, in a Keynesian unemployment situation. It terms of Figure 6, this would be represented by a point such as C *inside* TS'. Expansionary policy may then increase output in one economy without necessarily causing a contraction in the rest of the world (see the movement from C to B in Figure 5). One reason why this may very well require co-ordinated expansion has to do with the current-account implications of confining an expansion to one country while the other remains stagnant. We shall turn to some quantitative simulations of a two-country world at the end of Section III.

III. SIMULATION MODEL AND EMPIRICAL ANALYSIS

The graphical analysis of Section I is based on the detailed model in MEA. In this part of the paper we discuss the empirical relevance of the same model. First, the model's parameter values are selected to describe a 'representative' OECD economy. The response of this economy to a doubling of oil prices is studied under a variety of assumptions about labour market dynamics. A second economy is then added and we illustrate how multi-country interactions affect our numerical estimates. Throughout this section, we also appeal to the country data to support the general structure of the simulation model (for further empirical results, see Sachs, 1979).

The simulations convey a clear message: fuel inputs are sufficiently important in production, and the 1973 oil price rise was of such magnitude that a large part of the 1974-75 recession is directly attributable to the change in the relative of oil. While monetary policy was contractionary in most countries in 1974, the simulations suggest that even with accommodative policy the 1974-75 recession would have been severe, with significant classical unemployment.

The dynamic response and long-run behaviour of the economy after an OPEC-like disturbance are shown to depend heavily on the behaviour of wages, both nominal and real. For our small representative economy, with world prices and income given, a fall of 1 per cent in the long-run real wage increases employment by 0.65 per cent. The approximate doubling of the real price of oil in 1973 is calculated to require a 6.4 per cent decline in real wages to maintain employment in the home economy. In the

two-country setting, the wage effect is even more powerful. When real wages fall by 1 per cent in both countries, output in each increases by 2.3 per cent. The doubling of oil prices requires a 3.5 per cent decline in real wages in both countries for full employment to be restored.

In Section I, we suggested that an economy's response to external shocks is influenced by a few key structural characteristics. For example, the more dependent the economy is on net fuel imports, the more aggregate demand declines after an oil price increase. In drawing lessons from the representative economy, it is important to keep in mind how individual OECD economies differ from the average case. In addition to the price simulation model, then, we describe in this section key structural differences between the OECD economies that may explain some of the variety of macro-economic experience in the past six years.

The Representative Economy: Aggregate Supply

In this part, parameter values are assigned to the theoretical model. On the supply side, domestic final goods are produced with labour, intermediate inputs, and fixed capital. For the empirical simulations, we treat fuel as the only intermediate input. A two-level production process is specified. Capital and labour combine to produce value added; in turn, value added and fuel are used to produce the final output: $q = q[v(\ell, k), n]$. For concreteness, the value-added relation, V, and gross output, q, are described as constant-elasticity-of-substitution functions of their respective arguments (see note 38).

The role of oil prices in aggregate supply determination depends on the extent to which labour and fuel can substitute for the fixed factor k.

Suppose, for instance, that capital and energy are used in fixed proportion, while capital and labour are partially substitutable. Then oil is also a fixed factor, tied to capital. The cost of a marginal unit of output is just the labour cost, since fuel and capital costs are fixed; fuel prices do not enter marginal cost. Alternatively, suppose that oil is used in fixed proportion to output. The share of fuel costs in the marginal unit of output is then equal to the share of fuel costs in the average unit of output, i.e., the share of total fuel costs in total revenue. In general, the less substitutable is n for k *relative* to the substitutability of ℓ for k, the smaller is the effect of fuel prices on marginal cost.[38]

Most empirical evidence suggests a low short-run elasticity of substitution of capital and energy, σ_{kn}, and a somewhat higher elasticity

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[38] The technical argument is as follows. For a two-level CES production function we write final output Q as a CES function of value added, V, and intermediate input, N. In turn V is produced according to a CES function of L and K (fixed). Thus, $Q^{\rho} = aV^{\rho} + (1 - a)N^{\rho}$ and $V^{\rho_1} = bL_1^{\rho} + (1 - b)K_1^{\rho}$, with $\sigma = (1 - \rho)^{-1}$ and $\sigma_1 = (1 - \rho_1)^{-1}$. The σ's are, respectively, the elasticity of substitution of V, N and L, K; they are linear functions of the Allen-Uzawa partial elasticities $\sigma_{k\ell}$, σ_{kn}, and $\sigma_{\ell n}$. Now, $\sigma_{k\ell} = \sigma + (1 - \beta)^{-1}(\sigma_1 - \sigma)$, and $\sigma_{kn} = \sigma_{\ell n} = \sigma$, where $\beta = (\partial Q/\partial N)(N/Q) = P_n N/PQ$ and is the share of costs of input N in total revenue. Also let $\alpha = WL/PQ$ be the share of costs of L in total revenue. Then, in MEA (p. 6) we show $p = (\alpha' + \beta')^{-1}(\alpha' w + \beta' p_n + q)$, where $\alpha' = (1 - \alpha - \beta)^{-1}\alpha\sigma_1 > 0$, $\beta' = (1 - \alpha - \beta)^{-1}\beta\sigma_1\eta > 0$, and $\eta = \sigma_1^{-1}(1 - \beta)^{-1}[\sigma_1\alpha + \sigma(1 - \alpha - \beta)]$. The effect of fuel costs on marginal cost is given by $\partial p/\partial p_n = \beta'/(\alpha' + \beta')$. It is then easy to see that $\partial p/\partial p_n$ increases as σ/σ_1 increases. In turn σ/σ_1 rises with $\sigma_{kn}/\sigma_{k\ell}$. In the fixed-proportion case, $\sigma/\sigma_1 = 0$, and $\partial p/\partial p = \beta$. For $\sigma/\sigma_1 \to \infty$, we have $\partial p/\partial p_n \to 1$. In the simulations, $\sigma_{k\ell} = 1$, $\sigma_{kn} = \sigma_{\ell n} = 0.2$.

of substitution of capital and labour, $\sigma_{k\ell}$.[39] Mork and Hall (1978) assume that energy is used in fixed proportion to output, while value added is a Cobb-Douglas function, i.e., labour and capital have constant shares. We relax the first assumption, allowing a 1 per cent increase in the real price of energy to decrease the energy-output ratio by 0.2 per cent. We keep the assumption of a constant equilibrium share of labour in value added.

The aggregate production technology is fully specified by selecting initial factor shares for labour, energy, and capital. For the representative economy, the labour share in value added is put at 0.69, and the capital share at 0.31. At initial equilibrium, the marginal efficiency of capital is set at 0.1 per cent (Feldstein and Summers, 1977, calculated $\partial V/\partial K = 0.11$ for the United States). The ratio of capital to value added is then equal to $0.31/0.1 = 3.1$. A good approximation for the share of fuel in the gross output of the major OECD economies is 0.05.[40]

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[39] Mork (1978a, p. 29) finds $\sigma_{k\ell} = 1.06$, and $\sigma_{kn} = -0.14$ for 1975 (fourth quarter) assuming putty-putty technology. Our assumption of a two-level production process requires weak substitutability of K, L, and N (see Arrow, 1974, on the bearing of weak substitutability on the existence of a value-added function). The assumption requires $\sigma_{kn} = \sigma_{k\ell}$. Mork finds that $-0.14 = \sigma_{kn} \neq \sigma_{\ell n} = 0.14$ for 1975/IV, calling into question the existence of a real aggregate value-added function.

[40] The net input of energy is measured as the sum of net imports of energy and the domestic production of primary energy (ignoring inventory accumulation of primary energy). Net imports are measured by the net trade of ISIC category 3, 'mineral fuels'. To this is added domestic production (from U.N., *World Energy Supplies 1977*) valued at *world* prices. For 1975, energy inputs as a percentage of GNP were found to be: United States, 9.3; United Kingdom, 9.9; France, 4.6; Germany, 6.1;

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This share increased substantially after the 1973 oil price hike, indicating low short-run substitutability of energy for other factors. We assume for simplicity that there is no domestic production of energy.

After normalizing the variables at initial equilibrium the main aggregate supply equations are given by:

(1) $q = 0.617 + 0.655\ell + 0.05n$

(2) $p = -0.359 + 0.946w + 0.054p_n + 0.44q.$

The first expression is the (log) linear approximation of aggregate supply. For a fixed capital stock, a 1 per cent increase in labour input raises output by 0.65 per cent, and a 1 per cent increase in fuel use raises output by 0.05 per cent. Equation (2) is the price equation for a profit-maximizing firm. Factor prices are extremely important in determining the output price. Wage costs are almost fully passed through: with our assumptions, a 1 per cent increase in nominal wages causes a 0.95 per cent increase in output prices. About 5 per cent of a fuel price increase shows up in the final-goods price.[41] The level of output also affects p. Because the capital stock is fixed, marginal costs increase with output: each 1 per cent increase in output raises the marginal cost, and the

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Italy, 7.1; Canada, 6.3; and Japan, 5.4. To the extent that domestic prices are below the world level, the measure of energy inputs will be biased upward.

[41] The coefficients of w and p are related to the relative elasticities of substitution, as shown in note 38. If $\sigma_{kn} = \sigma_{k\ell}$, instead of our assumption that $\sigma_{kn} < \sigma_{k\ell}$, the coefficient of p_n would be 0.07, while the w coefficient would fall to 0.93.

price, of output by 0.44 per cent.[42]

It is illuminating to rewrite (2) as a supply function:

$$(3) \qquad q = 0.82 - 2.15(w - p) - 0.12(p_n - p).$$

This equation describes output as a decreasing function of real factor costs. For a given product wage (the wage deflated by domestic output prices), a 1 per cent increase in the relative price of oil causes aggregate supply to fall by 0.12. Let us now introduce the (log) consumer price index, as a weighted sum of domestic and foreign final-goods prices, with respective weights 2/3 and 1/3,

$$(4) \qquad p_c = 0.667p + 0.333(p^* + e).$$

We can now rewrite output supply as a negative function of the real wage, a negative function of the world price of fuel, and a positive function of the terms of trade, as was shown graphically in Figure 1:

$$(5) \qquad q = 0.82 - 2.15(w - p_c) - 0.12(p_n^* - p^*) + 0.70(p - p^* - e).$$

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[42] Econometric studies find a significant effect of energy prices on final-goods prices (see Mork, 1978b, for U.S. price equations). On the other hand, positive output effects on prices have not been as clearly demonstrated (see the discussion in Mork, 1978b, p. 11). In our own econometric work, reported in Sachs (1979), we find that a fixed-markup equation, i.e., one without output effects, does *not* describe the 1974-75 price behaviour adequately. In a markup price equation a dummy variable for 1974-75 is consistently negative. This suggests that the recession did in fact lower markups, as equation (2) predicts.

Wage Determination

The aggregate supply side is closed by positing a wage-determination process. It was shown in Sections I and II that the response of wages to the oil shock is crucial for the dynamic adjustment of output. Real wages must fall after a supply shock for full employment to be maintained. To the extent that nominal wages adjust slowly to price movements, part of that real wage decline can be effected through expansionary monetary policy. To the extent that wages are indexed, so that real wages adjust slowly while nominal wages are flexible, monetary adjustments lead only to compensating price movements, without affecting real output. Indeed, if real rather than nominal wages are rigid, a sustained period of unemployment might be necessary to restore equilibrium wage levels after a supply disturbance (see also Bruno, 1978).

Many writers have speculated as to whether actual wage processes are more accurately described by wages following past wages (wage-wage process) or current price expectations (wage-price process). The wage-wage process corresponds to *nominal* rigidity in that the real wage can be affected by anticipated monetary policy. We speculate that the wage-wage process results in large part from the existence of overlapping long-term contracts in the labour market.[43] Until the mid-1970s, aggregate real wage growth was so constant that the two hypotheses could not be econometrically distinguished. The increased variability in real wages since 1973 allows a partial answer to the question. Indeed, the evidence suggests that different countries have significantly different degrees of nominal rigidity.

[43] See Taylor (1978). It will be shown later that of the large OECD economies, only the United States and Canada exhibit a wage-wage process. Only in these two countries is there widespread use of overlapping long-term labour agreements with relatively little indexing.

In our empirical work and in the simulation model, nominal wage change is made a function of expected price changes, lagged wage changes, and the level of unemployment. The (log) nominal wage change is written as (where subscript -1 indicates one-period lag)

$$(6) \qquad w - w_{-1} = \alpha_0 + \alpha_1(\ell - \ell^S)_{-1} + \alpha_2(w_{-1} - w_{-2}) + (1 - \alpha_2)(p_c^e - p_{e_{-1}}).$$

We assume that firms are never rationed in the labour market so that observed labour input, ℓ, equals labour demand. Workers supply the demanded level of labour services, though the demand might be greater or less than their desired (notional) supply, ℓ^S. Wages then respond to the gap between ℓ and ℓ^S; the rate of adjustment is given by α_1.

Notional labour supply is a function of real wages and exogenous variables such as population growth and the labour force participation rates of various demographic groups. For the simulation model we merely consider ℓ^S to be linear in $w - p_c$, holding other exogenous influences constant:

$$(7) \qquad \ell^S = \alpha_3(w - p_c) + \alpha_4 \qquad \alpha_3 > 0.$$

When α_3 is large, labour supply is elastic and long-run real wages do not move much. For $\alpha_3 = 0$, we have the traditional assumption of inelastic long-run labour supply.

The level of α_2 determines the extent of wage-wage versus wage-price movements. A high α_2 signifies inertia in nominal wages, while a low α_2 signifies a wage-price response.

What can we say empirically about the behaviour of wages since the oil price shock of 1973? Table 1 conveys the most important information. During 1973-75 real wage growth accelerated over the previous trend in four

Table 1. Annual Percentage Change in Real Hourly Compensation: 1960-77

	United States	United Kingdom	France	Germany	Italy	Canada	Japan
1960-73	1.82	3.34	4.98	6.66	8.54	2.86	8.34
1973-75	0.83	5.96	6.39	7.15	7.38	3.80	5.24
1973-76	2.22	-1.81	4.90	4.14	2.08	4.27	-0.01
1973-77	1.88	7.93	3.44	4.53	1.53	-1.83	2.42

Source: Real hourly earnings are calculated as average hourly compensation in manufacturing deflated by the consumer price index. The wage data are from the U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, *Output per Hour, Hourly Compensation, and Unit Labor Costs in Manufacturing, Eleven Countries, 1950-1978*; the price data are from the *International Financial Statistics* of the IMF.

of the countries, and declined slightly in the United States and Italy and more sharply in Japan. The acceleration occurred in spite of a massive supply shock, high unemployment, and adverse productivity changes. After about eighteen months of recession, wages began to decelerate in the four countries in 1976, and continued to do so in 1977. The first notable point is that real wage growth declines slowly in response to excess supply in the labour market.

Econometric evidence allows us to measure the real wage response to unemployment and price changes. Phillips curve regressions are shown in Table 2.[44] Canada and the United States display an aggregate wage determination process that is distinct from the others. In these two countries wage inflation is essentially unaffected by the level of lagged unemployment, for given rates of past wage change and expected inflation. Both countries also display a combined wage-wage, wage-price process. For the other five economies, lagged unemployment has a significant depressing effect on current nominal wage change. Equally important, $\hat{\alpha}_2$ is small (even negative) and is not statistically significant for the other five economies, so that lagged wage inflation affects current wage change only through its impact on expected price inflation. The estimates of $\hat{\alpha}_5$ suggest that the oil shock may have had a direct effect on Japanese and Italian wages, which did *not* operate through unemployment or price inflation.

The implication of these regressions is best seen by rewriting (6) as a real-wage equation:

$$(8) \qquad w - p_c = (w_{-1} - p_{c_{-1}}) + \alpha_0 + \alpha_1(\ell - \ell^s)_{-1} - \alpha_2[(p_c^e - p_{c_{-1}}) - (w_{-1} - w_{-2})] + (p_c^e - p_c).$$

[44] In the estimates, ℓ^s is proxied by a time trend; α_3 is set equal to zero.

Table 2. Wage Equations, 1962-76[a]

$$\dot{w}_t = \alpha_0 + \alpha_1 \log(\text{manhours}_{t-1}) + \alpha_2 \dot{w}_{t-1} + (1 - \alpha_2)\dot{p}^e + \alpha_4 t + \alpha_5 D74 + \varepsilon_t$$

	United States	United Kingdom	France	Germany	Italy	Canada	Japan
$\hat{\alpha}_1$	0.03 1.92	0.47 1.6	0.36 1.63	0.35 2.17	0.73 2.44	0.08 1.44	0.85 7.6
$\hat{\alpha}_2$	0.66 8.37	-0.29 1.22	0.06 0.40	-0.13 0.26	-0.28 0.71	0.40 1.65	0.0 0.0
$\hat{\alpha}_5$	0.01 1.78	0.04 2.07	-0.01 0.62	0.01 0.24	-0.04	0.02 1.7	-0.06 2.8
R^2	0.89	0.52	0.16	0.05	0.30	0.50	0.71
$\hat{\rho}$	-0.9 9.1	0.10	-0.5 1.6	0.03 0.06	0.46 0.78	0.10 0.22	-0.51 1.5
d.w.	2.89	1.90	2.4	1.7	1.80	1.72	1.26
s.e.	0.003	0.017	0.016	0.025	0.036	0.007	0.018

[a] In equation (6) in the text, ℓ^s is proxied by a simple time trend. The equation is estimated in the form of (8). With an efficient price forecast, $p_c^e - p_c$ is uncorrelated with the RHS variables (though not necessarily with the error term ε_t), and so may be omitted from the regression. D74 is a dummy variable, equal to 1 in 1974 and 0 otherwise. This is assumed to represent a direct effect of the oil price shock which is not picked up by prices or unemployment. The equations are estimated by ordinary least squares, with the Cochrane-Orcutt correction for serial correlation (shown as $\hat{\rho}$). Small numerals are t ratios.

Source: The wage and price data are the same as in Table 1. The expected price variable is created by regressing prices on lagged prices, wages, money supply, and the unemployment rate, and taking fitted values. Manhours is total hours worked in manufacturing, from the same source as the wage data of Table 1.

If $\alpha_2 > 0$, policy-makers can reduce the real wage through inflationary policy, even if the policy is fully expected. Expansionary monetary policy will raise income (see Sachs, 1978). On the other hand, for $\alpha_2 = 0$, the real wage is invariant to expected inflation; a monetary expansion will lead only to an equiproportional change in the exchange rate and domestic prices.

We suspect that much of the difference in the macro-economic policy recommendations of American and European economists stems from the difference in the behaviour of their respective economies reflected in $\hat{\alpha}_2$. In the United States monetary policy *is* effective, while in most European economies, monetary policy probably operates chiefly on prices and not on output.

Aggregate Demand and Investment Behaviour

We complete the simulation model by specifying the determinants of aggregate demand. Since the demand side is less novel than the supply side, we proceed quickly.

Aggregate consumption and final-goods imports are functions of disposable income and the final-goods terms of trade. It is assumed that total household absorption is equal to 90 per cent of disposable income. The division of household expenditure between imports, c_m, and domestic goods, c, is assumed to depend on relative prices. A 1 per cent increase in world prices relative to domestic prices is assumed, in the long run, to cause a 0.8 percent decline in the ratio of imported to domestic goods in the consumer basket. Export demand is made a unit-elastic function of world income and the terms of trade.

The investment demand equation is important in view of the central role

of declining investment in the 1974-75 downturn. Unfortunately, a theoretically sound investment equation requires a long-run model, with explicit paths of capital accumulation and equity prices (see Blanchard, 1978). A less rigorous formulation is to write investment as a function of the ratio of the current marginal product of capital to k_c, the current long-term cost of capital. If we can assume perfect capital mobility, the domestic long-term cost of capital is given approximately by the world level.[45] For reasonable parameter values, we derive the following investment schedule:[46]

$$(9) \qquad \log(I) = -0.23 - 1.09(w - p) - 0.08(p_n - p) - 6.5k_c.$$

The regressions in Table 3 show that this extremely simple investment model can track much of the movement in fixed investment demand in recent years. Notice that the coefficient of the world cost of capital, proxied by a U.S. long-term real interest-rate measure, is negative and of reasonable magnitude. The two real factor costs enter with appropriate negative

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[45] The investment demand equation follows Kouri (1978a). Even with perfect capital mobility, the domestic and world cost of capital need not be exactly equal. One can show that countries with worsening terms of trade will have slightly higher long-term interest rates than countries with improving terms of trade. Moreover, differences in tax treatment of corporate income can create differences in the cost of corporate borrowing, even under perfect capital mobility.

[46] We take investment demand to be a constant-elasticity function of $(\partial Q/\partial k)/k_c$, with elasticity 0.5 . For a firm on its supply curve, $\partial Q/\partial K = K^{-1}[Q - L(\partial Q/\partial L) - N(\partial Q/\partial N)] = K^{-1}(Q - LW/P - NP_n/P)$. Thus, $\partial Q/\partial K$, the marginal product of capital, is also the profit per unit of capital. Now, Q, L, and N are functions of W/P and P_n/P by earlier arguments. Upon substitution for Q, L, N, and linearizing about the initial equilibrium, equation (9) is found.

Table 3. Investment Demand Equations[a]

$$\log(I_t) = \alpha_0 + \alpha_1 k_{c_t} + \alpha_2 (w - p)_t + \alpha_3 (p_n - p)_t + \alpha_4 t$$

	United States	United Kingdom	Germany	Canada
α_0	10.2 0.93	8.4 1.05	4.8 0.67	22.8 5.14
α_1	-7.6 4.47	-7.1 1.49	-3.6 1.13	-4.8 2.83
α_2	-1.27 0.52	-1.63 0.85	-0.10 0.05	-4.96 4.69
α_3	-0.54 5.35	-0.26 1.96	-0.44 2.20	-0.28 4.16
α_4	0.07 1.77	0.10 1.51	0.05 0.50	0.20 6.43
R^2	0.89	0.71	0.77	0.96
$\hat{\rho}$	0.32 0.92	0.18 0.51	0.30 0.83	-0.30 0.89

[a] Equations are estimated by ordinary least squares, with the Cochrane-Orcutt correction, for annual data, 1962-76. k_c is the U.S. long-term real cost of capital estimated by Feldstein and Summers (1978, p. 87). It is computed as the long-term bond yield minus the long-term expected rate of inflation. Small numerals are t ratios.

Source: Aggregate investment (I_t), national accounts data of the OECD. Average hourly compensation (w), as in Table 1. The price indexes p and p_n are constructed by the authors, and are described in Sachs (1978).

coefficients for all countries. However, the estimated coefficients of $(p_n - p)$ are throughout implausibly high [compare them with the 0.08 coefficient in (9)]. Capital-energy complementarity could in part account for the large coefficient. We suspect also that $p_n - p$ is, to some extent, proxying for an aggregate demand variable that might appear in an investment equation in addition to the profit variable. That is, the coefficient of $p_n - p$ also reflects the effect on I of the 1974-75 world recession. Finally, $p_n - p$ might proxy for long-run expectations of profitability, affecting I through stock-market prices.

According to the investment equations, it was not because of excessive real interest rates due to contractionary monetary policy that I dropped in 1974 and 1975: the Feldstein-Summers (1978) measure of the real long-term interest rate *fell* from an average of 4 per cent for 1966-73, to 2½ per cent for 1974-76.

The simulation model is closed by specifying the asset demand structure and the process of expectations formation. For the simulations, we assume a pegged though adjustable exchange rate. Assuming perfect capital mobility, the domestic short-term nominal interest rate is equal to the world level, as long as there is no expectation of devaluation. In our theoretical work, we spell out the dynamics of a freely floating exchange rate, which can easily be simulated.

The entire model is now set forth in Table 4. All equations are (log) linearized at the initial equilibrium.

Simulation Results for the Single-Economy Model

In this section we examine the response of the economy to an increase in

Table 4. Simulation Model

I. Structural Equations for the Representative Economy[a]

Aggregate supply

$$P = -0.359 + 0.946w + 0.054p_n + 0.444q$$

$$\ell = -0.613 + 1.32[q - 0.2(w - p)]$$

$$n = -2.993 + q - 0.2(p_n - p)$$

$$w_t = w_{t-1} + \alpha_1[\ell - \alpha_3(w - p_c - 0.15)]_{t-1} + \alpha_2(w_{t-1} - w_{t-2}) + (1 - \alpha_2)({}_{t-1}p^e_t - p_{t-1})$$

$$p_n = p^*_n + e$$

$$p_c = 0.667p + 0.333(p^* + e)$$

Aggregate demand

$$Q = C + I + G + X$$

$$C = [0.9V(1 - tax) - P^*EC_m]/P$$

$$I = 0.35[(Q - WL - P_nN)/PK_c]^{0.5}$$

$$G = \text{(exogenous)}$$

$$x_t = y^* + 0.25x_{t-1} - 0.75(p - p^* - e) - 0.836$$

$$c_{m_t} = 0.75c^d_{m_t} + 0.25c_{m_{t-1}}$$

$$c^d_{m_t} = -1.54 + 0.866(p - p^* - e) + v + \log(1 - tax) - p$$

$$V = PQ - P_n(N - H)$$

Asset markets

$$m - p_c = 0.5q - 0.5R$$

$${}_{t-1}e^e_t - e_t = R_t - R^*_t$$

With fixed exchange rates, ${}_{t-1}e^e_t \equiv e_t$ and m is endogenous; with flexible exchange rates, m is exogenous.

Expectations[b]

For all X_t, ${}_{t-j}X^e_t = E(X_t|\Omega_{t-j})$

Footnotes on p. 51.

Table 4. Simulation Model (contd)

II. Notation[c]

C	Aggregate consumption of domestic final good
C_m	Aggregate consumption of foreign final good
k_c	Real cost of capital
E	Exchange rate (units of domestic currency per foreign currency unit)
G	Government expenditure
H	Domestic production of intermediate input
I	Aggregate investment
K	Capital stock
L	Labour input
M	Money stock
N	Intermediate goods input
P_c	Consumer price index
P	Domestic final-goods price
P*	Foreign final-goods price (foreign currency units)
P_n	Domestic intermediate input price
P_n^*	Foreign intermediate input price (foreign currency units)
Q	Gross output
R	Nominal interest rate
tax	Domestic tax rate
V	Nominal gross national product
W	Nominal wage
X	Aggregate exports
Y*	World income

Footnotes on p. 51.

Notes to Table 4

a In the simulations, a (log) linearized version of this model is used. The equations for Q, C, I, and V need linearization; they then become:

$q = 0.413c + 0.215(\log I) + 0.171g + 0.2x + \text{constant}$

$c = 1.48v - p - 0.48(p^* + e + c_m) + 1.48 \log(i - tax) + \text{constant}$

$\log I = 2.06q - 1.46(w + \ell - p) - 0.1(p_n + n - p) - 6.5k_c + \text{constant}$

$v = 1.055q - 0.05(p_n + n) + \text{constant}.$

b The expectation of X_t formed at time $t - j$ is denoted by ${}_{t-j}X_t^e$. The information set at $t - j$ upon which the expectations are conditioned is denoted by Ω_{t-j}. When Ω_{t-j} includes the structural relations of the model, we have the assumption of rational expectations as stated.

c Except for k_c, all lower case variables are logarithms of upper case variables; asterisk denotes 'foreign'. Note that superscript e denotes expected value of variable and superscript d denotes desired level.

the world price of the intermediate good. Table 5 shows the dramatic changes in the relative price of fuels and other primary commodities from 1972-78. Energy prices, for which the simulation is designed, more than doubled between 1973 and 1974. In the following years, the relative price of oil fell by 10 per cent (and it increased again in 1979). Other primary prices displayed a more dramatic boom and bust, rising sharply in 1973-74, and then falling sharply in 1975, with the onset of the world recession. Our simulation considers a permanent doubling of world energy prices, although the rise in all the other prices contributed to the world stagflation, and their fall no doubt aided the partial world recovery.

For our representative economy, the oil price rise requires a 6.4 per cent decline in real wages for full employment to be restored. Even with long-run inelastic labour supply, output falls 0.8 per cent, because of substitution away from energy inputs. If the labour supply is perfectly elastic, with real wages fixed at their pre-shock level, output declines by 4.5 per cent. Because the model is linear, we conclude that each 1 per cent fall in real wages boosts domestic output by 0.58 per cent.

The detailed discussion of short-run dynamics is postponed until the two-country case. Here, we make some general observations about dynamic adjustment. The wage determination process is important for the short-run response of the economy to the price-hike. In the model, the oil price rise is calculated to cause a one-year blip in the consumer price index of about 1.5 per cent. Real wages fall in the year of the price rise, because (a) the blip is unexpected and (b) wages follow lagged wages

Table 5. International Price Indexes

(US $, 1970 = 100)

	Manufactured goods, developed countries (1)	Primary commodity exports other than fuel, LDC (2)	Fuel exports, all market economies (3)	(2)/(1) (4)	(3)/(1) (5)
1960	84	85	101	1.0	1.2
1965	88	89	97	1.0	1.1
1970	100	100	100	1.0	1.0
1971	105	95	123	0.9	1.2
1972	113	105	132	0.9	1.2
1973	133	156	177	1.2	1.3
1974	162	241	499	1.5	3.1
1975	182	191	541	1.1	3.0
1976	183	205	568	1.1	3.1
1977	199	256	627	1.3	3.1
1978[a/]	225	237	633	1.1	2.8

[a] Preliminary estimates.

Source: Columns (1) and (2) from UNCTAD, *Monthly Commodity Price Bulletin* (April 1978), p. 3.
Column (3) from U.N., *Statistical Yearbook 1976*, p. 58, and U.N., *Monthly Bulletin of Statistics* (April 1978), p. 162.

as well as current prices.[47] If nominal wage change is linked half to expected price and half to expected wage changes ($\alpha_2 = 0.5$ in the wage equation), the unexpected jump of 1.5 per cent in the CPI in the year of the oil price hike causes a 1.1 per cent fall in real wages in the same year. As discussed in Section I, this temporary decline in $w - p_c$ mitigates the contractionary effects of the shock.

If long-run labour supply is highly inelastic ($\alpha_3 \simeq 0$), it is likely that real wages, although unexpectedly reduced, are still above the equilibrium level ($\ell^s > \ell^d$), given the sharp increase in unemployment in the year of the shock. As $w - p_c$ falls in succeeding years, so does $p - e - p^*$. With fixed e and p^*, the nominal price level p declines. On the other hand, if workers try to make up for the temporary decline in real wages (consistent with an elastic long-run labour supply), inflation will continue in future periods as $w - p_c$ rises. It should be remembered, though, that the behaviour of the price level is determined more by the exchange rate e than by the real terms of trade, $p - e - p^*$.

The importance of the exchange rate in domestic inflation is shown by a simulated 10 per cent devaluation. Real wages fall temporarily and output and employment expand. In our representative economy, the devaluation causes an increase of about 5 per cent in prices in the first

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[47] The size of the real wage decline in the year of the shock depends upon the extent of the formal indexation provisions in labour contracts. In our model, nominal wage change is linked to expected price inflation by the term $(1 - \alpha_2)(p^e_{c_{-1}} - p_{c_{-1}})$ in wage equation (8). In the simulations we assume that one half of the linkage is to actual and one half to expected prices. The term becomes $\frac{1}{2}(1 - \alpha_2)(p_c - p_{c_{-1}}) + \frac{1}{2}(1 - \alpha_2)(p^e_{c_{-1}} - p_{c_{-1}})$.

year, with the remaining 5 per cent increase distributed in succeeding years. The latter price increase is brought about by the rise in real wages, generated by the rise in demand for labour after the devaluation.

Simulation Results for the Two-Country Model

In Section II, we described how an import price shock can shift a many-country aggregate supply frontier. Following a suggestion of Fair (1979) it is easy to illustrate the interactions between countries with our simulation model. We link the industrial economy to a mirror image, making the exports of one equal to the imports of the other. Various experiments are then performed by changing the structural labour market characteristics in one of the countries. In this model, we assume that the two industrial countries import oil from OPEC, which exports oil but not industrial goods. At this point, OPEC consumption behaviour is not modelled; we assume for simplicity that oil revenues are saved in the short run (no new theoretical issues are raised by including OPEC spending on industrial exports).

For two identical economies, the effect of a real oil price shock is easily adduced. Assume that the price of oil doubles in terms of a basket of the two countries' final goods, with each final good having equal weight in the basket. We again appeal to the aggregate supply relation (5). Since the countries are mirror images, the terms of trade, $p - p^* - e$, must remain unchanged, by symmetry. Also, $w - p_c$ is fixed in the short run, by assumption. Therefore, the output effect of the oil shock is

$$\Delta q = \frac{\partial q^s}{\partial (p - p_n)}(p - p_n) = -(0.12)\log(2.0) = -0.083, \tag{10}$$

i.e. 8.3 per cent.

An 8.3 per cent decline in output might seem rather large. Of course, at this point real wages have not been allowed to decline at all in reaction to the jump in unemployment. Each subsequent fall of 1 per cent in the real wage in both countries produces a 2.3 per cent increase in output. Real wages must decline at least 3.5 per cent in each country for full employment to be restored.

What happens to the world real rate of interest along the adjustment path? Simply, k_c falls if the global aggregate demand effect exceeds the aggregate supply effect just measured, as would be the case for the real interest rate in a closed-economy model. Given our assumptions, the deflationary demand effect of the oil shock dominates after the first year. Real interest rates jump 40 basis points in the year of the shock, and then fall 120 basis points in the two succeeding years. Very modest support for this effect is offered by the measures of the U.S. long-run real interest rates in Feldstein and Summers (1978). They find that the long-term U.S. corporate bond rate minus the rate of long-term expected inflation fell from an average of 4.1 per cent for 1966-73, to 2.6 per cent for 1974-76, after the oil shock.

When the economies have different fiscal policies, different rates of domestic energy production, or different patterns of real wage change, the final-goods terms of trade vary during the adjustment path. Consider the case where the home country has rapid real-wage adjustment and inelastic labour supply, while the foreign country has slower wage adjustment and long-run labour supply inelasticity.[48] The effect of the oil shock is

[48] For this simulation, the home country labour-market parameters are $\alpha_1 = 0.3$, $\alpha_2 = 0$, $\alpha_3 = 0$, while the foreign country values are $\alpha_1 = 0.1$, $\alpha_2 = 0$, $\alpha_3 = 3.0$.

Table 6. The 1974 Oil Price Rise: Output, Trade Balance, and Real Wage Effects in the Two-Country Model

	1973	1974	1975	1976	Long-run
W/P_c	1.16	1.16	1.12	1.11	1.10
$(W/P_c)^*$	1.16	1.16	1.15	2.15	1.15
Q	1.63	1.50	1.58	1.60	1.62
Q^*	1.63	1.50	1.57	1.59	1.59
$PX - P^*EC_m$	0	0	0.01	0.015	0.02
$P^*X^* - (P/E)C_m^*$	0	0	-0.01	-0.015	-0.02

illustrated in Table 6. The initial 8.3 per cent output decline is the same in both countries. At home, $w - p_c$ falls more rapidly and output expands more quickly. Since long-run $w - p_c$ is lower at home, long-run output is higher.

The following results, easily established analytically, are suggested:

1. A real wage decline in one country causes real income to rise in both countries.
2. A long-run real wage increase in one country lowers real wages in the other.[49]
3. The economy with the larger real wage decline, *ceteris paribus*, experiences a trade surplus; the other economy, of course, has an equal and opposite deficit.

A fourth proposition, not evident from the table is:

4. The economy with greater domestic production of oil experiences a smaller decline in output than does the other.

How does the simulation estimate of an 8.3 per cent impact effect on output compare with actual magnitudes of output decline in the industrial economies? Table 7 gives a very rough measure. Actually, the 8.3 per cent is a mid-range estimate of the decline of GNP relative to trend for the four countries. One interesting source of intercountry variation is Canada. The recession in Canada is late and relatively small. This is no doubt a reflection of our proposition 4: Canada is a net exporter of

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[49] When both countries have long-run labour supply inelasticity, real wages must decline by 3.5 per cent to restore full employment. Now the country with inelastic labour supply experiences a 5.0 per cent wage decline, because real wages fail to drop significantly in the other economy.

Table 7. Output: Percentage Deviation from Trend[a]

	United States	United Kingdom	Germany	Canada
1973	0.8	2.2	0.3	1.3
1974	-5.6	-1.5	-3.6	-0.9
1975	-10.5	-0.6	-10.6	-5.4

[a] The deviation from trend is measured by regressing log(GNP) on time. The 1973 entry is the regression residual. For 1974-75, deviations of actual GNP from projected trend values are computed.

Source: OECD.

energy resources. The calculations are meant only to hint at plausible measures for the output decline in the recession years. We are now preparing a more detailed inter-country comparison of output and price responses in the 1970s.

As a final experiment, consider the case of fixed exchange rates and sticky nominal wages. The oil shock has a less contractionary impact effect than is reported above. Assume a given world stock of money and Cambridge money demand functions in each country of the form $M^d = PQ^{0.2}$, where 0.2 is the assumed short-run income elasticity of demand for money. The decline in output that follows the oil shock will cause prices to rise. With two identical countries, each 1 per cent decline in income leads to a 0.2 per cent rise in prices. The unexpected rise in prices following an oil price increase will reduce real wages in the short-run, as in the one-country model. When short-run indexation (see note 47) is 0.5, a doubling of oil prices causes a 1.4 per cent unexpected spurt in prices. Real wages are reduced by $0.5 \times 1.4\% = 0.7\%$ in the first period. Consequently, the output decline is reduced from 8.3 to 6.7 per cent in the first year.

IV. CONCLUDING REMARKS

This may be an opportune moment to suggest directions for further research. Theoretical models of open economies must be extended to allow for both classical and Keynesian unemployment, whose relative importance has been a general issue in our paper. Econometric work might be used to determine more precisely how much of the 'great recession' was in fact classical or Keynesian. New statistical techniques for markets in disequilibrium offer tools for careful empirical research in this direction.

Our simulation did not address the sharp temporary rise in non-fuel commodity prices in 1972-73, though that temporary shock raises important questions. Its additional effect on top of (and preceding) the oil price rise was to deepen the stagflation of the mid-1970s. Once world output fell and excess supply of those commodities forced their price down, the effect on domestic final-goods markets would imply a rightward shift of the supply curve. With domestic prices rigid downward, a ratchet effect may have developed, turning a temporary supply shock into more permanent Keynesian unemployment.

Next we note the polar view of exchange rates as either determined by perfect capital mobility or fixed. The role of the current account and imperfect capital mobility, along the lines recently modelled by Kouri (1978b), should be explicitly incorporated into the system.

On the basis of the preliminary comparative country estimates given here, especially with respect to labour market behaviour, it can be seen that there is room for considerable additional analysis of the differences in patterns of institutional behaviour and policy responses between countries.

Let us stress again that this paper has explicitly confined itself to

short-run aspects of economic developments. One central long-run issue is that of capital accumulation. For a full analysis of a supply shock, explicit account must be taken of the repercussions on long-run capacity and growth levels. It seems very likely that OECD countries have not only suffered a short-term set-back but are now on a lower long-run growth path, although oil alone cannot explain that.

As a final long-run issue with short-term policy implications one should mention a development which has become increasingly important in the 1970s. We have in mind the internal structural implications for the highly industrialized economies of the rapid growth of manufacturing exports by semi-industrialized LDCs. These have been completely ignored in the present paper although for some OECD countries, this is gradually becoming a major issue. In at least one respect, however, the analysis of this question would fall quite naturally into the general approach that we would like to advocate. Short-term price and output adjustments and real structural changes may be very hard to keep apart.

References

Arrow, Kenneth J. "The Measurement of Real Value Added." In *Nations and Households in Economic Growth: Essays in Honor of Moses Abramovitz.* Edited by P. David and M. Reder. New York: Academic Press, 1974.

Artus, Jacques. "Measures of Potential Output in Manufacturing for Eight Industrial Countries, 1955-1978," *IMF Staff Papers,* XXIV (March 1977), 1-35.

Blanchard, Olivier Jean. "Monetary and Fiscal Policy Under Rational Expectations (Parts I and II)." Unpublished draft, Harvard University, 1978.

Blinder, Alan S. *Government Policy and the Great Stagflation.* 1979. (Forthcoming, Academic Press, Inc.)

Bruno, Michael. "Exchange Rates, Import Costs, and Wage-Price Dynamics," *Journal of Political Economy,* LXXXVI (June 1978), 379-404.

———. *Import Prices and Stagflation in the Industrial Countries: Preliminary Analysis.* (Discussion Paper No. 788.) Jerusalem: Falk Institute (revised) 1979.

——— and Jeffrey Sachs. *Macro-Economic Adjustment with Import Price Shocks: Real and Monetary Aspects.* (Discussion Paper No. 793.) Jerusalem: Falk Institute, 1979. (Referred to as MEA.)

Fair, Ray. "Macroeconomic Models: The Open Economy." In *International Economic Policy: Theory and Evidence.* Edited by Rudiger Dornbusch and Jacob Frenkel. Baltimore: Johns Hopkins University Press, 1979.

Feldstein, Martin S., and Lawrence Summers. "Is the Rate of Profit Falling?" *Brookings Papers on Economic Activity,* (No. 1, 1977), pp. 211-27.

——— and ———. "Inflation, Tax Rates, and the Long-Term Interest Rate," *Brookings Papers on Economic Activity* (No. 1, 1978), pp. 61-110.

Gordon, Robert J. "Alternative Responses of Policy to External Supply Shocks," *Brookings Papers on Economic Activity* (No. 1, 1975), pp. 183-204.

Hudson, Edward, and Dale W. Jorgenson. "Energy Prices and the U.S. Economy, 1972-1976," *National Resources Journal*, XVIII (October 1978), 877-97.

Kouri, Pentti, J.K. *Profitability and Growth in a Small Open Economy.* (Institute for International Economic Studies Seminar Paper No. 101.) Stockholm, 1978a.

———. *Balance of Payments and the Foreign Exchange Market: A Dynamic Partial Equilibrium Model.* (Cowles Foundation Discussion Paper No. 510.) New Haven, Conn.: Yale University, 1978b.

Malinvaud, E. *The Theory of Unemployment Reconsidered*, Oxford: Blackwell, 1977.

Mork, Knut Anton. *The Aggregate Demand for Primary Energy in the Short Run and Long Run for the U.S., 1949-1975.* (Energy Laboratory Working Paper No. 7.) Boston, Mass.: M.I.T., 1978a.

———. *The Inflationary Impact of Higher Energy Prices, 1973-1975.* (Energy Laboratory Working Paper No. 14.) Boston, Mass.: M.I.T., 1978b.

——— and Robert E. Hall. *The Energy Price Shock and the 1974-75 Recession.* (Energy Laboratory Working Paper No. 17.) Boston, Mass.: M.I.T., 1978.

OECD. *Towards Full Employment and Price Stability.* (A Report to the OECD by a group of independent experts.) Paris: OECD, 1977.

Phelps, Edmund. "Commodity Supply Shocks and Full-Employment Monetary Policy," *Journal of Money, Credit, and Banking*, X (May, 1978), 206-21.

Sachs, Jeffrey. "Wage indexation, Flexible Exchange Rates, and Macro-Economic Policy." 1978. (Forthcoming in *Quarterly Journal of Economics*.)

———. "Macro-Economic Adjustment to Import Price Shocks: The Empirical Analysis," Unpublished draft, 1979.

Solow, Robert M. "What to Do (Macroeconomically) When OPEC Comes." Draft, 1978. (Forthcoming in NBER Conference volume.)

Taylor, John. "Aggregate Dynamics and Staggered Contracts." 1979. (Forthcoming in *Journal of Political Economy*.)