OECD Economics Department Working Papers No. 44

Price Determination in the Major Seven Country Models in INTERLINK

Ulrich Stiehler

https://dx.doi.org/10.1787/443241862143

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by

Ulrich Stiehler
(General Economics Division)

July 1987

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

This paper presents new domestic price blocks for the major seven economies in INTERLINK, the Economics and Statistics Department's world econometric model. Theoretical, statistical and practical aspects of new behavioural price equations are discussed in a model context. Results from a variety of diagnostic simulations using the new price blocks are presented, suggesting some important improvements in the overall simulation properties of INTERLINK compared to previous versions.

* * *

Cet article présente de nouveaux blocs de prix intérieurs pour les sept principaux pays d'INTERLINK, le modèle économétrique mondial du Département des affaires économiques et statistiques. Les aspects théoriques, statistiques et pratiques des nouvelles équations de comportement des prix sont discutés dans le cadre du modèle. Les résultats obtenus après un grand nombre de simulations visant à établir un diagnostic et utilisant les nouveaux blocs de prix sont présentés dans cette étude. Comparés à ceux des versions précédentes, ils suggèrent d'importantes améliorations de l'ensemble des propriétés de simulation du modèle INTERLINK.

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The author would like to thank Mr. Sven Blondal and Mme. Anick Lotrous for efficient research assistance; and David Coe, Richard Herd, Peter Jarrett, John Martin and Pete Richardson for helpful comments and suggestions.

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PRICE DETERMINATION IN THE MAJOR SEVEN COUNTRY MODELS IN INTERLINK

INTRODUCTION

This paper presents new domestic price blocks for the major seven economies in INTERLINK, the Economic and Statistics Department's world econometric model. A number of substantial changes have been made to the INTERLINK model over the last few years, the most important being the incorporation of neo-classical production and factor-demand functions. New money demand functions have strengthened the degree of crowding-out present in the model. As a result of these developments, short-run cyclical and long-run equilibrium forces interact in more complex ways than before. Therefore, increasing attention has recently been paid to the self-equilibrating mechanisms of the model and its long-run properties. The re-specification of the domestic price blocks has to be seen in this context.

An important role of the domestic price blocks is to provide a link between the supply and demand forces acting on product markets. In the earliest versions of the model, domestic inflation was basically determined by the growth of unit labour costs and some ad hoc measure of excess demand. In a subsequent stage, domestic price formation was based on the cost-dual of the supply block's production function (see Helliwell et al., 1986). Both of these specifications have, on occasion, given rise to problems in the context of full-model simulations. Of particular importance was the question of the extent to which changes in individual factor costs affect aggregate inflation and factor substitution. This paper investigates a somewhat more balanced approach, combining cyclical and external influences on price setting with a tendency to maintain constant factor shares in the long run. The goal has been to ensure a greater degree of consistency between price formation and other important features of the model, in particular the expectations-augmented Phillips curve and the money demand function.

The paper is organised as follows. Section I discusses the design of the price block, drawing on theoretical considerations as well as on practical experience with previous versions of the model. Section II presents the specification of the price block. Section III discusses the estimation procedure and presents the results. Some simulation exercises specifically designed to reveal the dynamic properties of the wage/price block are reported in Section IV. The final section is a summary, including some suggestions for future work.

I. DESIGN CONSIDERATIONS

A. Theoretical considerations

The model adopted here follows the mainstream of postwar economic theory of price determination as presented in Sylos-Labini (1957), Modigliani (1958) and Nordhaus (1972) and thus shares important theoretical foundations with a large number of comparable macroeconomic models (1). Basic assumptions are a homogeneous production structure, constant returns to scale and oligopolistic competition in product markets. A brief summary of the theoretical spirit of the model is presented below; Annex I gives a more formal derivation of the behavioural equation which stands at the centre of the new price block.

Under perfect competition, producers take prices as given and equate marginal costs to prices by adjusting output. However, under the more relevant case of imperfect competition profit maximisation requires a joint output and pricing decision by the firm, since prices are set as a mark-up on minimum average costs. Using INTERLINK mnemonics, the general form of this oligopolistic price equation can be written as:

$$PQB = \frac{(\eta . q+1)}{\eta . q} . COST \qquad [1]$$

where PQB = the oligopolistic profit-maximising price of producers
η = the price elasticity of demand
q = the ratio between the market size under perfect competition and the minimum size of the firm, capturing the degree of market imperfection and implying a pure monopoly case if q=1
COST = the weighted sum of factor rewards (including import costs if PQB is measured at the level of gross output but excluding import costs if PQB is a value-added deflator) per unit of output

If the external environment for all competitors is given, the mark-up on average costs will be constant as suggested by price theory. In the macroeconomic application adopted here, however, the profit-maximising mark-up is assumed to vary with the margin of domestic and foreign competitors' supply potential, on the assumption that the output loss which a firm incurs when it raises its price will not be independent of the rate at which competitors are able to expand their output. Domestic competitors' supply potential is proxied by a macroeconomic indicator of capacity utilisation (physical or profit-constrained). Foreign competitors' elasticity of supply is proxied by the ratio of world market to home market prices. The parameters of the individual firm's demand curve can then be interpreted as a constant summarising other structural features of the home market. This leads to the following general specification:

$$PQB = \frac{(\eta . q+1)}{\eta . q} . f\left(\frac{QBV}{QBPOT}, \frac{PMQ}{PQB}\right) . COST \qquad [2]$$

where QBV = domestic output
QBPOT = domestic potential output
PMQ = a domestic-output-weighted index of world market prices

In this specification, disparities between actual and potential output and between domestic and world prices represent disequilibrium influences, while minimum average costs (which are proportional to marginal costs under constant returns to scale) represent the equilibrium forces acting on prices. In the presence of fixed capital and endogenously growing capacity, minimum average costs should be defined at the level of normal capacity utilisation, with excess demand being measured as deviations from this normal level. The log-linear version of equation [2] is:

$$\ln(PQB) = a_0 + a_1.\ln(COST) + a_2.\ln(QBV/QBPOT) + a_3.\ln(PMQ) \quad [3]$$

where -- depending on the definition of PQB -- the parameter on foreign prices (a_3) can be interpreted either as the import content of (gross) production or as the share of those goods and services in domestic production for which the "law of one price" is expected to hold.

To introduce dynamics, the level equation [3] has been formulated in first differences:

$$\begin{aligned} d\ln(PQB) = {} & a_0 + a_1.d\ln(COST) + (1-a_1)d\ln(PMQ) + a_2.\ln(QBV/QBPOT) \quad [4] \\ & + a_3.\ln(PMQ_{t-1}/PQB_{t-1}) + a_4.\ln(COST_{t-1}/PQB_{t-1}) \end{aligned}$$

where dln represents changes in logarithms. The two final error-correction terms, besides adding dynamics to the underlying levels equation, ensure long-run homogeneity and guarantee that the equilibrium level of the price index is determinate. They also imply that changes in excess demand will have a lagged impact on the price level. Equation [4] gives the general specification of domestic price formation in the new price blocks.

In the model adopted here, PQB is the domestic gross output deflator, gross output being defined as the business sector's value added plus intermediate energy consumption, but excluding non-energy imports. PQB is the central aggregate output price measure in the model which, in a subsequent stage, determines the deflators for each expenditure category. This approach has been chosen in order to -- firstly -- ensure a degree of consistency between price formation and the supply-side of the model, and -- secondly -- to capture the inflation effects of imported and domestic energy price changes properly. These inflation effects are crucial for modelling the real wage and profit response to large energy price changes at the level of the OECD economy as a whole.

B. Operational considerations: experience with previous versions of the price block

The theoretical considerations discussed so far are also common to previous versions of the model. Practical experience with the price block and its interaction with the rest of the model has been a more important motivation for re-specifying the domestic price blocks, and some important elements of this experience will be discussed in the remaining part of this section.

Price determination in the model results from the interaction of a variety of supply and demand forces in factor, product and financial markets. If some of these influences are missing in the specification of the price blocks or if undue weight is given to any one of them, implausible aggregate price movements may occur. Recent experience revealed a number of implausible price responses in full-model simulations which in part, emerged after including a neo-classical production function without adjusting other sectors of the model (2). Three areas which have given rise to particular concern relate to the inflation effects of monetary policy changes, the inflation effects of changes in economic activity, and the inflation effects of energy price changes. The following discussion of the difficulties which the model encountered in these areas will help to explain the re-specification of the price block presented in the next section. Table 1 illustrates some of the more disturbing features of the previous model, although it fails to reflect the richness of the experience which led to their identification (3).

Inflation effects of monetary policy changes. The main transmission mechanism, through which a tightening of monetary policies affects the economy, is higher interest rates. The overall impact of an interest-rate rise on the price level, in turn, depends on three partial effects: i) the positive impact of higher interest rates on capital costs; ii) the impact of higher capital costs on prices; and iii) the negative impact of higher interest rates on prices through other channels than capital costs, i.e. through product and labour markets (leaving aside the potentially powerful, negative, effect of a higher exchange rate, in order to isolate the properties of the domestic price formation process). In the previous version of the model, fixed exchange rates implied that the price-increasing effect coming through higher capital costs tended to dominate the price-reducing effects through labour and product markets, except in the United States, where the net effect was small but correctly-signed. This was partly attributable to the responsiveness of the measure of long-term real interest rates which is included in the definition of capital costs, given that long rates respond relatively strongly to changes in the short rate while bond markets' price expectations adapt very slowly (4).

A stylised example may illustrate the problem as it is also apparent in the top panel of Table 1. In the definition of capital costs embodied in the model, the current-period real interest rate has a weight of only 5 per cent. However, since an exogenous change in nominal rates implies -- given adaptive expectations -- a similar change in real rates, a 100 basis-point rise in interest rates will, at a baseline level of real rates of about 2 1/2 per cent, raise real rates by 40 per cent, generating a direct increase in the cost of capital of about 2 per cent. Thus, with capital costs accounting for 30-40 per cent of total costs (and assuming fixed exchange rates), a 100 basis-point rise in nominal interest rates entailed -- in the previous version of the model -- a direct positive effect on the aggregate price level of about 3/4 per cent.

Inflation effects of changes in economic activity. By contrast with the user cost of capital, the previous model's measure of excess demand tended to show little movement in simulations. This feature is a side-effect of the structure of the supply block which rests on a measure of normal (or equilibrium) output that is a function of actual employment (5). Except for fluctuations in the intensity of using employed labour, "capacity" tends to follow the path of actual output and employment. Thus, although fluctuations in output are accompanied by similar fluctuations in capital productivity, the ratio of actual to normal output -- the activity variable in the previous version of the price block -- behaves much more steadily. The degree of

Table 1

SOME FEATURES OF FULL-MODEL SIMULATIONS
WITH THE PREVIOUS PRICE BLOCK

(Deviation as a per cent of baseline after five years)

	United States	Japan	Germany	France	United Kingdom	Italy	Canada
	a) Interest-rate changes and inflation: 200 basis points rise in short-term interest rates						
Long-term real expected interest rates (a)	0.6	0.4	0.4	0.4	0.5	0.5	0.4
User cost of capital	2.5	3.2	4.0	2.8	4.6	8.5	3.3
Excess demand (a)	-0.5	-1.5	1.1	-0.7	-0.4	-1.3	-0.7
Gross output deflator	-0.6	0.2	1.2	0.5	0.1	1.1	0.2
	b) Output fluctuations and inflation: fiscal shock equivalent to 1 per cent of GDP (wages exogenised)						
Actual output	1.3	2.4	0.4	2.1	1.0	0.9	1.1
Normal output	1.0	1.0	1.0	1.1	1.1	0.6	1.0
Excess demand (a)	0.3	1.4	-0.6	1.0	-0.1	0.3	0.2
Private consumption deflator	0.6	0.2	-0.2	0.2	0.1	0.2	0.7
	c) Energy price changes and inflation: 10 per cent fall in the price of imported energy						
Energy import price	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0
Business sector energy costs	-4.5	-6.1	-4.7	-4.7	-3.5	-2.5	-3.5
Gross output deflator	-0.6	-0.1	-1.1	-1.5	-0.7	-0.1	-0.9
GDP deflator	-0.4	0.1	-1.1	-2.6	-1.2	-0.0	-0.6
Private consumption deflator	-0.5	-0.2	-1.4	-2.9	-1.2	-0.1	-0.8

a) Deviation in percentage points.

steadiness -- or in other words, the responsiveness of normal output -- was particularly striking for Germany, the United Kingdom and Canada.

The primary role of the normal output measure in the supply block is to determine how a given change of demand is being satisfied in the very short run: by changes in actual output or by changes in inventories. The determinants of this split are conceptually of a very short-term nature. Price equations, however, require an indicator of demand pressure which is likely to affect price prospects over a much longer time horizon, which is why an indicator of demand pressure more appropriate to the determination of prices has been added in the new version of the model.

Inflation effects of energy price changes. The previous model included two channels for the transmission of energy price changes: i) via the price of energy as an intermediate input in production, affecting the factor mix and the sales price of gross output; and ii) via the consumption price of energy as a direct influence on expenditure deflators. Likely changes in the sectoral price structure and their effect on overall profit margins and, hence, the value-added deflator as the main domestic determinant of final expenditure deflators, were neglected. The absence of sympathetic domestic price changes tended to underestimate the inflation effects of energy price changes at the level of the value-added deflator and concealed important structural differences between the seven major economies such as the relative sizes of domestic energy sectors.

The constant weights at which energy price changes affected expenditure deflators in the old system also weakened the response of aggregate inflation. Fixed weights tended to understate the growing share of energy in final expenditure in value terms and, hence, the growing impact of energy prices on consumer price changes. For the purpose of simulating large energy price changes, more realistic, variable weights were called for -- a change which necessarily introduces another element of baseline dependency into the model.

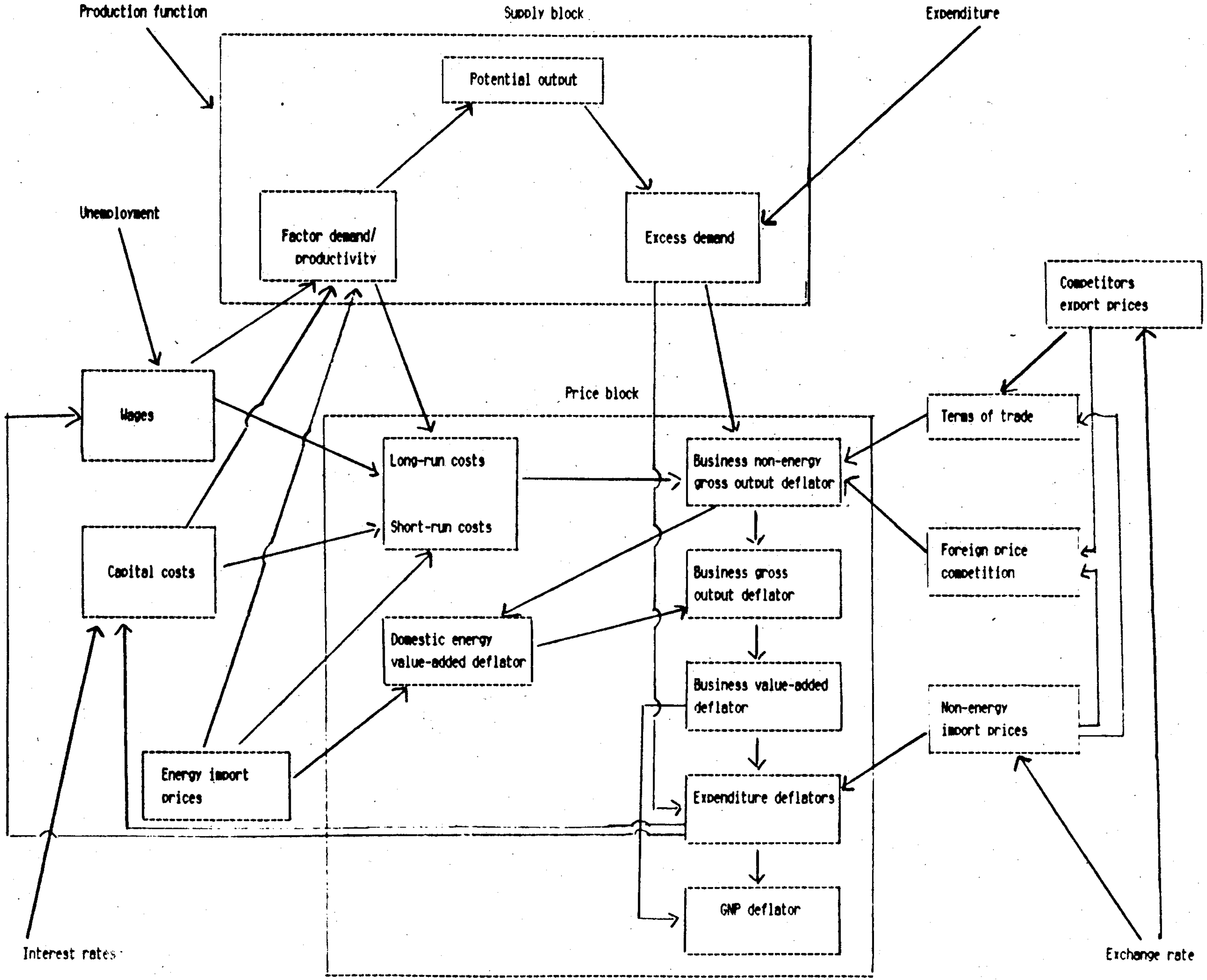
II. SPECIFICATION

The new price block is designed to solve the problems encountered with the previous price block in the context of full-model simulations. It consists of behavioural equations for the gross output deflator of the domestic private non-energy sector (PQBNE), for the value-added deflator of domestic energy production (PQBE) and for final expenditure deflators. It also includes a number of definitional equations for normal long-run costs, actual short-run costs, for the gross output deflator of the total business sector (PQB), for the value-added deflator of the total business sector (PGDPB) and for the aggregate value-added or GDP deflator (PGDP). The deflator for stockbuilding plays the role of the implicit residual between the GDP deflator, derived at the aggregate level, and the weighted sum of expenditure deflators. Diagram 1 gives an overview of the inner structure of the price block in the form of a flow diagram.

The following section presents the specification of the behavioural equations, bearing in mind the theoretical and practical considerations discussed above. The key equation for the gross output deflator of the non-energy sector is discussed at some length, followed by a brief

Diagram 1

THE STRUCTURE OF THE PRICE BLOCK



presentation of the specification of the equations for the value-added deflator of the domestic energy sector and for the final expenditure deflators.

A. The gross output deflator for the non-energy sector

Equation [4] above is the general form of the aggregate output-deflator equation. In light of the operational issues discussed above, three further refinements have been added:

-- The deflator is defined at the level of the non-energy sector of the private economy allowing domestic energy prices to be treated separately;

-- A terms-of-trade proxy is included as an additional explanatory variable which allows temporary profit-margin effects from non-energy import costs to be captured;

-- The contributions of foreign and energy prices to domestic price formation are allowed to change over time by including variable weights of foreign trade and energy in production and consumption.

The expanded version of equation [4] is therefore:

$$\begin{aligned} dln(PQBNE) = {} & a_0 + a_1.dln(COST) + a_2.(QBV/QBPOT) \\ & + a_3.W_1.ln(PMQNE_{t-1}/PQBNE_{t-1}) \\ & + a_4.(1-W_1).ln(COST_{t-1}/PQBNE_{t-1}) + a_5.W_2.dln(TOT) \end{aligned} \qquad [5]$$

where PQBNE = gross value-added deflator of the domestic non-energy sector
TOT = a terms-of-trade measure which excludes energy
PMQNE = a domestic output-weighted index of world market prices.
W_1, W_2 = foreign trade weights
$a_0 \approx -a_2$
$a_1 = 1$

PQBNE is defined as the sum of domestic incomes and the business sector energy bill per unit of output. The coefficient on changes in unit factor costs (a_1) should be unity, since other possible cost components such as non-energy imports are excluded by the definition of a value-added deflator. In order to allow for a unit coefficient on domestic costs and to avoid the possibility of short-run over-shooting when domestic costs and foreign prices change in the same direction, the impact of foreign competitors' prices is being lagged one period (and $1-a_1$ in equation [4] has been set to zero). This specification suggests that in the short run and for a given level of excess demand, prices tend to increase at the same rate as costs, and profit margins are constant. In the longer run, however, prices are determined by competitive supply, and profit margins vary endogenously. Margins will tend to fall if the level of costs is higher than the level of foreign competitors' prices and vice versa.

The long-run elasticity of the domestic price level with respect to foreign competitors' prices is $W_1.a_3/[1-(1-W_1.a_3-(1-W_1)a_4)] = W_1.a_3/(W_1.a_3+(1-W_1)a_4)$, while the long-run elasticity with respect to unit costs is $(1-W_1)a_4/(W_1.a_3+(1-W_1)a_4)$. Hence, in the long run prices are homogeneous in weighted domestic unit costs and weighted foreign prices. This feature is likely to strengthen the already present full system's tendency towards price uniformity across countries by allowing for more responsive profit margins on domestic markets. The excess demand measure is expressed as a ratio, and a constant term has been included in the equation; consequently, the normal or inflation-neutral level of economic activity is $-a_0/a_2$. The long-run semi-elasticity of prices with respect to changes in excess demand is $a_2/(W_1.a_3+(1-W_1)a_4)$. The independent variables in equation [5] can be briefly described as follows.

Unit costs (COST) are defined as:

$$COST = (ETB/QBV).WSSE + (ENBV/QBV).PENB + (KBV/QBV).UCC \qquad [6]$$

where ETB = business sector employment
WSSE = compensation per employee
ENBV = business sector energy consumption
PENB = deflator for business-sector intermediate energy consumption
KBV = business sector capital stock
UCC = user cost of capital.

In log-difference form, the growth of total unit costs is a linear function of each of the three unit cost categories (6):

$$dln(COST) = a_1.dln(WSSE/(QBV/ETB)) + a_2.dln(PENB/(QBV/ENBV)) + a_3.dln(UCC/(QBV/KBV)) \qquad [7]$$

where $a_1 = (WSSE_{t-1}.ETB_{t-1})/(COST_{t-1}.QBV_{t-1})$
$a_2 = (PENB_{t-1}.ENBV_{t-1})/(COST_{t-1}.QBV_{t-1})$
$a_3 = (UCC_{t-1}.KBV_{t-1})/(COST_{t-1}.QBV_{t-1}) = 1-a_1-a_2$

This defines the basic cost concept of the new price blocks but it has subsequently been modified in two respects: i) the weight applied to capital costs is limited to current gross investment, the rest of the capital stock being regarded as "sunk costs"; and ii) the weights a_1, a_2, a_3 are estimated means rather than representing the current-period factor mix determined in the supply block.

The weights in equation [7] (a_1, a_2, a_3) can be interpreted as "normal" or "equilibrium" income shares which are, by definition, constant. This introduces a feature of domestic price formation which is independent of the factor demand block of the model. Whereas the factor-demand equations, consistent with a CES production function, assume substitution elasticities of less than one with respect to changes in relative factor prices, the definition of COST given above assumes constant "normal" income shares and, hence, a substitution elasticity of unity with respect to changes in real factor prices. An important implication for the long-run properties of the model is that relative factor price changes will not only initiate substitution effects in the supply block; in combination with the price block they will also affect aggregate output and inflation (7).

The typical specification of empirical price equations relates prices to cyclically-adjusted as opposed to actual unit costs, especially when an explicit cyclical variable (excess demand) is also included in the equation. However, because of the lags at which factor demands respond to changes in output requirements, cyclical influences from input costs are not identical to those from demand or output. In order to allow for these differences, unit costs are defined as a weighted average of cyclically-adjusted (CNORM) and actual short-run costs (COST), with the weights determined empirically. For most countries, the cyclically-adjusted cost measure (CNORM) exercises a dominant influence making it the most important channel through which domestic cost changes feed into the aggregate price level.

A new potential output concept used to define an excess demand measure affecting domestic price formation has been incorporated into the model (see Jarrett and Torres, 1987). Potential output (QBPOT) is obtained from the production function using the actual capital stock, actual energy input and a measure of potential employment. The latter is defined as cost-minimising labour demand given the actual capital-energy bundle and the parameters of the production function. For a number of countries, the measure of cost-minimising employment has tended to exceed the labour force in recent periods, implying real wages to have been below their warranted levels. Potential employment was therefore constrained to stay within the limit of the labour force adjusted for an exogenous "minimum unemployment rate" (8). Diagram 2 shows the history of actual unemployment and the various output gaps used in the model, bearing in mind, however, that this history says relatively little about the behaviour of these measures in full-model simulation.

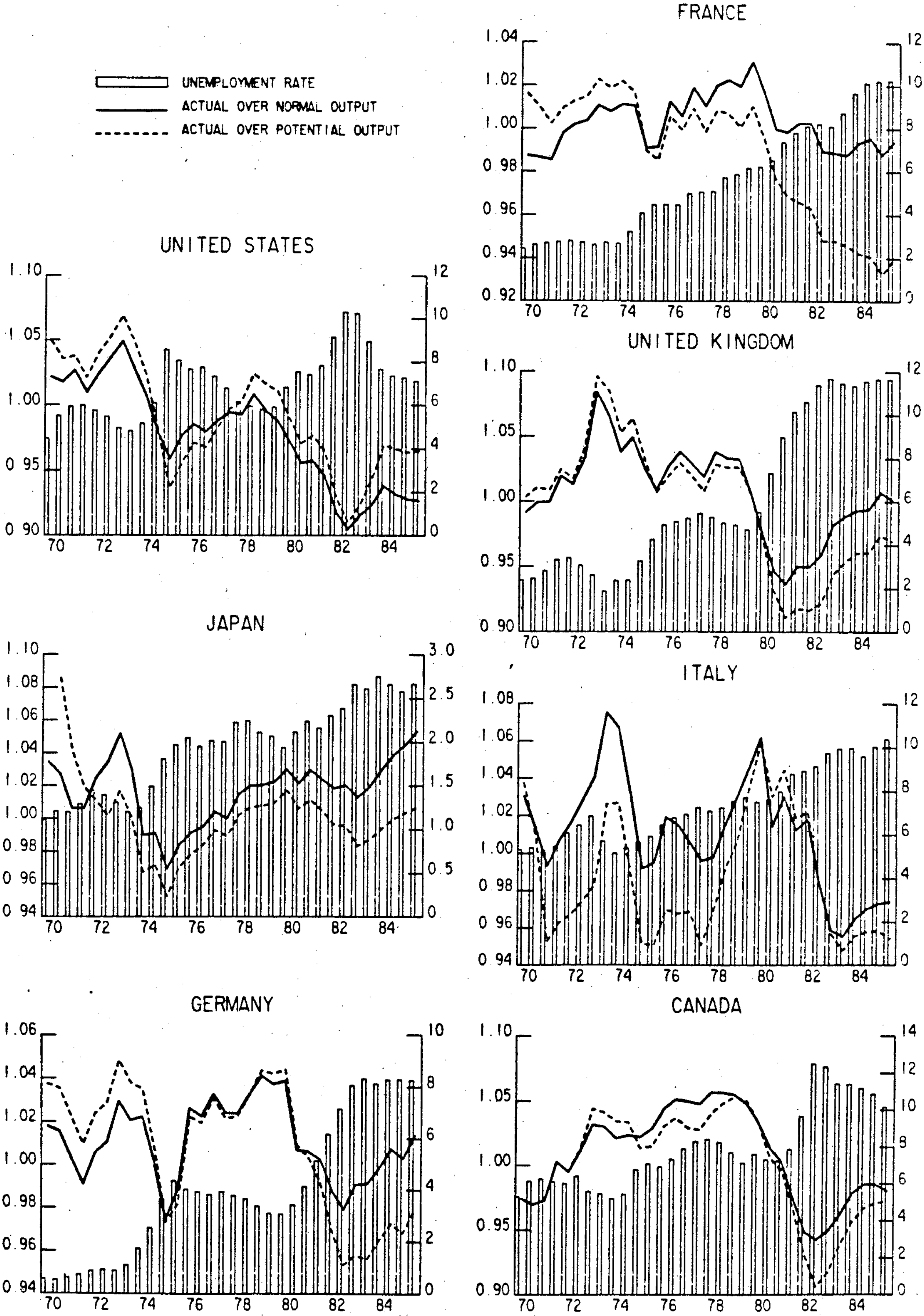
Foreign competitors' prices affect the level of domestic producers' profit margins -- a role which depends on the competitiveness and openness of the economies' product markets rather than on the actual import content in production or expenditure. Competitors' prices are measured by a weighted foreign trade price index using the same commodity breakdown as in the INTERLINK trade matrix, i.e. raw materials, food, manufactures and services (energy being included in the definition of total costs) (9). The aggregate index is then weighted by the share of total foreign trade (excluding energy) in gross output, as a proxy for the economy's openness, and thus the impact of foreign price competition increases over time as foreign markets gain in importance (10).

The GDP deflator often shows a perverse short-run response to abrupt changes in import prices, suggesting a separate influence of changes in the terms of trade on domestic prices. This is a reflection of a rational behaviour of economic agents: in the short run, profit margins absorb a part of import price changes, particularly if these are expected to be temporary. Competition will ensure the adjustment of final sales prices only after some delay. Although temporary, this phenomenon can nevertheless be an important factor in the response of profits and economic activity to terms-of-trade changes.

In a behavioural equation for the aggregate value-added deflator, some specific allowance must be made for this effect. This has been done by including the difference between the growth rates of merchandise export and merchandise import deflators, weighted by the share of merchandise trade (excluding energy) in total expenditure, in the aggregate price equation as an additional explanatory variable (11). Thus, if import prices fall relative to export prices, profit margins are temporarily increased putting some upward pressure on the value-added deflator.

Diagram 2

MODEL MEASURES OF ECONOMIC ACTIVITY



8. Domestic energy and final expenditure deflators

A new behavioural equation endogenising the value-added deflator for domestic energy production (PQBE) has been included in the model. The endogenous weight applied to this deflator allows the importance of domestic energy to vary both across countries and over time. The aggregate gross output deflator for the total business sector (PQB) is then obtained as a weighted average of prices in the non-energy (PQBNE) and energy (PQBE) sectors:

$$PQB = (1-WDE)PQBNE + WDE.PQBE \qquad [8]$$

The weight of domestic energy is endogenised, given a benchmark level, by means of the following definitional equation (12):

$$WDE = (ENBV + XEV - MEV)/QBV \qquad [9]$$

where XEV = energy exports in constant prices
MEV = energy imports in constant prices.

This definition assumes -- in the absence of a more developed energy sector in the model -- that households' and governments' energy bills change proportionately with that of the business sector.

Explicitly allowing for the direct influence of sympathetic energy prices at the level of final output provides the model with an important additional channel for exogenous world energy price changes to affect domestic inflation and output, taking account of the importance of energy in each country's domestic production. This channel is particularly important for the United States, the United Kingdom and Canada. National Accounts data have been used to define the domestic energy sector. The aim has been to to identify a sector whose profits are most likely to vary in parallel with energy prices rather than to achieve consistency with official, more narrowly-defined energy statistics (13). Diagram 3 compares the history of the computed value-added deflator of this sector with OPEC export prices, energy costs in production and the energy component of the consumer price index.

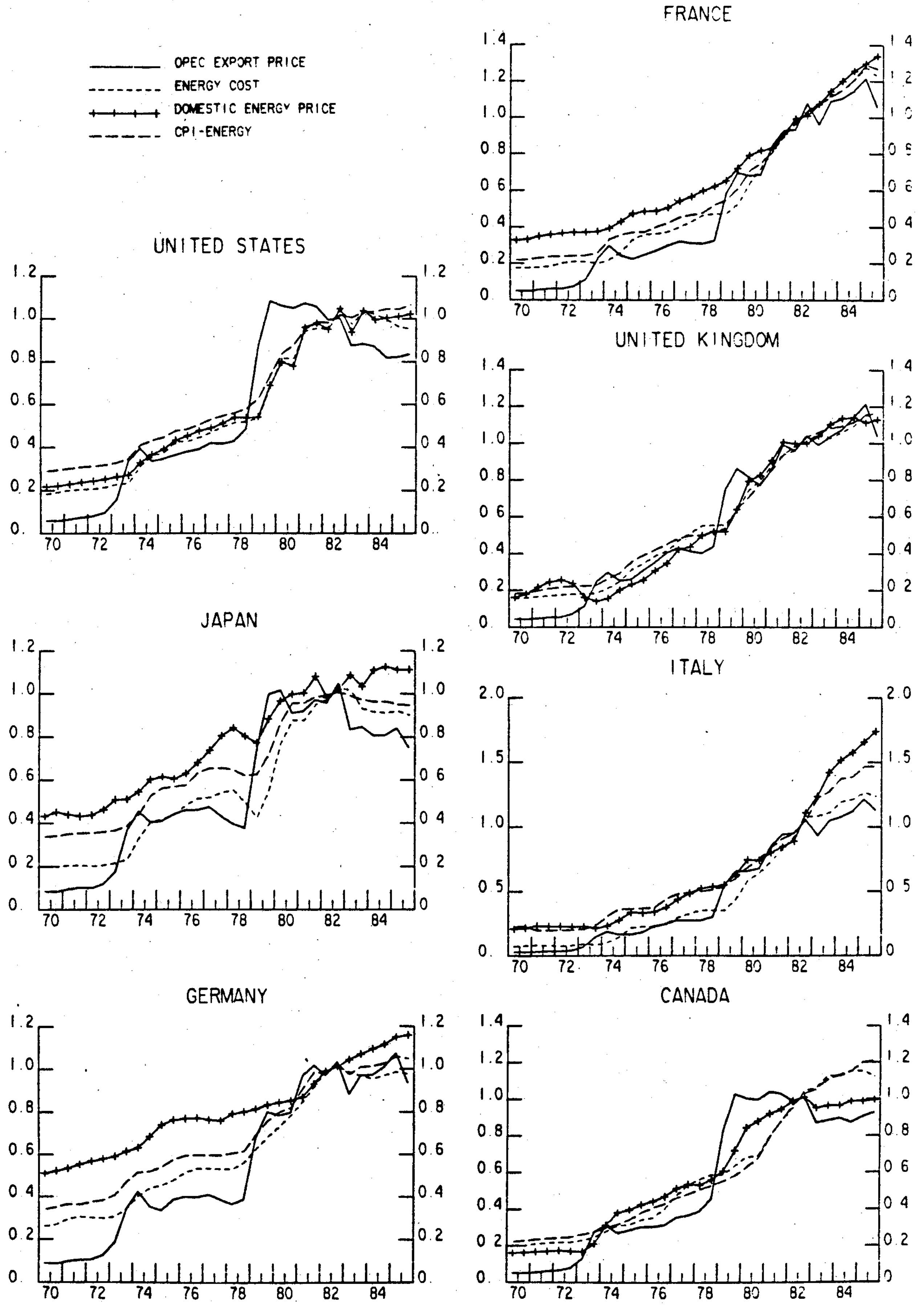
In the absence of usable data on potentially important institutional influences on domestic energy price formation, the specification of the equations is relatively simple and transparent (14). The value-added deflator of the domestic energy sector is related to the output deflator for the non-energy sector (PQBNE) and energy import prices (PME) with an empirically-estimated lag distribution:

$$dln(PQBE) = a_0 + a_1.dln(PME) + a_2.dln(PME_{t-i}) + (1-a_1-a_2)dln(PQBNE) \qquad [10]$$

Each of the major seven country models includes final expenditure deflators for private consumption, government consumption, business fixed investment, residential investment and government investment (15). The deflators for exports and imports of goods and services are determined in the foreign trade block. The deflator for inventory changes is a residual -- designed to ensure consistency between the sum of expenditure deflators and the aggregate value-added deflator. Cross-equation parameter constraints limit the responsiveness of this residual.

Diagram 3

ENERGY PRICE MEASURES



The general form of the expenditure-deflator equations, choosing the private consumption deflator (PCP) as an example, is as follows:

$$\begin{aligned} dln(PCP) = {} & a_0 + (1-a_1.V_1-a_2.V_2)dln(PGDPB) + a_1.V_1.dln(PMNE) \\ & a_2.V_2.dln(PME) + a_3.(QBV/QBPOT) \end{aligned} \quad [11]$$

where PMNE = non-energy import prices
PME = energy import prices
V_1 = the input/output coefficient of non-energy imports, specific to the expenditure category
V_2 = the input/output coefficient of energy, specific to the expenditure category.

The behavioural equations determine the expenditure deflators before net indirect taxes. Changes in net indirect taxes affect the expenditure deflators by means of some simple simulation rules. The domestic cost measure is the business-sector value-added deflator (PGDPB), obtained by excluding intermediate energy consumption from the business-sector gross value-added deflator:

$$PGDPB = (PQB.QBV-PENB.ENBV)/(QBV-ENBV) \quad [12]$$

The proportionate change in the expenditure-specific input/output weight is the same as for the shares of energy and non-energy imports in total expenditure, assuming the relative differences in import contents across expenditure categories to remain constant over time (16).

At uniform profit margins across all sectors of production and distribution, the coefficients on the input/output-weighted import prices (a_1, a_2) should be unity. To the extent that these coefficients differ from one (as is always the case in practice), import price changes imply secondary effects on sectoral profit margins coming in addition to the primary aggregate effect on the value-added deflator. Similarly, some of the deflator equations include secondary excess demand effects where such could be identified. In most cases, the aggregate excess demand effect (from the PQBNE equation) is amplified in the business fixed investment deflator equation and dampened in the private consumption deflator equation. The secondary excess demand effects are constrained to sum to zero across the estimated deflator equations implying no excess demand effect in the implicit stockbuilding deflator.

III. ESTIMATION RESULTS

A. The gross output deflator for the non-energy sector

The specification of the output-deflator equation as presented in Section II, is relatively rich. This richness is primarily a reflection of the experience with previous vintages of the price block, while also responding to changes made in other parts of the model. The specification nevertheless raises serious problems in estimation, particularly the high degree of multicollinearity among the independent variables. This well-known feature of empirical research with relatively few observations is particularly problematic for price equations, and was dominant in the conventional regression analysis which preceded the work reported here. Annex II presents an analysis of the degree of multicollinearity in the estimated equations for the gross output deflator.

To deal with the problem of multicollinearity, the "mixed" regression technique was finally adopted in order to incorporate extraneous information in the estimation of the parameters (17). Some of the parameters have been imposed while in other cases the historical data were allowed to determine parameter values within a restricted range. All of the estimation was done in percentage change form and used semi-annual data starting from various periods in the mid-sixties to the second semester of 1983 (18). A three-step estimation strategy was adopted:

1. As a first step, the parameters defining the cyclically-adjusted or normal long-run cost measures were estimated in equations which included cyclical variables.

2. In a second stage, priors on the parameters for those variables which determine the level of profit margins (i.e. variables other than costs) were determined -- in some cases individually -- using ordinary least square estimates.

3. These priors were subsequently used in a mixed regression which included all variables, while also imposing homogeneity in short-run and cyclically-adjusted costs.

The cyclically-adjusted cost measure (CNORM) defined in Table 2 is derived from price equations reported in Annex Table A2. The unit cost categories (LC, EC and CC) are defined as in equation [7], except that unit labour costs use a cyclically-adjusted measure of labour productivity consistent with the definition of potential output (19). The lag structure of labour and energy costs was determined by maximising the significance of the excess demand influence. The residual impact effect needed for achieving overall homogeneity was allocated to capital costs, defined as a relatively invariant, long-term moving average in order to avoid some of the problems noted above concerning the responsiveness of capital costs to changes in interest rates. The eleven-semester moving average applied to capital costs is consistent with the average length of an OECD cycle and with the definition of expected sales in the factor demand equations of the supply block.

The difference between the growth of prices and the growth of normal unit costs (CNORM) was then allocated to the various determinants of profit margins (or disequilibrium influences). Generally speaking, a simultaneous estimation of the parameters on these variables was hampered by the serious degree of multicollinearity. The estimated auxiliary equations, some of which include normalized costs and only individual disequilibrium forces, are reported in Annex Table A3. This information was used for prior parameter estimates of the disequilibrium influences. These prior estimates are reported, together with the variance attached to them, in Table 3 (20).

Table 4 summarises the final estimates. These results were obtained in an iterative procedure between mixed and ordinary regressions. The parameters of variables other than costs were determined in mixed regressions -- i.e. using priors -- under the constraint of given parameters for long- and short-run costs, the latter two respecting homogeneity; the parameters on long- and short-run costs were determined by means of constrained ordinary

Table 2

DEFINITION OF NORMAL LONG-RUN COSTS

$$CNORM = a_1 . \sum_{i=0}^{m} LC_{t-i}/(m+1) + a_2 \sum_{i=0}^{n} EC_{t-i}/(n+1) + (1-a_1-a_2) . \sum_{i=0}^{s} CC_{t-i}/(s+1)$$

	LC (Unit labour costs)		EC (Unit energy costs)		CC (Unit capital costs)	
	a_1	lags (m)	a_2	lags (n)	$(1-a_1-a_2)$	lags (s)
United States	0.82	2	0.06	1	0.12	10
Japan	0.79	2	0.11	0	0.10	10
Germany	0.79	3	0.11	0	0.10	10
France	0.75	2	0.08	0	0.17	10
United Kingdom	0.73	1	0.12	0	0.15	10
Italy	0.70	3	0.12	0	0.18	10
Canada	0.80	3	0.10	0	0.10	10

Table 3

GROSS OUTPUT DEFLATOR FOR THE NON-ENERGY SECTOR:
PRIOR ESTIMATES FOR THE DISEQUILIBRIUM INFLUENCES

(Prior variances in parentheses)

	Excess demand	Foreign competitors' prices	Terms-of-trade changes
	(QBV/QBPOT)	$(\frac{PMQNE_{t-1}}{PQBNE_{t-1}})$	(TOT)
United States	0.040 (0.001)	0.265 (0.005)	0.572 (0.01)
Japan	0.150 (0.005)	0.153 (0.005)	1.218 (0.01)
Germany	0.134 (0.005)	0.096 (0.005)	0.599 (0.01)
France	0.165 (0.005)	0.233 (0.005)	0.506 (0.01)
United Kingdom	0.133 (0.005)	0.208 (0.005)	0.508 (0.01)
Italy	0.128 (0.005)	0.213 (0.005)	0.766 (0.01)
Canada	0.040 (0.001)	0.265 (0.005)	0.867 (0.01)

Table 4

GROSS OUTPUT DEFLATOR FOR THE NON-ENERGY SECTOR: FINAL ESTIMATION RESULTS
(Mixed regression technique)

$$\text{dln PQBNE} = a_0 + a_1.\text{dln CNORM} + (1-a_1-a_{11})\text{dln COST} + a_{11}.\text{dln COST}(-1) + a_2(\text{QBV/QBPOT}) + a_3.W_1.\ln(\text{PMQNE}(-1)/\text{PQBNE}(-1)) + a_4.(1-W_1)\ln(\text{COST}(-1)/\text{PQBNE}(-1)) + a_5.W_2.\text{dln.TOT}$$

	a_0	a_1 (a)	$1-a_1-a_{11}$	a_{11} (a)	a_2	a_3	a_4	a_5	SEE	DW (b)	Chi^2 (c)
United States	-0.0764 (-3.17)	0.7759 (4.98)	0.2241	—	0.0830	0.1812	0.1272	0.6410	0.011	1.48 (1.52)	5.52
Japan (d)	-0.0283 (-2.92)	0.4986 (3.15)	0.5014	—	0.0307	0.0767	0.1261	0.7098	0.010	1.57 (1.83)	0.62
Germany	-0.0486 (-1.35)	0.7541 (4.46)	0.2459	—	0.0479	0.0796	0.3971	0.6777	0.008	1.20 (1.24)	4.74
France (e)	-0.0369 (-2.01)	0.6685 (2.47)	0.3315	—	0.0489	0.0374	0.1687	0.6345	0.010	1.42 (1.46)	0.40
United Kingdom (f)	-0.0610 (-3.67)	0.8475 (3.98)	0.1525	—	0.0510	0.1663	0.0626	0.5322	0.010	2.04 (2.33)	0.27
Italy	-0.1156 (-3.78)	0.5144 (5.84)	0.3616	0.1240 (8.92)	0.1101	0.1929	0.3431	0.7265	0.020	1.55 (1.59)	1.11
Canada (g)	-0.0579 (-2.62)	0.7481 (5.12)	0.2519	—	0.0593	0.2433	0.1207	0.8493	0.009	1.66 (1.90)	0.11

a) t-statistics in parentheses.

b) The Durbin-Watson statistics shown in parentheses are based on the historical observations excluding prior means and variances. See note (17) in text.

c) The critical value at the 5 per cent level is 14.1 for all equations except for Italy where it is 15.5. Test statistics below the critical value indicate that the compatibility of the priors with with data cannot be rejected.

d) Dummy S1 1974 — S2 1975: -0.030 (-4.45).

e) Dummy S1 1975 — S2 1975: -0.030 (-3.66).

f) Dummies S1 1973 — S2 1975: -0.015 (-2.86)
S1 1980 — S2 1983: 0.012 (2.42).

g) Dummies S1 1976 — S2 1976: -0.014 (-2.08)
S1 1983 — S2 1983: 0.025 (3.56).

least-square estimates, under the constraint of given parameters for the other variables, etc. This iterative procedure was continued until the estimated coefficients converged. Table 4 includes t-ratios on the cost variables which can be interpreted in the standard way. More important, however, are the Chi^2 statistics which indicate that compatibility of the priors with the data cannot be rejected in any of the estimated equations. The adjusted R^2 statistics were always higher than 0.975 but are not reported, since the large number of explanatory variables and the degree of multicollinearity limit their meaningfulness. Table 5 presents the implied long-run elasticities with respect to excess demand, foreign competitors' prices and domestic costs as well as the mean lag of the price adjustment.

To highlight some of the single-equation properties, the variability of profit margins may be interpreted as an indicator of competitiveness in product markets. Given the specification of the equations, profit margins will be more variable the smaller the impact of actual costs, and the larger the impact from excess demand and foreign competitors' prices. The short-run impact of actual costs *versus* cyclically-adjusted costs is determined by the coefficients a_{11} and $(1-a_1-a_{11})$ in Table 4. The long-run impact of actual costs is given by the long-run elasticity with respect to the domestic cost level compared with the long-run elasticities with respect to foreign competitors' prices and excess demand as shown in Table 5.

The results include some noteworthy features, bearing in mind, however, that the implications on the overall model behaviour can only be recognised in full-model simulations. Relatively competitive product markets characterise the *United States*, the *United Kingdom* and *Canada*, where profit margins are responsive both with respect to domestic demand and foreign competition. For the United Kingdom, this result needs to be qualified somewhat due to a relatively large weight of current wages within the cyclically-adjusted cost measure itself (see Table 2). By contrast, product markets appear particularly rigid in *Japan*. The other countries are more ambiguous. *Germany* shows little profit-margin flexibility in the long run, although in the short run profit margins tend to absorb domestic cost changes to a considerable extent. In *France*, profit margins also appear to be rigid and little affected by foreign price competition, but they react relatively strongly to domestic demand fluctuations. In *Italy*, the influence of actual short-run costs is most dominant, while the relatively strong impact effect of excess demand reflects, *inter alia*, particularly large cyclical variations in productivity growth which is included in the unit cost measure. This is an example of the need to take the actual behaviour of the various disequilibrium variables into account and to review these properties more broadly in a full-model context (21).

B. Domestic energy and final expenditure deflators

The main role of the equations for the *value-added deflator of the domestic energy sector* (PQBE) is to provide an additional transmission channel for energy price changes in the context of full-model simulations. Various specifications and sub-samples were investigated, but -- given rather different response patterns after the first and the second oil crises and in the absence of justifiable priors -- ordinary regression results covering only the period since 1978 were considered most relevant.

The estimation results which are provisionally incorporated into the model are shown in Table 6, and Diagram 4 illustrates the tracking performance

Table 5

LONG-RUN PROPERTIES OF EQUATIONS FOR THE GROSS OUTPUT DEFLATOR
OF THE NON-ENERGY SECTOR (a)

	Long-run elasticities			Mean lag (half-years)
	Excess demand (b)	Foreign competitors' prices	Domestic cost levels	
United States	0.57	0.43	0.57	5.8
Japan	0.29	0.29	0.71	8.3
Germany	0.19	0.14	0.86	3.0
France	0.42	0.13	0.87	7.6
United Kingdom	0.54	0.53	0.47	9.6
Italy	0.39	0.27	0.73	2.5
Canada	0.36	0.52	0.48	5.1

a) These calculations use 1984 levels of the foreign trade weight.

b) Semi-elasticity.

Table 6

ESTIMATION RESULTS FOR THE VALUE-ADDED DEFLATOR OF DOMESTIC ENERGY SECTORS

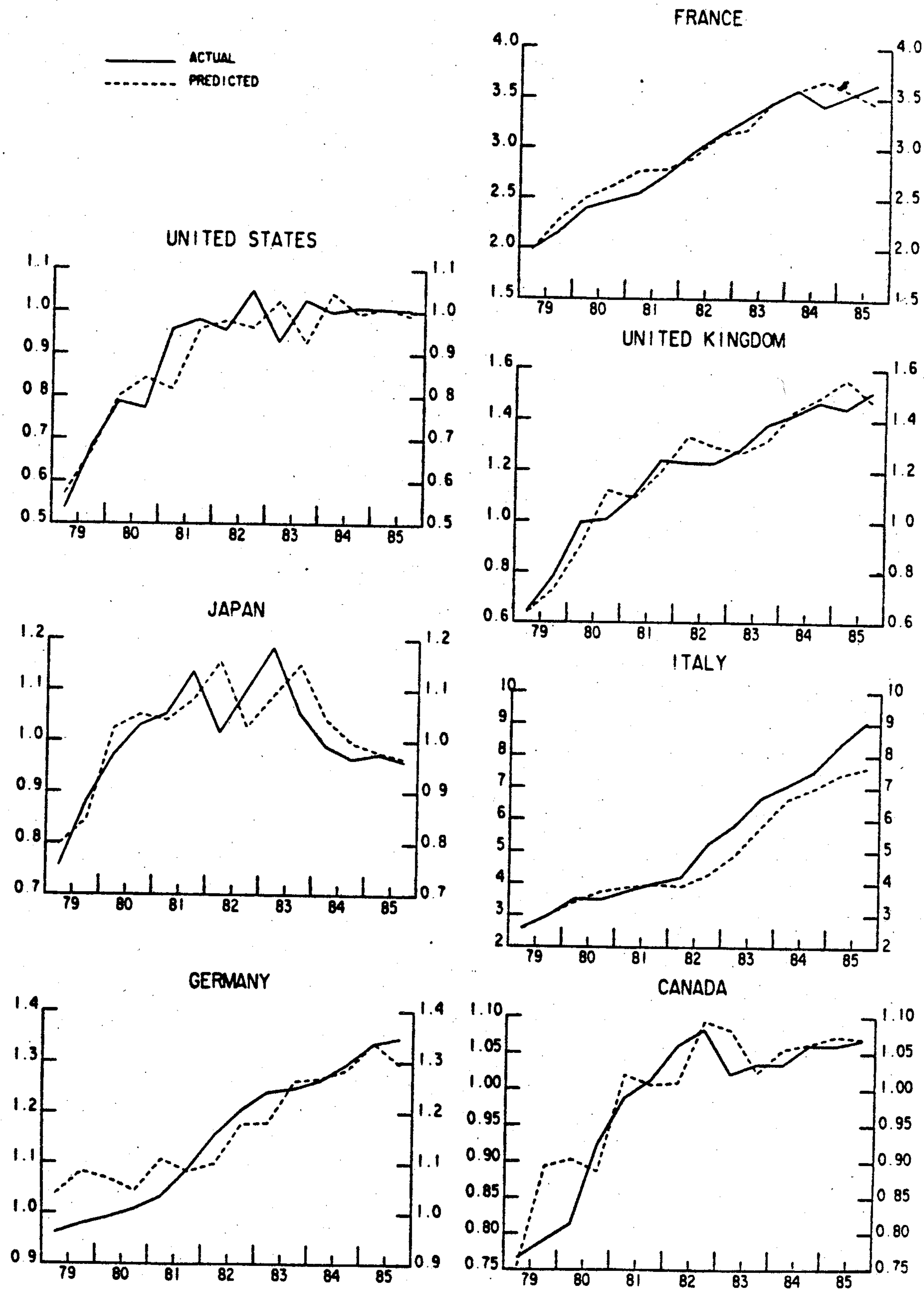
$$dlnPQBE = a_0 + a_1.dlnPME + a_2.dlnPME(-1) + (1-a_1-a_2).dlnPQBNE$$

(t-statistics in parentheses)

	a_0	a_1	a_2	Sample	DW	Adj. R^2
United States	-0.002 (-0.04)	0.449 (1.9)	--	1978II - 1981II	2.4	0.32
Japan	0	0.285 (2.6)	--	1977II - 1983II	2.5	0.37
Germany	--	0.350 (i)				
France	--	0.350 (i)				
United Kingdom	-0.013 (-0.7)	0.786 (4.2)	--	1978II - 1983II	0.73	0.76
Italy	-0.007 (-2.2)	0.469 (2.4)	--	1978II - 1981II	1.76	0.45
Canada	0.002 (0.2)	0.336 (8.6)	0.0567 (1.5)	1971II - 1983II	1.99	0.79

Diagram 4

**DOMESTIC ENERGY PRICE EQUATIONS:
TRACKING PERFORMANCE (a)**



a) The predictions are static.

of these equations from 1979I to 1985II. Given the small number of observations and problems inherent in this area where institutional influences are particularly important, the equations reported are probably best thought of as simulation rules based on recent experience rather than empirically-estimated reduced-form price equations. The variation in domestic energy prices nevertheless appears more "explicable" and better correlated with the variation in traded energy prices in the case of the two net energy exporters, the United Kingdom and Canada. No acceptable estimation results could be obtained for Germany and France. In these two cases, coefficients are imposed whose size falls between the estimated coefficients of Japan and Italy.

Table 7 presents estimation results for the complete menu of expenditure deflators. A mixed regression technique was used in order to constrain the coefficients to stay within a reasonable distance from the input/output weights (XNE and XE). The prior estimates assumed unit coefficients on weighted non-energy and energy imports, i.e. impact effects strictly consistent with the expenditure-specific import contents. Given the homogeneity constraint, this also implied a prior estimate on the domestic influence coming through the value-added deflator. As before, the Chi^2 statistics serve as tests for the compatibility with the sample.

The overall impact effect of domestic cost changes (a_1) can be seen in Table 7. In the majority of cases, domestic costs have a weight between 75 and 90 per cent. The ranking corresponds broadly, although not strictly, to the foreign trade shares of the seven economies. The actual impact effect of import price changes is given by the estimated coefficients (a_2 and a_3) multiplied by the input-output weights (XNE, XE). The recent trends in these weights are shown in Table 8.

IV. SIMULATION PROPERTIES OF THE NEW PRICE BLOCK

This section presents model simulations designed to reveal the dynamic properties of the new price block. The overall properties of the latest version of INTERLINK are presented in Richardson (1987); only issues directly related to changes in the area of domestic price formation are presented below. The first part of this section presents simulation results for the wage/price block in isolation. In these simulations, interactions with the rest of the model due to endogenous changes of factor demand, output, unemployment, etc. have been suppressed in order to isolate the dynamics of cost/price spirals. The second part presents full-model simulation results.

A. Wage/price block simulation results

Tables 9-13 report detailed results of block simulations for various exogenous shocks administered to the more important independent variables of the price block. The simulations -- all in single-country mode -- cover the period 1983I to 1987II. Exchange rates and interest rates are always fixed except where these variables are shocked. Given the importance of the wage response in the interaction of costs and prices, the simulation results for the exchange rate and the oil price shocks are presented for alternative assumptions of exogenous and endogenous wages (22).

Table 7

EXPENDITURE DEFLATOR EQUATIONS: FINAL ESTIMATION RESULTS

$$dln\ PCP = a_0 + a_1.dln\ PGDPB + a_2.XNE.dln\ PMNE + a_3.XE.dln\ PME + a_4.(QBV/QBPOT)$$

$$dln\ PCG = a_0 + a_1.dln\ PGDPB + a_2.XNE.dln\ PMNE + a_3.XE.dln\ PME + a_5.dln\ WRG\ (a)$$

$$a_1 = 1-a_2.XNE - a_3.XE\ (b)$$

(Where lags enter, these are shown in parentheses, 0 denoting the current period, 1 denoting period t-1, etc. More than one period indicates a moving average.)

	a_0	a_1	a_2	a_3	a_4	Adj. R^2	SEE	DW	Chi^2	Chi^2 (c)
PCP										
United States	0.010	0.928	0.752	1.433 (2)	-0.012	0.52	0.005	1.80	1.0557	7.81
Japan	0.029	0.913	1.045 (0,1,2)	0.522 (0,1,2)	-0.026	0.67	0.007	1.66	0.0628	7.81
Germany	0.025	0.803	0.889	0.666	-0.025	0.55	0.008	2.07	1.4649	7.81
France	-0.001	0.785	1.157 (0,1,2)	1.080	--	0.87	0.007	1.36	0.4503	5.99
United Kingdom	0.028	0.819	0.885	1.098	-0.032	0.80	0.006	2.56	0.2967	7.81
Italy	-0.011	0.763	1.218	0.695	0.011	0.86	0.012	1.72	0.4613	7.81
Canada	-0.001	0.776	1.444 (0,1,2)	0.529 (2)	--	0.48	0.010	1.27	0.3505	5.99
PIB										
United States	-0.033	0.897	1.420 (1,2,3)	1.398 (0,1,2)	0.032	0.52	0.010	1.37	0.2609	7.81
Japan	-0.040	0.870	1.157	1.476	0.038	0.82	0.008	2.34	0.0446	7.81
Germany	-0.052	0.843	0.761 (2)	1.359	0.054	0.54	0.007	2.12	3.1577	7.81
France	-0.004	0.761	1.250	1.308 (0,1,2)	--	0.68	0.012	1.36	0.0092	5.99
United Kingdom	-0.075	0.795	0.869	0.828	0.066	0.57	0.015	2.57	0.0657	7.81
Italy	0.082	0.728	1.389	1.253	-0.082	0.81	0.012	2.44	0.0200	7.81
Canada	-0.008	0.746	1.016	0.994 (1,2)	--	0.51	0.016	0.87	0.0006	5.99
PIH										
United States	0.004	0.925	1.066 (0,1,2,3,4)	0.854 (0,1)	--	0.36	0.014	1.28	0.0012	5.99
Japan	0.009	0.886	1.174	1.107	--	0.52	0.026	0.93	0.0729	5.99
Germany	0.008	0.824	0.921	1.044	--	0.79	0.020	0.68	0.0247	5.99
France	0.005	0.852	0.728	1.105	--	0.90	0.013	2.01	0.0077	5.99
United Kingdom	0.011	0.802	0.819	1.100	--	0.40	0.047	2.50	0.0194	5.99
Italy (d)	0.012 (3.85)	0.645	1.759 (4.07)	1.836 (2.68)	--	0.81	0.013	1.89	--	--
Canada	0.002	0.867	0.520	1.001	--	0.80	0.024	1.47	0.0008	5.99

Table 7 (continued)

	a_0	a_1	a_2	a_3	a_5	Adj. R^2	SEE	DW	Chi^2	Chi^2 (c)
PIG										
Japan	0.002	0.869	1.117	1.556		0.72	0.009	1.41	1.989	5.99
Germany	0.002	0.877	0.598 (2)	1.029		0.21	0.021	0.83	0.346	5.99
France	0.002	0.768	1.249 (0,1,2)	1.059		0.61	0.013	1.53	0.031	5.99
United Kingdom	0.002	0.783	0.895	1.235		0.48	0.025	1.38	0.007	5.99
Italy	0.004	0.798	1.023	0.966		0.51	0.017	2.15	0.001	5.99
Canada	0.000	0.742	0.896	0.947 (1,2)		0.44	0.015	1.62	0.007	5.99
PCG										
United States	0.003	0.395	0.708	0.784	0.552	0.95	0.008	1.83	2.032	7.81
Japan	-0.029	0.366	0.950	0.702 (1)	0.600	0.98	0.017	2.84	0.000	7.81
Germany (d)	0.002 (1.12)	0.382	0.816 (1.14)	1.172	0.522 (1.28)	0.74	0.008 (5.85)	2.75	--	--
France (d)	0.002 (0.97)	0.418	1.677 (2.54)	1.086	0.471 (1.49)	0.89	0.006 (5.00)	1.78	--	--
United Kingdom	0.000	0.395	0.566	0.616	0.534	0.67	0.013	2.56	0.0543	7.81
Italy	0.001	0.158	0.724	0.670	0.800	0.98	0.006	1.41	0.0470	7.81
Canada	0.002	0.420	0.942	0.944 (1,2)	0.524	0.93	0.013	2.44	0.6925	7.81

The half-yearly estimation period goes from various periods in the second half of the sixties to 1983II.

a) In the government consumption deflator equations, government wages (WRG) enter as an additional variable.

b) Weights for 1984I are used to compute the values for a_1.

c) Critical values at the 5 per cent level.

d) Ordinary least squares, t-ratios in parentheses.

Variable names:

PCP = Private consumption deflator
PIB = Business fixed investment deflator
PIH = Residential construction deflator
PIG = Government investment deflator
PCG = Government consumption deflator
PMNE = Non-energy imports deflator
PME = Energy imports deflator
WRG = Government wages

Table 8

IMPORT WEIGHTS USED IN EXPENDITURE DEFLATOR EQUATIONS

XNE = non-energy imports, XE = energy imports,
CP = private consumption, CG = goverment consumption,
IT = business fixed investment and housing combined.

(Percentage shares, multiplied by 100)

	XNE.CP	XE.CP	XNE.IT	XE.IT	XNE.CG	XE.CG	XNE.CP	XE.CP	XNE.IT	XE.IT	XNE.CG	XE.CG
			UNITED STATES						**JAPAN**			
1977 S1	6.7	2.3	5.2	1.4	5.5	1.0	7.3	4.1	6.6	4.5	1.9	2.6
S2	6.8	2.6	5.2	1.6	5.6	1.2	6.8	3.9	6.1	4.3	1.8	2.5
1978 S1	6.9	2.4	5.3	1.4	5.7	1.1	6.1	3.6	5.4	4.0	1.6	2.3
S2	7.6	2.1	5.8	1.3	6.2	0.9	5.6	3.0	5.0	3.3	1.5	1.9
1979 S1	7.5	2.0	5.8	1.2	6.2	0.9	5.4	2.5	4.9	2.7	1.4	1.6
S2	7.4	2.2	5.7	1.3	6.1	1.0	6.5	2.9	5.8	3.2	1.7	1.8
1980 S1	7.6	3.0	5.8	1.8	6.2	1.3	7.4	4.5	6.7	4.9	2.0	2.8
S2	7.6	3.5	5.9	2.1	6.2	1.6	7.4	5.6	6.6	6.2	1.9	3.6
1981 S1	7.6	3.0	5.8	1.8	6.2	1.4	6.6	5.1	6.0	5.6	1.7	3.2
S2	7.5	3.1	5.7	1.9	6.1	1.4	6.3	5.0	5.6	5.5	1.6	3.2
1982 S1	7.7	2.6	5.9	1.6	6.3	1.2	6.5	4.9	5.8	5.4	1.7	3.1
S2	7.4	2.2	5.7	1.3	6.1	1.0	6.5	4.9	5.9	5.3	1.7	3.1
1983 S1	7.3	2.3	5.6	1.4	6.0	1.0	6.3	4.8	5.7	5.3	1.7	3.1
S2	7.4	1.8	5.7	1.1	6.1	0.8	6.0	4.1	5.3	4.5	1.6	2.6
1984 S1	7.9	1.9	6.1	1.2	6.5	0.9	6.3	4.0	5.6	4.4	1.7	2.6
			GERMANY						**FRANCE**			
1977 S1	17.1	3.1	14.8	1.8	7.4	1.9	14.2	4.2	16.3	2.3	5.3	1.8
S2	16.9	2.9	14.6	1.7	7.3	1.7	13.9	3.8	16.0	2.1	5.2	1.6
1978 S1	17.1	3.0	14.8	1.7	7.4	1.8	13.4	3.9	15.5	2.2	5.0	1.6
S2	16.7	2.7	14.4	1.6	7.2	1.6	13.3	3.4	15.3	1.9	5.0	1.4
1979 S1	16.7	2.7	14.4	1.5	7.2	1.6	13.4	3.2	15.4	1.8	5.0	1.3
S2	17.0	3.2	14.7	1.8	7.4	1.9	13.7	3.5	15.7	2.0	5.1	1.5
1980 S1	17.5	3.9	15.1	2.2	7.6	2.3	14.1	4.2	16.3	2.4	5.3	1.8
S2	17.7	4.4	15.3	2.5	7.7	2.6	14.2	5.1	16.4	2.9	5.3	2.2
1981 S1	17.8	4.4	15.4	2.5	7.7	2.6	13.7	5.3	15.8	3.0	5.1	2.2
S2	18.0	4.8	15.6	2.8	7.8	2.9	13.6	5.7	15.7	3.2	5.1	2.4
1982 S1	17.9	5.0	15.5	2.9	7.8	3.0	13.9	5.8	16.1	3.2	5.2	2.4
S2	18.1	4.7	15.6	2.7	7.8	2.8	14.0	5.3	16.1	3.0	5.2	2.2
1983 S1	17.6	4.6	15.2	2.7	7.6	2.8	14.3	5.5	16.5	3.1	5.3	2.3
S2	17.9	4.2	15.4	2.4	7.7	2.5	14.1	4.8	16.3	2.7	5.3	2.0
1984 S1	19.0	4.2	18.4	2.4	8.2	2.5	14.2	4.7	16.4	2.6	5.3	2.0
			UNITED KINGDOM						**ITALY**			
1977 S1	18.1	3.6	22.4	2.7	11.1	2.5	16.9	5.4	16.9	3.5	3.9	2.0
S2	18.8	3.1	23.3	2.3	11.5	2.1	16.3	5.2	16.3	3.4	3.7	2.0
1978 S1	17.9	2.7	22.2	2.0	10.9	1.8	15.9	4.9	15.9	3.2	3.7	1.9
S2	18.3	2.3	22.6	1.7	11.2	1.6	15.3	4.5	15.3	2.9	3.5	1.7
1979 S1	18.0	2.3	22.2	1.7	11.0	1.6	16.5	4.8	16.5	3.1	3.8	1.8
S2	18.7	2.2	23.1	1.6	11.4	1.5	16.8	4.6	16.8	3.0	3.9	1.7
1980 S1	18.1	2.6	22.4	1.9	11.0	1.8	17.7	5.4	17.7	3.5	4.1	2.0
S2	18.1	2.7	22.4	2.0	11.0	1.8	17.0	5.8	17.0	3.7	3.9	2.2
1981 S1	15.6	2.4	19.3	1.8	9.5	1.7	17.6	6.6	17.6	4.2	4.1	2.5
S2	15.1	2.3	18.6	1.7	9.2	1.5	15.9	7.3	15.9	4.7	3.7	2.8
1982 S1	17.1	2.7	21.1	2.0	10.4	1.8	16.7	7.9	16.7	5.1	3.8	3.0
S2	16.9	2.5	20.9	1.8	10.3	1.7	17.1	7.0	17.1	4.5	3.9	2.6
1983 S1	16.4	2.2	20.2	1.6	10.0	1.5	15.4	7.0	15.4	4.5	3.5	2.7
S2	18.0	2.0	22.2	1.5	11.0	1.4	15.4	6.5	15.4	4.2	3.5	2.5
1984 S1	18.0	2.0	22.2	1.5	11.0	1.4	15.8	6.4	15.8	4.2	3.6	2.4
			CANADA									
1977 S1	14.3	1.6	23.1	0.9	5.1	0.6						
S2	14.9	1.6	24.0	0.9	5.3	0.6						
1978 S1	14.6	1.8	23.6	1.0	5.2	0.7						
S2	15.2	1.5	24.6	0.9	5.4	0.6						
1979 S1	15.8	1.6	25.5	0.9	5.6	0.6						
S2	16.5	1.5	26.6	0.9	5.9	0.6						
1980 S1	16.6	2.0	26.8	1.1	5.9	0.8						
S2	15.7	2.4	25.3	1.3	5.6	0.9						
1981 S1	15.5	2.2	25.1	1.2	5.5	0.8						
S2	15.9	2.4	25.7	1.4	5.7	0.9						
1982 S1	15.5	2.2	25.0	1.2	5.5	0.8						
S2	14.1	1.7	22.7	1.0	5.0	0.7						
1983 S1	13.3	1.5	21.4	0.8	4.7	0.6						
S2	14.1	1.0	22.7	0.6	5.0	0.4						
1984 S1	15.1	1.2	24.3	0.7	5.4	0.5						

A general feature of all the simulations is that the expenditure deflators respond less than the output deflators because import prices are assumed to be unchanged, except in the cases of a uniform increase in all costs (including foreign prices) and of an exchange-rate depreciation. The housing and government consumption deflators follow the aggregate output deflators relatively closely, reflecting smaller impacts of import prices as implied by the results shown in Table 7.

The simulations reported in Table 9a assume a sustained 2 per cent increase in all costs (i.e. labour, capital, energy and import prices) to illustrate the speed and extent to which overall homogeneity in costs and prices is achieved. This depends mainly on the weight of current wages within the combined measure of cyclically-adjusted and actual costs (see Tables 2 and 4). For the United States, Germany and Canada, this weight is smaller than for the other countries. Nevertheless, by the second year at least 85 per cent of the increase in costs have been reflected in the GDP deflator in all countries.

A simulation of an exogenous, sustained 2 per cent increase in the level of nominal wages, the single most important cost component, is presented in Table 9b (23). In this simulation, prices are also affected by the endogenous response of domestic costs other than wages. The price response, which is similar across countries, typically does not build up monotonically but peaks between the second and the fourth year and tends to gradually weaken thereafter. This mainly reflects the restraining influence from constant foreign competitors' and import prices -- an effect which is most important in the case of Italy.

Table 10a presents a simulation of a sustained 2 per cent increase in the capital cost measure relevant for the determination of prices (see note (19)), without specifying the origin of such an increase and with wages responding endogenously. The impact on the GDP deflator of an increase in capital costs is relatively small and quite uniform across countries. Table 10b shows an alternative case where short-term interest rates are permanently increased by 200 basis points letting capital costs (as well as wages) respond endogenously. Table 10b shows only the pure cost effect of interest-rate changes. In full-model simulations of increases in interest rates, the impact on prices is negative in all countries (see Richardson, 1987). The monotonic, cumulative, increase in the price response to changes in interest costs is a consequence of the long lags at which changes in short-term interest rates feed into the user cost of capital. Depending on the baseline level of the expected real rate of return, the same absolute change in interest rates represents a different proportional change in capital costs in each country. This effect is particularly significant in the case of Italy where real interest-rate measures have been persistently low and negative.

A simulation of a 10 per cent increase in the price of imported energy is presented in Table 11. Higher imported energy prices affect final expenditure deflators directly and raise the costs of production at the same time. The response to changes in energy import prices also takes the country-specific weights of energy in domestic production into account. This can be seen by comparing the response of the GDP deflator with the response of the non-energy output deflator (Table 11a). An additional positive contribution to the GDP deflator occurs in those countries where domestic

Table 9

WAGE/PRICE BLOCK SIMULATIONS: MAJOR COST CHANGES

(Percentage differences from baseline)

a) 2 per cent increase in all costs

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	1.3	1.5	1.1	1.3	1.5	1.2	1.1	1.2
	84	1.7	1.3	1.8	1.8	1.9	1.8	1.8	1.8
	85	1.3	1.4	2.0	1.6	2.0	1.9	2.0	1.9
	86	1.3	1.3	2.0	1.6	2.0	1.9	2.0	1.9
	87	1.3	1.3	1.9	1.8	2.1	1.9	2.0	1.9
ENERGY OUTPUT DEFLATOR	83	1.3	1.3	1.3	1.5	1.5	1.4	1.3	1.4
	84	1.9	2.3	1.8	1.9	2.0	1.8	1.8	1.9
	85	1.7	2.1	1.9	1.9	2.1	1.9	2.0	2.0
	86	1.3	2.1	1.7	1.7	2.0	1.5	1.9	1.8
	87	1.3	2.2	1.8	1.8	2.2	1.6	1.9	1.9
GDP/GNP DEFLATOR	83	0.9	1.2	1.1	1.3	1.4	1.1	1.1	1.2
	84	1.7	1.3	1.6	1.8	1.8	1.7	1.8	1.8
	85	1.3	1.3	2.0	1.8	1.9	1.9	2.0	1.9
	86	1.3	1.8	2.0	1.8	1.9	1.9	2.0	1.9
	87	1.3	1.7	1.9	1.7	2.0	1.8	1.9	1.9
PRIVATE CONSUMPTION DEFLATOR	83	0.9	1.1	0.9	1.1	1.2	1.0	0.9	1.0
	84	1.5	1.7	1.5	1.5	1.6	1.4	1.5	1.6
	85	1.6	1.7	1.7	1.5	1.7	1.6	1.7	1.6
	86	1.5	1.7	1.7	1.5	1.7	1.5	1.6	1.6
	87	1.5	1.7	1.7	1.5	1.7	1.5	1.6	1.6
BUSINESS FIXED INVESTMENT DEFLATOR	83	1.3	1.2	0.9	1.0	1.2	1.3	0.8	1.0
	84	1.7	1.7	1.5	1.5	1.6	1.5	1.4	1.5
	85	1.3	1.7	1.7	1.5	1.7	1.6	1.5	1.6
	86	1.3	1.7	1.7	1.5	1.6	1.6	1.5	1.6
	87	1.3	1.6	1.7	1.5	1.7	1.6	1.4	1.6
HOUSING DEFLATOR	83	1.3	1.2	0.9	1.1	1.2	1.0	1.0	1.0
	84	1.5	1.7	1.6	1.6	1.5	1.4	1.6	1.6
	85	1.3	1.8	1.7	1.7	1.6	1.5	1.8	1.7
	86	1.3	1.7	1.7	1.7	1.5	1.4	1.7	1.7
	87	1.3	1.7	1.7	1.6	1.6	1.4	1.7	1.6
GOVERNMENT CONSUMPTION DEFLATOR	83	0.6	1.1	1.2	1.2	1.6	0.9	1.0	1.1
	84	1.3	2.0	1.8	1.7	1.8	1.4	1.7	1.7
	85	1.5	1.9	1.9	1.7	1.9	1.5	1.9	1.8
	86	1.7	1.5	1.8	1.7	1.9	1.7	1.9	1.8
	87	1.3	1.7	1.8	1.7	2.0	1.5	1.8	1.8

b) 2 per cent increase in wages

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	0.9	1.0	0.8	1.0	1.3	0.9	0.8	0.9
	84	1.6	1.5	1.5	1.6	1.7	1.4	1.5	1.5
	85	1.5	1.5	1.7	1.6	1.7	1.6	1.7	1.6
	86	1.5	1.5	1.6	1.6	1.7	1.5	1.7	1.6
	87	1.5	1.4	1.6	1.5	1.6	1.4	1.6	1.5
ENERGY OUTPUT DEFLATOR	83	0.5	0.7	0.5	0.6	0.7	0.4	0.6	0.6
	84	0.9	1.2	1.0	1.0	1.0	0.8	1.0	1.0
	85	0.9	1.3	1.0	1.1	1.0	0.9	1.1	1.0
	86	0.3	1.2	0.9	1.0	1.0	0.6	1.0	0.9
	87	0.3	1.3	1.0	1.0	1.0	0.6	1.0	1.0
GDP/GNP DEFLATOR	83	0.8	1.0	0.9	1.1	1.2	0.9	0.9	1.0
	84	1.5	1.6	1.6	1.5	1.6	1.4	1.5	1.5
	85	1.6	1.6	1.8	1.6	1.6	1.5	1.7	1.6
	86	1.5	1.5	1.7	1.5	1.6	1.4	1.6	1.6
	87	1.5	1.5	1.7	1.5	1.6	1.4	1.6	1.5
PRIVATE CONSUMPTION DEFLATOR	83	0.3	0.9	0.7	0.8	1.0	0.7	0.7	0.8
	84	1.4	1.4	1.3	1.2	1.3	1.1	1.2	1.3
	85	1.4	1.4	1.5	1.3	1.3	1.2	1.4	1.3
	86	1.3	1.4	1.4	1.2	1.3	1.1	1.3	1.3
	87	1.3	1.4	1.4	1.2	1.3	1.0	1.3	1.3
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.4	0.9	0.7	0.8	1.0	0.7	0.7	0.8
	84	1.5	1.4	1.3	1.2	1.3	1.1	1.1	1.3
	85	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.3
	86	1.5	1.3	1.4	1.2	1.3	1.1	1.2	1.3
	87	1.5	1.2	1.4	1.2	1.3	1.1	1.1	1.2
HOUSING DEFLATOR	83	0.5	0.9	0.8	0.9	1.0	0.6	0.7	0.8
	84	1.5	1.4	1.3	1.4	1.2	1.0	1.3	1.3
	85	1.5	1.4	1.5	1.4	1.2	1.1	1.5	1.4
	86	1.5	1.4	1.5	1.4	1.2	1.0	1.4	1.3
	87	1.4	1.3	1.4	1.3	1.2	0.9	1.3	1.3
GOVERNMENT CONSUMPTION DEFLATOR	83	0.6	1.0	1.1	0.9	1.5	0.8	0.9	1.0
	84	1.2	1.9	1.7	1.4	1.6	1.3	1.6	1.5
	85	1.5	1.3	1.7	1.4	1.7	1.4	1.7	1.6
	86	1.6	1.7	1.7	1.4	1.7	1.6	1.7	1.6
	87	1.6	1.6	1.7	1.4	1.8	1.7	1.7	1.6

Table 10

WAGE/PRICE BLOCK SIMULATIONS: CAPITAL COST CHANGES

(Percentage differences from baseline)

a) 2 per cent increase in normal capital costs

(Wages endogenous)

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	0.3	0.1	0.2	0.3	0.3	0.2	0.2	0.2
	84	0.4	0.2	0.3	0.4	0.5	0.3	0.2	0.3
	85	0.6	0.2	0.3	0.4	0.6	0.3	0.2	0.4
	86	0.5	0.3	0.3	0.4	0.6	0.3	0.2	0.4
	87	0.3	0.2	0.3	0.4	0.5	0.2	0.2	0.3
ENERGY OUTPUT DEFLATOR	83	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.2
	84	0.2	0.2	0.2	0.3	0.3	0.2	0.1	0.2
	85	0.3	0.2	0.2	0.3	0.3	0.2	0.1	0.2
	86	0.3	0.2	0.2	0.2	0.3	0.1	0.1	0.2
	87	0.3	0.2	0.2	0.2	0.3	0.1	0.2	0.2
GDP/GNP DEFLATOR	83	0.3	0.1	0.2	0.3	0.3	0.2	0.1	0.2
	84	0.3	0.2	0.3	0.4	0.4	0.3	0.2	0.3
	85	0.4	0.2	0.3	0.4	0.5	0.3	0.2	0.3
	86	0.4	0.2	0.3	0.4	0.5	0.3	0.2	0.3
	87	0.3	0.2	0.3	0.3	0.5	0.2	0.2	0.3
PRIVATE CONSUMPTION DEFLATOR	83	0.3	0.1	0.2	0.2	0.3	0.2	0.1	0.2
	84	0.3	0.2	0.3	0.3	0.4	0.2	0.1	0.3
	85	0.4	0.2	0.3	0.3	0.4	0.2	0.2	0.3
	86	0.4	0.2	0.3	0.3	0.4	0.2	0.2	0.3
	87	0.4	0.2	0.2	0.3	0.4	0.2	0.2	0.3
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.3	0.1	0.2	0.2	0.3	0.2	0.1	0.2
	84	0.4	0.2	0.3	0.3	0.4	0.2	0.1	0.3
	85	0.4	0.2	0.3	0.3	0.4	0.3	0.2	0.3
	86	0.3	0.2	0.3	0.3	0.4	0.2	0.2	0.3
	87	0.3	0.2	0.2	0.3	0.4	0.2	0.2	0.3
HOUSING DEFLATOR	83	0.3	0.1	0.2	0.3	0.3	0.2	0.1	0.2
	84	0.4	0.2	0.3	0.4	0.4	0.2	0.2	0.3
	85	0.4	0.2	0.3	0.4	0.4	0.2	0.2	0.3
	86	0.4	0.2	0.3	0.4	0.4	0.2	0.2	0.3
	87	0.3	0.2	0.3	0.3	0.4	0.1	0.2	0.3
GOVERNMENT CONSUMPTION DEFLATOR	83	0.1	0.1	0.2	0.3	0.2	0.1	0.1	0.1
	84	0.2	0.2	0.2	0.4	0.3	0.2	0.1	0.2
	85	0.2	0.2	0.3	0.4	0.4	0.2	0.1	0.3
	86	0.3	0.2	0.3	0.4	0.4	0.2	0.2	0.3
	87	0.3	0.2	0.2	0.3	0.4	0.2	0.2	0.3

b) 200 basis points increase in interest rates

(Wages endogenous)

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	84	0.1	0.1	0.1	0.1	0.1	0.4	0.0	0.1
	85	0.1	0.2	0.1	0.2	0.3	0.8	0.1	0.3
	86	0.3	0.3	0.3	0.3	0.5	1.2	0.2	0.4
	87	0.4	0.5	0.4	0.5	0.7	1.7	0.3	0.6
ENERGY OUTPUT DEFLATOR	83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	84	0.0	0.1	0.0	0.1	0.1	0.2	0.0	0.1
	85	0.1	0.1	0.1	0.1	0.2	0.4	0.1	0.2
	86	0.1	0.2	0.2	0.2	0.3	0.6	0.1	0.2
	87	0.2	0.4	0.3	0.3	0.5	0.9	0.2	0.4
GDP/GNP DEFLATOR	83	-0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	84	0.0	0.1	0.1	0.1	0.1	0.3	0.0	0.1
	85	0.1	0.2	0.1	0.2	0.2	0.7	0.1	0.2
	86	0.2	0.3	0.2	0.3	0.4	1.1	0.1	0.4
	87	0.4	0.5	0.4	0.5	0.6	1.5	0.2	0.6
PRIVATE CONSUMPTION DEFLATOR	83	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	84	0.1	0.1	0.1	0.1	0.1	0.3	0.0	0.1
	85	0.1	0.2	0.1	0.2	0.2	0.6	0.1	0.2
	86	0.2	0.3	0.2	0.3	0.4	0.9	0.1	0.3
	87	0.3	0.5	0.3	0.4	0.6	1.3	0.2	0.5
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	84	0.1	0.1	0.1	0.1	0.1	0.3	0.0	0.1
	85	0.1	0.2	0.1	0.2	0.2	0.6	0.1	0.2
	86	0.2	0.3	0.2	0.3	0.4	0.9	0.1	0.3
	87	0.4	0.4	0.3	0.4	0.5	1.2	0.2	0.5
HOUSING DEFLATOR	83	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	84	0.1	0.1	0.1	0.1	0.1	0.3	0.0	0.1
	85	0.1	0.2	0.1	0.2	0.2	0.5	0.1	0.2
	86	0.2	0.3	0.2	0.3	0.3	0.8	0.1	0.3
	87	0.4	0.4	0.3	0.4	0.5	1.1	0.2	0.5
GOVERNMENT CONSUMPTION DEFLATOR	83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	84	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1
	85	0.1	0.1	0.1	0.2	0.2	0.3	0.1	0.2
	86	0.1	0.3	0.2	0.3	0.3	0.6	0.1	0.3
	87	0.2	0.4	0.3	0.5	0.5	0.9	0.2	0.4

Table 11

WAGE/PRICE BLOCK SIMULATIONS: 10 PER CENT INCREASE IN ENERGY IMPORT PRICES.

(Percentage differences from baseline)

a) Wages exogenous

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	0.2	0.5	0.2	0.1	0.4	0.1	0.1	0.2
	84	0.3	0.7	0.4	0.3	0.4	0.4	0.3	0.4
	85	0.3	0.7	0.4	0.3	0.4	0.4	0.3	0.4
	86	0.3	0.6	0.5	0.3	0.5	0.4	0.3	0.4
	87	0.3	0.6	0.5	0.3	0.5	0.4	0.3	0.4
ENERGY OUTPUT DEFLATOR	83	4.3	4.2	3.3	3.2	3.1	4.1	2.9	3.3
	84	[illegible]	3.4	3.4	3.4	4.4	4.4	3.4	3.9
	85	4.5	3.5	3.4	3.5	4.6	4.5	3.5	3.9
	86	4.2	3.3	3.1	3.2	4.3	3.6	3.3	3.6
	87	4.2	3.7	3.4	3.3	4.6	3.7	3.4	3.8
GDP/GNP DEFLATOR	83	0.3	0.3	0.1	0.2	0.4	0.2	0.3	0.2
	84	0.3	0.5	0.2	0.2	0.6	0.4	0.4	0.4
	85	0.4	0.5	0.2	0.3	0.7	0.4	0.4	0.4
	86	0.4	0.4	0.2	0.3	0.7	0.4	0.4	0.4
	87	0.4	0.4	0.3	0.3	0.7	0.4	0.4	0.4
PRIVATE CONSUMPTION DEFLATOR	83	0.3	0.4	0.4	0.6	0.6	0.6	0.3	0.5
	84	0.6	0.7	0.4	0.7	0.9	0.7	0.4	0.6
	85	0.5	0.7	0.4	0.6	0.9	0.3	0.5	0.7
	86	0.6	0.6	0.5	0.7	0.9	0.7	0.4	0.6
	87	0.5	0.7	0.5	0.7	0.9	0.7	0.5	0.7
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.3	0.9	0.4	0.3	0.5	0.7	0.3	0.5
	84	0.3	1.1	0.4	0.5	0.7	0.9	0.4	0.7
	85	0.3	1.1	0.4	0.6	0.8	0.9	0.4	0.7
	86	0.3	1.1	0.5	0.6	0.7	0.3	0.4	0.7
	87	0.3	1.1	0.5	0.6	0.8	0.9	0.4	0.7
HOUSING DEFLATOR	83	0.4	0.3	0.3	0.4	0.5	1.0	0.4	0.5
	84	0.4	1.0	0.4	0.5	0.7	1.1	0.5	0.7
	85	0.3	1.0	0.4	0.6	0.8	1.2	0.5	0.7
	86	0.3	0.7	0.4	0.6	0.8	1.1	0.5	0.7
	87	0.3	1.0	0.5	0.6	0.8	1.1	0.5	0.7
GOVERNMENT CONSUMPTION DEFLATOR	83	0.2	0.2	0.3	0.5	0.3	0.2	0.2	0.3
	84	0.2	0.3	0.4	0.6	0.4	0.2	0.2	0.3
	85	0.2	0.3	0.4	0.6	0.4	0.2	0.2	0.3
	86	0.2	0.3	0.3	0.5	0.4	0.2	0.2	0.3
	87	0.2	0.3	0.3	0.5	0.4	0.2	0.2	0.3

b) Wages endogenous

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	0.2	0.7	0.3	0.3	0.3	0.4	0.1	0.3
	84	0.4	1.3	0.8	1.0	1.1	1.1	0.4	0.9
	85	0.5	1.7	1.2	1.3	1.7	1.4	0.6	1.2
	86	0.7	[illegible]	1.4	1.4	2.0	1.4	0.8	1.3
	87	0.7	1.5	1.4	1.3	2.1	1.3	0.9	1.4
ENERGY OUTPUT DEFLATOR	83	4.6	4.3	3.4	3.4	3.2	4.2	3.0	3.6
	84	4.7	3.7	3.7	3.9	4.9	4.8	3.5	4.2
	85	4.7	4.3	3.9	4.2	5.3	5.1	3.7	4.4
	86	4.4	4.4	3.6	3.8	5.2	4.1	3.6	4.2
	87	4.5	4.7	4.0	4.0	5.7	4.1	3.7	4.4
GDP/GNP DEFLATOR	83	0.3	0.5	0.3	0.5	0.6	0.5	0.3	0.4
	84	0.3	1.1	0.7	1.0	1.3	1.0	0.5	0.9
	85	0.5	1.5	1.0	1.3	1.9	1.3	0.7	1.2
	86	0.3	1.6	1.1	1.3	2.1	1.3	0.9	1.3
	87	1.0	1.7	1.2	1.3	2.3	1.2	1.0	1.4
PRIVATE CONSUMPTION DEFLATOR	83	0.3	0.6	0.5	0.9	0.8	0.8	0.3	0.6
	84	0.7	1.2	0.8	1.3	1.4	1.2	0.5	1.0
	85	0.3	1.6	1.1	1.5	1.9	1.5	0.7	1.3
	86	1.0	1.7	1.2	1.6	2.0	1.4	0.8	1.4
	87	1.1	1.8	1.3	1.6	2.2	1.3	0.9	1.4
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.4	1.1	0.5	0.5	0.6	0.9	0.3	0.6
	84	0.5	1.7	0.8	1.1	1.3	1.3	0.5	1.1
	85	0.3	2.0	1.1	1.3	1.7	1.6	0.6	1.3
	86	0.9	2.1	1.2	1.4	1.9	1.6	0.7	1.4
	87	1.1	2.1	1.4	1.4	2.0	1.5	0.8	1.5
HOUSING DEFLATOR	83	0.4	0.9	0.5	0.7	0.7	1.1	0.4	0.8
	84	0.5	1.5	0.8	1.1	1.3	1.5	0.6	1.1
	85	0.7	1.9	1.1	1.4	1.7	1.8	0.3	1.3
	86	0.9	2.0	1.2	1.5	1.8	1.7	0.8	1.4
	87	1.0	2.0	1.3	1.5	2.0	1.6	0.9	1.5
GOVERNMENT CONSUMPTION DEFLATOR	83	0.2	0.4	0.6	0.8	0.5	0.4	0.2	0.4
	84	0.3	1.0	0.9	1.2	1.2	0.8	0.4	0.8
	85	0.4	1.5	1.2	1.5	1.7	1.1	0.5	1.1
	86	0.5	1.7	1.2	1.5	2.0	1.2	0.7	1.3
	87	0.7	1.6	1.3	1.5	2.1	1.2	0.8	1.3

energy production is important (the United States, the United Kingdom and Canada). Once wages are endogenised, the overall results also reflect the country-specific dynamics of the wage/price spiral, amplifying the fifth-year response of the GDP deflator by a factor of 3 on average (Table 11b). In the United Kingdom, the combination of an important domestic energy sector and a dynamic wage/price spiral gives rise to a particularly strong response of domestic prices to energy price changes. The results for the United States and Canada reflect the relatively long lags at which wages respond to price changes in these two countries.

Table 12 presents simulations of a sustained 10 per cent <u>depreciation</u> of the exchange rate accompanied by unchanged nominal short-term interest rates. The price response to exchange-rate changes reflects the importance of foreign trade, the speed with which changes in foreign trade prices are passed into domestic prices, and the speed with which changes in prices are reflected in changes in nominal wages. As long as wages are exogenous, the ranking of the price response across countries is consistent with the short- and long-run elasticities of domestic prices with respect to foreign prices reported in Tables 4, 5 and 7. On average, a 10 per cent depreciation entails an increase in the GDP deflator of about 1 1/2 per cent after three to five years. The Italian model is very responsive to an exchange-rate shock, primarily because of the strength of the direct influences of foreign trade prices, whereas the responsiveness of the models for the United Kingdom and Canada results from a combination of openness and product-market competition. Allowing for endogenous wage responses changes the cross-country pattern. The price response in the United States and Canada is now among the weakest because of the characteristic inertia of North American wage formation with respect to price changes. In Japan and Germany, where wages react quickly to inflation, the price response strengthens substantially compared to the case with exogenous wages. In the United Kingdom and Italy strong product-market effects of import price changes combine with equally dynamic wage/price spirals.

A simulation of a sustained percentage point increase in <u>capacity utilisation</u> (actual relative to potential output), with endogenous wages but holding unemployment and interest rates constant, is presented in Table 13. The price effect attributable to changes of excess demand in product markets is limited in comparison to the indirect price effect which a change in the unemployment rate achieves through the response of wages (see Richardson, 1987), bearing in mind, however, that for achieving a 1 percentage point cut in the unemployment rate, a 2-3 percentage point increase in the rate of capacity utilisation may be required. In the United States and Italy, the potential for "demand-pull" inflation is nevertheless more apparent than elsewhere.

B. <u>Full-model simulation results</u>

The interaction between the wage/price block and the rest of the model is highlighted in full-model simulations presented in Tables 14-17. In these simulations, wages or prices are exogenously shocked in a particular period; the ultimate change in wages and prices will also depend on the response of economic activity, unemployment, and the profitable factor-mix in production. Two cases are considered: i) an increase in the add-factor on wages by 2 per cent in the starting period; and ii) an increase in the add-factor on the

Table 12

WAGE/PRICE BLOCK SIMULATIONS: 10 PER CENT DEPRECIATION

(Percentage differences from baseline)

a) Wages exogenous

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	0.3	0.9	0.6	0.5	0.5	0.7	0.6	0.6
	84	0.7	1.2	1.0	0.8	1.1	1.5	1.1	1.1
	85	1.1	1.4	1.3	1.1	1.5	1.9	1.4	1.4
	86	1.4	1.5	1.5	1.1	1.8	2.2	1.7	1.6
	87	1.6	1.5	1.5	1.1	2.1	2.4	1.9	1.7
ENERGY OUTPUT DEFLATOR	83	5.2	2.7	3.9	3.8	3.7	4.8	3.6	4.0
	84	5.4	4.2	4.2	4.2	5.4	5.5	4.3	4.7
	85	5.6	4.4	4.3	4.4	5.7	5.8	4.6	5.0
	86	5.2	4.5	4.0	4.0	5.5	4.9	4.5	4.7
	87	5.4	4.3	4.4	4.2	6.2	5.1	4.6	5.0
GDP/GNP DEFLATOR	83	0.5	0.6	0.6	0.6	0.8	0.8	0.8	0.7
	84	0.3	1.0	0.8	0.8	1.3	1.3	1.2	1.0
	85	1.1	1.2	1.0	1.0	1.6	1.7	1.4	1.3
	86	1.4	1.3	1.2	1.0	1.8	2.0	1.7	1.5
	87	1.5	1.3	1.3	1.1	2.1	2.1	1.9	1.6
PRIVATE CONSUMPTION DEFLATOR	83	0.4	0.8	0.8	1.0	1.0	1.1	0.8	0.8
	84	1.0	1.2	1.0	1.2	1.5	1.6	1.1	1.2
	85	1.3	1.4	1.2	1.4	1.8	1.9	1.4	1.5
	86	1.3	1.5	1.3	1.4	2.0	2.1	1.6	1.6
	87	1.3	1.5	1.4	1.4	2.3	2.2	1.8	1.8
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.5	1.3	0.8	0.6	0.8	1.2	0.7	0.9
	84	1.0	1.7	1.0	1.0	1.4	1.7	1.0	1.2
	85	1.3	1.8	1.2	1.2	1.7	2.1	1.2	1.5
	86	1.5	1.9	1.3	1.2	1.8	2.3	1.4	1.6
	87	1.3	1.9	1.4	1.2	2.1	2.4	1.5	1.8
HOUSING DEFLATOR	83	0.5	1.2	0.8	0.8	0.9	1.5	0.9	0.9
	84	0.9	1.5	1.0	1.0	1.3	1.9	1.2	1.3
	85	1.3	1.7	1.1	1.2	1.6	2.2	1.5	1.5
	86	1.3	1.3	1.3	1.3	1.8	2.3	1.7	1.7
	87	1.3	1.3	1.4	1.3	2.0	2.5	1.9	1.8
GOVERNMENT CONSUMPTION DEFLATOR	83	0.3	0.3	0.6	0.9	0.4	0.3	0.4	0.5
	84	0.4	0.5	0.6	1.1	0.7	0.4	0.6	0.6
	85	0.5	0.6	0.7	1.3	0.8	0.5	0.7	0.7
	86	0.7	0.5	0.7	1.3	0.9	0.5	0.8	0.8
	87	0.5	0.5	0.9	1.3	1.1	0.5	0.9	0.8

b) Wages endogenous

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	0.3	1.2	1.0	0.9	0.9	1.2	0.7	0.9
	84	0.9	2.4	2.1	2.0	2.3	2.7	1.4	2.0
	85	1.5	3.4	3.1	2.7	3.7	4.0	2.2	3.0
	86	2.3	4.1	3.8	3.1	4.8	4.7	3.0	3.7
	87	3.0	4.6	4.2	3.1	5.7	5.0	3.6	4.1
ENERGY OUTPUT DEFLATOR	83	5.2	2.9	4.2	4.1	3.9	5.0	3.7	4.1
	84	5.3	5.1	4.9	5.0	6.1	6.2	4.5	5.3
	85	5.3	6.0	5.4	5.5	7.1	7.0	5.1	6.0
	86	5.7	6.6	5.4	5.3	7.3	6.0	5.3	6.0
	87	5.2	7.3	6.2	5.5	8.5	6.3	5.8	6.5
GDP/GNP DEFLATOR	83	0.5	1.0	1.1	1.1	1.1	1.2	0.9	1.0
	84	1.0	2.2	2.0	2.0	2.5	2.6	1.5	2.0
	85	1.6	3.3	2.9	2.7	3.8	3.8	2.2	2.9
	86	2.2	4.0	3.6	3.0	4.7	4.4	2.9	3.5
	87	2.9	4.3	4.0	3.0	5.5	4.7	3.5	4.0
PRIVATE CONSUMPTION DEFLATOR	83	0.5	1.1	1.2	1.4	1.2	1.5	0.8	1.1
	84	1.2	2.3	1.9	2.1	2.5	2.5	1.4	2.0
	85	1.7	3.2	2.7	2.7	3.6	3.5	2.0	2.8
	86	2.3	4.0	3.4	3.0	4.3	3.9	2.6	3.3
	87	2.9	4.3	3.7	3.0	5.0	4.1	3.1	3.7
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.5	1.7	1.2	1.0	1.1	1.5	0.8	1.1
	84	1.2	2.7	1.9	1.9	2.3	2.7	1.3	2.0
	85	1.3	3.7	2.7	2.5	3.4	3.6	1.8	2.8
	86	2.4	4.2	3.3	2.8	4.0	4.1	2.3	3.3
	87	3.0	4.5	3.7	2.8	4.7	4.3	2.6	3.7
HOUSING DEFLATOR	83	0.6	1.5	1.1	1.2	1.1	1.5	0.9	1.2
	84	1.1	2.6	1.9	2.0	2.2	2.8	1.5	2.0
	85	1.7	3.5	2.8	2.7	3.2	3.6	2.1	2.5
	86	2.3	4.2	3.4	3.0	3.9	3.9	2.7	3.3
	87	3.0	[illegible]	3.7	3.0	4.6	4.1	3.2	3.7
GOVERNMENT CONSUMPTION DEFLATOR	83	0.3	0.7	1.1	1.3	0.8	0.7	0.5	0.8
	84	0.5	1.9	1.9	2.1	2.0	1.6	0.9	1.6
	85	0.7	3.0	2.7	2.8	3.2	2.4	1.5	2.4
	86	1.4	3.3	3.2	3.0	4.0	3.0	2.1	2.9
	87	1.9	4.1	3.5	3.1	4.8	3.4	2.6	3.3

Table 13

WAGE/PRICE BLOCK SIMULATIONS: 1 PERCENTAGE POINT INCREASE IN CAPACITY UTILISATION

(Percentage differences from baseline)

(Wages endogenous)

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
	84	0.4	0.2	0.2	0.2	0.2	0.5	0.2	0.3
	85	0.5	0.3	0.3	0.4	0.4	0.9	0.4	0.5
	86	0.9	0.5	0.5	0.6	0.6	1.2	0.6	0.7
	87	1.2	0.6	0.6	0.7	0.7	1.5	0.8	0.9
ENERGY OUTPUT DEFLATOR	83	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
	84	0.2	0.1	0.1	0.2	0.1	0.3	0.2	0.2
	85	0.3	0.2	0.2	0.3	0.2	0.5	0.3	0.3
	86	0.5	0.4	0.3	0.4	0.3	0.6	0.4	0.4
	87	0.6	0.5	0.4	0.5	0.5	0.7	0.5	0.5
GDP/GNP DEFLATOR	83	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
	84	0.3	0.2	0.2	0.2	0.2	0.5	0.2	0.3
	85	0.5	0.3	0.3	0.4	0.3	0.8	0.4	0.4
	86	0.8	0.5	0.4	0.5	0.5	1.1	0.6	0.6
	87	1.1	0.6	0.5	0.7	0.6	1.3	0.7	0.8
PRIVATE CONSUMPTION DEFLATOR	83	0.1	0.0	-0.0	0.1	0.0	0.2	0.1	0.1
	84	0.3	0.1	0.1	0.2	0.1	0.5	0.2	0.2
	85	0.5	0.2	0.1	0.3	0.2	0.8	0.4	0.3
	86	0.7	0.3	0.2	0.4	0.2	1.0	0.5	0.5
	87	0.9	0.4	0.2	0.6	0.3	1.2	0.7	0.6
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.2	0.1	0.2	0.1	0.2	0.0	0.1	0.1
	84	0.5	0.2	0.4	0.2	0.4	0.1	0.2	0.3
	85	0.8	0.4	0.7	0.3	0.7	0.3	0.3	0.5
	86	1.1	0.5	0.9	0.4	1.0	0.3	0.4	0.7
	87	1.4	0.8	1.1	0.6	1.2	0.3	0.6	0.9
HOUSING DEFLATOR	83	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	84	0.3	0.2	0.2	0.2	0.2	0.4	0.2	0.2
	85	0.5	0.3	0.3	0.4	0.3	0.6	0.4	0.4
	86	0.8	0.4	0.4	0.5	0.4	0.8	0.5	0.6
	87	1.1	0.6	0.5	0.6	0.5	0.9	0.7	0.7
GOVERNMENT CONSUMPTION DEFLATOR	83	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.1
	84	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.2
	85	0.3	0.2	0.2	0.4	0.2	0.5	0.2	0.3
	86	0.4	0.4	0.3	0.5	0.3	0.7	0.4	0.4
	87	0.5	0.5	0.3	0.6	0.4	0.9	0.5	0.6

gross output deflator for the non-energy sector (PQBNE) by 2 per cent in the starting period. For each case, two simulations were carried out assuming either unchanged nominal interest rates (Tables 14 and 15) or unchanged money supplies (Tables 16 and 17). In all cases, real government expenditure and exchange rates were held constant.

The results include a number of interesting features. In general, an ex ante increase of the level of either wages or prices reduces the level of real income over time. This outcome is largely explained by substitution mechanisms in factor markets, by the presence of wealth effects and by the degree of financial crowding out which the money demand functions imply. While the dynamics of the wage/price spiral tend to amplify the initial shock, the resulting losses in output and employment have a moderating effect. Under accommodating monetary policies, a 2 per cent one-time rise in wages has in most countries a maximum effect on the price level of 2-4 per cent after three to four years (Table 14). In Canada, the price response is particularly weak, in Germany particularly strong (see below). A 2 per cent one-time shock to prices (or profit margins) has a peak effect on the level of the GNP deflator of 3 1/2 to 5 per cent after three to four years (Table 15). Again, in Canada the price response remains significantly more moderate, whereas in Japan it is particularly strong.

The cross-country pattern in the endogenous response of prices and inflation over time depends importantly on three factors:

i) the speed with which wages respond to prices;

ii) the size of output and employment losses in response to higher cost levels; and

iii) the responsiveness of wages with regard to changes in unemployment (and in some cases with regard to short-run changes in labour productivity).

Bearing these factors in mind, the country-specific features may be summarised as follows. The United States is characterised by relatively long lags in the interaction between wages and prices, while at the same time the effect of unemployment on wages is relatively strong. These features tend to limit the overall price effect of autonomous wage increases. In Japan and Germany, the interaction of wages and prices is rapid which explains strong short-run inflation dynamics. Over the longer run, however, labour-market performance becomes critical. In both Japan and Germany, short-run changes in labour productivity feed directly into wages, whereas prices depend mainly on nominal costs and cyclically-adjusted measures of productivity growth. Thus, in Japan the weakening of actual labour productivity which accompanies the weakening of output tends to moderate the growth of the relevant unit labour cost measure; in Germany the acceleration of productivity growth has the opposite effect, while the response of wages with respect to unemployment is too weak to provide a sufficient offsetting influence. These differences in the behaviour of productivity mainly reflect the country-specific factor demand equations which are discussed in Jarrett and Torres (1987).

In France the interaction of factor and product markets generates overall results very close to the average for the seven economies. The United Kingdom model is strongly influenced by a wage equation which assumes

Table 14

FULL-MODEL SIMULATIONS: 2 PER CENT SHOCK TO THE ADD FACTOR ON WAGES, FIXED INTEREST RATES

(Percentage differences from baseline)

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON-ENERGY GROSS OUTPUT DEFLATOR	83	0.9	1.4	1.3	1.4	1.5	1.1	0.8	1.2
	84	1.7	3.0	3.2	2.5	2.9	1.8	1.6	2.4
	85	2.0	3.9	4.9	3.0	3.5	2.1	1.8	3.0
	86	2.2	4.1	5.7	2.9	3.6	1.8	1.6	3.1
	87	2.2	3.6	5.5	2.4	3.1	1.5	1.1	2.8
ENERGY OUTPUT DEFLATOR	83	0.5	1.0	0.9	0.9	0.9	0.6	0.5	0.7
	84	1.0	2.4	2.1	1.7	1.8	1.0	1.0	1.5
	85	1.1	3.1	3.0	2.0	2.2	1.1	1.2	2.0
	86	1.1	3.3	3.3	1.8	2.0	0.8	1.0	1.9
	87	1.1	3.2	3.5	1.5	1.9	0.6	0.7	1.8
BUSINESS OUTPUT DEFLATOR	83	0.9	1.5	1.4	1.4	1.5	1.1	0.8	1.2
	84	1.7	3.2	3.4	2.6	2.8	1.8	1.6	2.4
	85	2.0	4.1	5.2	3.0	3.4	2.1	1.8	3.1
	86	2.2	4.3	6.0	2.9	3.5	1.8	1.6	3.2
	87	2.2	3.7	5.7	2.4	3.0	1.5	1.1	2.8
GDP/GNP DEFLATOR	83	0.8	1.5	1.5	1.5	1.6	1.1	0.8	1.3
	84	1.5	3.3	3.5	2.6	2.9	1.8	1.6	2.5
	85	1.9	4.2	5.2	3.0	3.5	2.0	1.8	3.1
	86	2.2	4.3	6.1	2.9	3.5	1.8	1.6	3.2
	87	2.2	3.8	5.7	2.5	3.1	1.5	1.1	2.8
PRIVATE CONSUMPTION DEFLATOR	83	0.3	1.3	1.3	1.1	1.3	0.9	0.7	1.1
	84	1.5	2.9	3.0	2.1	2.4	1.5	1.4	2.1
	85	1.3	3.3	4.5	2.5	3.0	1.7	1.5	2.7
	86	2.0	4.1	5.4	2.5	3.0	1.5	1.4	2.8
	87	2.0	3.7	5.2	2.1	2.6	1.2	1.0	2.5
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.9	1.3	1.2	1.2	1.3	0.9	0.7	1.1
	84	1.7	2.8	2.8	2.2	2.5	1.5	1.3	2.1
	85	1.9	3.6	4.3	2.6	3.0	1.7	1.5	2.6
	86	2.2	3.7	5.2	2.6	2.9	1.5	1.3	2.7
	87	2.2	3.2	4.9	2.1	2.4	1.0	0.9	2.4
HOUSING DEFLATOR	83	0.9	1.3	1.3	1.3	1.2	0.8	0.7	1.1
	84	1.5	2.8	3.0	2.3	2.3	1.4	1.4	2.1
	85	1.9	3.7	4.6	2.7	2.8	1.5	1.6	2.7
	86	2.1	4.0	5.4	2.7	2.8	1.4	1.4	2.8
	87	2.1	3.5	5.2	2.3	2.4	1.2	1.0	2.5
GOVERNMENT CONSUMPTION DEFLATOR	83	0.5	1.5	1.7	1.3	1.8	1.0	0.9	1.3
	84	1.5	3.7	3.8	2.3	3.0	1.8	1.7	2.5
	85	1.7	4.7	5.4	2.8	3.6	2.0	1.9	3.2
	86	2.1	4.9	6.1	2.8	3.7	2.0	1.7	3.3
	87	2.2	4.2	5.8	2.4	3.3	1.8	1.3	3.0
WAGES	83	1.9	3.0	3.2	2.6	2.5	2.4	2.0	2.5
	84	2.2	4.5	5.1	3.4	3.6	2.8	2.1	3.4
	85	2.5	5.3	6.8	3.7	4.1	2.7	2.2	3.9
	86	2.3	5.3	7.3	3.5	4.0	2.2	1.9	3.9
	87	2.3	4.9	6.5	3.0	3.5	1.6	1.3	3.4
USER COST OF CAPITAL	83	0.3	1.1	0.9	1.0	1.0	0.5	0.6	0.8
	84	1.3	1.9	1.6	1.4	1.3	0.4	0.9	1.3
	85	1.4	1.9	2.1	1.3	0.8	-0.4	0.6	1.1
	86	1.4	1.4	1.9	1.0	0.2	-0.9	0.3	0.8
	87	1.4	0.8	1.2	0.7	-0.1	-1.0	0.0	0.4
BUSINESS SECTOR EMPLOYMENT	83	-0.4	-0.2	-0.5	-0.3	-0.2	-0.3	-0.4	-0.3
	84	-0.1	-0.4	-0.9	-0.3	-0.5	-0.3	-0.5	-0.4
	85	-0.2	-0.5	-0.9	-0.4	-0.8	-0.3	-0.8	-0.6
	86	-0.2	-0.7	-0.9	-0.4	-1.1	-0.3	-1.0	-0.7
	87	-0.3	-0.7	-1.3	-0.5	-1.2	-0.3	-0.9	-0.7
BUSINESS FIXED INVESTMENT	83	0.5	-0.1	1.1	0.4	0.4	0.6	0.3	0.5
	84	0.3	-1.5	1.8	0.8	1.2	-0.1	0.5	0.5
	85	1.0	-2.4	3.4	1.2	1.8	0.3	0.5	0.8
	86	1.3	-2.7	3.4	1.1	2.3	1.1	0.3	1.0
	87	1.2	-2.4	1.6	0.8	2.4	1.3	0.1	0.7
GDP/GNP REAL	83	0.0	-0.2	-0.1	-0.2	0.0	-0.1	0.0	-0.1
	84	0.1	-0.7	-0.2	-0.3	-0.0	-0.2	-0.1	-0.2
	85	0.1	-1.2	-0.0	-0.3	-0.2	-0.2	-0.3	-0.3
	86	0.1	-1.5	-0.4	-0.4	-0.3	-0.1	-0.4	-0.4
	87	0.0	-1.4	-1.3	-0.4	-0.4	-0.1	-0.4	-0.6

Table 15

FULL-MODEL SIMULATIONS: 2 PER CENT SHOCK TO THE ADD FACTOR ON PRICES, FIXED INTEREST RATES

(Percentage differences from baseline)

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	2.4	5.3	2.9	2.8	2.8	2.7	2.3	2.8
	84	3.0	5.0	4.3	4.3	4.3	4.1	2.6	3.9
	85	3.7	5.9	5.1	5.1	4.9	4.8	2.5	4.6
	86	4.2	5.3	4.9	5.2	4.8	4.8	1.9	4.5
	87	4.3	5.1	3.9	4.9	4.0	4.2	1.0	3.9
ENERGY OUTPUT DEFLATOR	83	1.4	2.3	1.9	1.8	1.6	1.4	1.6	1.7
	84	1.7	4.0	2.7	2.9	2.6	2.2	1.8	2.5
	85	2.1	4.5	3.2	3.4	3.0	2.6	1.8	3.0
	86	2.2	4.6	2.7	3.2	2.7	2.1	1.3	2.7
	87	2.3	4.4	2.3	3.1	2.4	1.8	0.7	2.4
BUSINESS OUTPUT DEFLATOR	83	2.4	5.5	3.2	2.9	2.7	2.8	2.3	2.8
	84	3.0	5.3	4.6	4.4	4.2	4.1	2.5	4.0
	85	3.7	6.1	5.4	5.2	4.8	4.8	2.5	4.6
	86	4.2	6.0	5.1	5.3	4.6	4.8	1.9	4.5
	87	4.3	5.3	3.9	4.9	3.9	4.3	0.9	3.9
GDP/GNP DEFLATOR	83	2.1	5.3	3.0	2.7	2.4	2.4	2.0	2.6
	84	2.7	5.1	4.4	4.1	3.9	3.7	2.3	3.7
	85	3.4	5.9	5.2	4.9	4.5	4.5	2.3	4.4
	86	3.9	5.9	4.9	5.1	4.4	4.5	1.7	4.3
	87	4.1	5.2	3.8	4.7	3.7	4.0	0.8	3.8
PRIVATE CONSUMPTION DEFLATOR	83	2.1	5.2	2.6	2.4	2.4	2.2	2.0	2.4
	84	2.7	4.9	4.0	3.6	3.6	3.3	2.2	3.5
	85	3.3	5.7	4.7	4.3	4.2	3.9	2.2	4.1
	86	3.3	5.8	4.6	4.5	4.1	3.9	1.7	4.1
	87	3.9	5.3	3.8	4.2	3.5	3.4	0.8	3.6
BUSINESS FIXED INVESTMENT DEFLATOR	83	2.2	5.0	2.6	2.4	2.3	2.2	2.0	2.4
	84	2.3	4.6	3.9	3.6	3.5	3.4	2.2	3.4
	85	3.5	5.2	4.5	4.4	3.9	4.1	2.1	4.0
	86	4.0	5.0	4.2	4.6	3.5	4.2	1.6	3.9
	87	4.1	4.3	3.1	4.3	2.8	3.7	0.8	3.3
HOUSING DEFLATOR	83	2.2	5.1	2.8	2.6	2.3	2.0	2.1	2.5
	84	2.3	4.7	4.0	4.0	3.4	3.0	2.3	3.5
	85	3.5	5.5	4.8	4.7	3.9	3.6	2.3	4.1
	86	4.2	5.6	4.6	4.9	3.7	3.7	1.7	4.0
	87	4.2	5.0	3.7	4.6	3.1	3.3	0.9	3.5
GOVERNMENT CONSUMPTION DEFLATOR	83	1.1	1.9	2.1	2.6	1.7	1.0	1.2	1.6
	84	1.3	3.9	3.6	3.9	3.2	2.2	1.6	2.8
	85	2.1	4.9	4.3	4.7	3.8	2.9	1.7	3.5
	86	2.3	5.0	4.1	5.0	3.7	3.3	1.2	3.6
	87	3.3	4.4	3.3	4.7	3.1	3.2	0.3	3.2
WAGES	83	0.7	2.2	2.3	1.7	1.2	1.8	0.6	1.5
	84	1.6	3.7	3.6	3.2	2.9	3.2	1.1	2.7
	85	2.5	4.5	4.2	4.0	3.5	3.8	1.0	3.4
	86	3.4	4.6	3.8	4.2	3.2	3.7	0.2	3.3
	87	3.7	4.2	2.9	4.0	2.5	3.1	-0.8	2.8
USER COST OF CAPITAL	83	2.0	2.5	2.1	2.1	1.8	1.4	1.7	1.9
	84	2.2	2.9	2.3	2.4	1.8	0.9	1.3	2.0
	85	2.4	2.4	1.8	2.3	0.9	-0.3	0.8	1.5
	86	2.7	1.7	1.0	2.0	0.1	-1.1	0.3	1.0
	87	2.7	1.2	0.2	1.7	-0.3	-1.4	-0.1	0.6
BUSINESS SECTOR EMPLOYMENT	83	0.5	0.2	0.2	0.2	0.0	0.2	0.1	0.2
	84	0.1	-0.0	0.4	0.2	-0.4	0.1	-0.6	-0.1
	85	-0.0	-0.2	0.3	0.1	-0.9	-0.0	-1.2	-0.3
	86	-0.2	-0.2	-0.2	0.0	-1.3	-0.1	-1.1	-0.4
	87	-0.3	-0.2	-0.8	-0.1	-1.4	-0.1	-0.8	-0.5
BUSINESS FIXED INVESTMENT	83	-0.4	-1.0	1.0	0.3	0.1	-1.1	-0.5	-0.2
	84	-0.5	-1.1	2.0	0.9	-0.0	0.6	-1.2	0.1
	85	0.2	-1.1	1.9	0.9	0.4	2.2	-1.9	0.4
	86	0.6	-0.3	0.2	0.5	1.3	3.8	-2.5	0.5
	87	0.7	0.6	-1.6	-0.2	1.7	4.2	-2.7	0.4
GDP/GNP REAL	83	-0.2	-0.7	-0.0	0.0	-0.3	-0.3	-0.3	-0.3
	84	-0.5	-1.6	-0.1	-0.2	-0.7	-0.5	-0.8	-0.6
	85	-0.5	-2.0	-0.5	-0.4	-0.9	-0.5	-1.1	-0.9
	86	-0.5	-1.9	-1.2	-0.7	-0.9	-0.5	-1.1	-1.0
	87	-0.6	-1.5	-1.7	-0.8	-0.9	-0.5	-0.9	-1.0

"hysteresis" in the natural rate of unemployment (see Chan-Lee et al., 1987). The result is that, in the absence of the equilibrating influence of higher unemployment, the aggregate price effects become more persistent. For Italy, as in other simulations discussed previously, the price response remains particularly constrained by external factors which are helpful in stabilizing the level of real expenditure. The resulting relative stability in employment in combination with highly responsive real wages contains the Italian price response within fairly moderate limits (24). The same applies even more to the case of Canada. As with the model for the United States, the Canadian model exhibits a certain inertia in the wage/price spiral as well as strong real wage responsiveness, but there is also a particularly rapid adjustment of labour demand. Together with an important influence of foreign prices on domestic prices, these features are sufficient to minimise the overall price effect of exogenous increases in wages or profit margins.

The assumption of fixed money supplies tends to weaken the price response substantially (Tables 16 and 17). In the case of an exogenous wage increase, the restraining effect becomes important from the third year. By the fifth year, the price level in the United States, Japan and the United Kingdom has risen by 1-2 per cent less than under accommodating monetary policies. The difference is generally somewhat bigger in the case of an exogenous increase in profit margins, given that the price response under accommodating monetary policies had also been stronger. The cross-country pattern in the degree to which a fixed money supply moderates the overall price response owes much to the parameters of the money demand function or in other words, to the rise in interest rates which will be required to hold money demand constant. This is the main reason for a relatively important difference between the cases of accommodating and non-accommodating monetary policy in the United Kingdom, and for particularly small differences in Italy and Canada. The case of Germany is somewhat peculiar and may be revealing a more fundamental problem with the German model. The weakening influence of non-accommodating monetary policy on economic activity and profitability affects labour demand in such a way that productivity improves compared to the case of accommodating monetary policy. However, by the fifth year the positive effect of better productivity performance on wages, a link which is characteristic of the German wage equation, seems to become stronger than the negative effect on prices.

V. SOME CONCLUDING REMARKS

The work on domestic price formation for the major seven economies has been guided by the need to improve the simulation properties of the model in the presence of new supply and money-demand blocks.

The key domestic price equation is for the gross output deflator of the private non-energy sector. Prices are modelled as a "variable mark-up" on the costs of labour, capital and energy; profit margins (i.e. the mark-up) are determined by excess demand, foreign price competition and terms of trade changes. The value-added deflator for domestic energy sectors is modelled separately. The aggregate output deflator for the total business sector, combining the energy and non-energy sectors, determines the final expenditure deflators.

Table 16

FULL-MODEL SIMULATIONS: 2 PER CENT SHOCK TO THE ADD FACTOR ON WAGES, FIXED MONEY SUPPLY

(Percentage differences from baseline)

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	0.9	1.5	1.2	1.3	1.4	1.1	0.8	1.2
	84	1.6	3.0	2.8	2.3	2.3	1.7	1.6	2.2
	85	1.5	3.4	4.1	2.5	2.2	1.8	1.8	2.5
	86	1.2	3.1	5.2	2.3	1.5	1.3	1.5	2.3
	87	0.3	2.5	5.7	1.9	0.9	0.8	1.0	1.9
ENERGY OUTPUT DEFLATOR	83	0.5	1.1	0.8	0.9	0.8	0.6	0.5	0.7
	84	0.9	2.4	1.8	1.5	1.4	0.9	1.1	1.4
	85	0.3	2.7	2.6	1.7	1.4	1.0	1.2	1.6
	86	0.6	2.5	3.1	1.4	0.9	0.5	0.9	1.4
	87	0.4	2.2	3.7	1.2	0.5	0.3	0.6	1.3
BUSINESS OUTPUT DEFLATOR	83	0.9	1.6	1.3	1.4	1.3	1.1	0.8	1.2
	84	1.5	3.1	3.0	2.3	2.2	1.7	1.6	2.2
	85	1.4	3.5	4.4	2.5	2.1	1.7	1.8	2.5
	86	1.2	3.2	5.5	2.3	1.5	1.3	1.5	2.3
	87	0.3	2.5	6.0	1.9	0.8	0.8	1.0	2.0
GDP/GNP DEFLATOR	83	0.3	1.6	1.4	1.5	1.4	1.1	0.9	1.2
	84	1.5	3.2	3.1	2.4	2.3	1.7	1.7	2.3
	85	1.4	3.6	4.5	2.6	2.3	1.8	1.6	2.6
	86	1.2	3.3	5.7	2.4	1.6	1.4	1.5	2.4
	87	0.9	2.6	6.2	2.0	1.0	0.9	1.0	2.1
PRIVATE CONSUMPTION DEFLATOR	83	0.3	1.5	1.2	1.1	1.2	0.9	0.7	1.0
	84	1.4	2.9	2.7	1.9	1.9	1.4	1.4	2.0
	85	1.3	3.4	4.0	2.1	1.9	1.4	1.6	2.2
	86	1.1	3.2	5.2	2.0	1.4	1.0	1.3	2.2
	87	0.7	2.7	5.7	1.6	0.9	0.6	0.9	1.9
BUSINESS FIXED INVESTMENT DEFLATOR	83	0.3	1.4	1.0	1.1	1.2	0.9	0.7	1.0
	84	1.5	2.7	2.2	1.9	1.9	1.4	1.4	1.9
	85	1.4	3.0	3.3	2.2	1.7	1.5	1.5	2.1
	86	1.2	2.6	4.2	2.0	0.9	1.2	1.2	1.9
	87	0.8	1.7	4.6	1.7	0.3	0.7	0.8	1.5
HOUSING DEFLATOR	83	0.3	1.4	1.2	1.2	1.1	0.8	0.8	1.1
	84	1.5	2.3	2.6	2.1	1.8	1.3	1.5	1.9
	85	1.4	3.2	3.9	2.3	1.7	1.3	1.6	2.2
	86	1.2	3.0	4.9	2.2	1.2	1.0	1.3	2.1
	87	0.3	2.4	5.5	1.7	0.6	0.7	0.9	1.8
GOVERNMENT CONSUMPTION DEFLATOR	83	0.6	1.5	1.7	1.2	1.7	1.0	0.9	1.2
	84	1.2	3.5	3.4	2.1	2.6	1.7	1.8	2.3
	85	1.4	3.9	5.0	2.4	2.6	1.9	1.9	2.7
	86	1.4	3.6	6.1	2.2	2.0	1.7	1.7	2.7
	87	1.2	2.9	6.7	1.8	1.3	1.4	1.2	2.4
WAGES	83	1.9	2.9	3.1	2.5	2.4	2.4	2.0	2.5
	84	2.0	4.0	4.6	3.2	3.3	2.7	2.2	3.1
	85	1.9	4.2	6.4	3.3	3.1	2.5	2.2	3.4
	86	1.7	3.9	7.6	3.0	2.3	1.8	1.9	3.2
	87	1.2	3.5	8.0	2.4	1.5	1.1	1.2	2.7
USER COST OF CAPITAL	83	0.8	1.6	1.3	1.5	1.2	0.9	0.9	1.2
	84	1.3	2.8	2.6	2.7	2.2	1.3	1.6	2.1
	85	1.2	2.7	3.6	3.5	2.4	1.0	1.6	2.3
	86	1.1	2.0	4.7	4.0	2.4	0.8	1.4	2.3
	87	1.0	1.5	5.6	4.4	2.6	0.9	1.2	2.5
BUSINESS SECTOR EMPLOYMENT	83	-0.4	-0.3	-0.9	-0.3	-0.2	-0.3	-0.4	-0.4
	84	-0.3	-0.6	-2.3	-0.4	-0.6	-0.3	-0.6	-0.7
	85	-0.6	-0.8	-3.3	-0.5	-1.3	-0.3	-0.9	-1.1
	86	-0.6	-0.9	-4.0	-0.6	-1.6	-0.3	-1.0	-1.3
	87	-0.5	-0.8	-4.6	-0.6	-1.5	-0.3	-0.8	-1.3
BUSINESS FIXED INVESTMENT	83	0.4	-0.7	-0.4	-0.6	-0.6	0.4	0.2	-0.2
	84	0.1	-4.2	-2.0	-1.8	-2.4	-1.4	0.0	-1.7
	85	-0.3	-4.3	-1.4	-2.7	-3.9	-1.8	-0.6	-2.4
	86	-0.4	-6.1	-1.1	-4.0	-4.3	-1.6	-1.2	-2.7
	87	-0.8	-4.2	-1.5	-5.1	-3.6	-1.5	-1.5	-2.6
GDP/GNP REAL	83	-0.0	-0.6	-0.6	-0.5	-0.1	-0.1	-0.0	-0.3
	84	-0.2	-1.7	-1.6	-0.7	-0.6	-0.4	-0.4	-0.8
	85	-0.3	-2.3	-1.5	-0.9	-1.0	-0.4	-0.7	-1.0
	86	-0.3	-2.2	-1.5	-1.2	-1.0	-0.3	-0.7	-1.0
	87	-0.2	-1.5	-2.0	-1.4	-0.7	-0.2	-0.6	-0.9

Table 17

FULL-MODEL SIMULATIONS: 2 PER CENT SHOCK TO THE ADD FACTOR ON PRICES,
FIXED MONEY SUPPLY

(Percentage differences from baseline)

COUNTRY	YEAR	USA	JAP	GER	FRA	UKM	ITA	CAN	SIMPLE MEAN
NON ENERGY GROSS OUTPUT DEFLATOR	83	2.3	3.6	2.7	2.7	2.6	2.7	2.4	2.7
	84	2.6	4.8	3.6	3.8	3.5	3.9	2.7	3.5
	85	2.8	4.9	4.3	4.3	3.3	4.2	2.5	3.7
	86	2.7	4.3	4.8	4.2	2.5	3.7	1.8	3.4
	87	2.3	3.8	4.7	3.8	1.6	2.8	0.8	2.8
ENERGY OUTPUT DEFLATOR	83	1.4	2.5	1.7	1.8	1.5	1.4	1.6	1.7
	84	1.5	3.7	2.3	2.6	2.1	2.1	1.8	2.3
	85	1.6	3.9	2.7	2.9	2.0	2.3	1.7	2.5
	86	1.4	3.5	2.8	2.6	1.4	1.6	1.2	2.1
	87	1.2	3.3	3.0	2.4	1.0	1.1	0.6	1.8
BUSINESS OUTPUT DEFLATOR	83	2.4	3.8	3.0	2.9	2.5	2.8	2.4	2.8
	84	2.6	5.0	3.8	3.9	3.4	3.8	2.6	3.6
	85	2.8	5.0	4.5	4.3	3.2	4.2	2.4	3.8
	86	2.7	4.5	5.0	4.2	2.4	3.6	1.7	3.4
	87	2.2	3.9	4.9	3.8	1.6	2.7	0.8	2.8
GDP/GNP DEFLATOR	83	2.1	3.5	2.7	2.6	2.3	2.4	2.1	2.5
	84	2.3	4.8	3.6	3.7	3.2	3.5	2.4	3.4
	85	2.5	4.9	4.4	4.2	3.0	3.9	2.2	3.6
	86	2.5	4.3	4.9	4.1	2.2	3.5	1.6	3.3
	87	2.1	3.8	4.9	3.8	1.4	2.7	0.6	2.8
PRIVATE CONSUMPTION DEFLATOR	83	2.1	3.5	2.6	2.3	2.2	2.2	2.1	2.4
	84	2.3	4.7	3.5	3.2	3.0	3.0	2.3	3.2
	85	2.5	4.9	4.2	3.6	3.0	3.3	2.1	3.4
	86	2.3	4.5	4.8	3.6	2.3	2.9	1.5	3.2
	87	2.1	4.1	4.8	3.3	1.6	2.1	0.7	2.7
BUSINESS FIXED INVESTMENT DEFLATOR	83	2.2	3.2	2.3	2.4	2.1	2.3	2.1	2.4
	84	2.5	4.2	2.9	3.2	2.7	3.3	2.3	3.0
	85	2.6	4.1	3.3	3.7	2.3	3.8	2.1	3.1
	86	2.5	3.5	3.6	3.7	1.4	3.6	1.4	2.8
	87	2.1	2.9	3.5	3.4	0.5	3.0	0.7	2.3
HOUSING DEFLATOR	83	2.2	3.4	2.6	2.5	2.1	2.0	2.2	2.4
	84	2.4	4.5	3.4	3.5	2.7	2.8	2.4	3.1
	85	2.7	4.6	4.1	3.9	2.6	3.1	2.3	3.3
	86	2.6	4.2	4.5	3.9	1.9	2.8	1.6	3.1
	87	2.2	3.7	4.5	3.6	1.2	2.2	0.7	2.6
GOVERNMENT CONSUMPTION DEFLATOR	83	1.0	1.9	1.9	2.5	1.6	1.0	1.2	1.6
	84	1.3	3.5	3.0	3.5	2.6	2.1	1.6	2.5
	85	1.6	3.6	3.9	4.0	2.6	2.6	1.6	2.9
	86	1.8	3.3	4.5	3.9	1.8	2.7	1.1	2.7
	87	1.7	2.8	4.5	3.7	1.0	2.4	0.2	2.3
WAGES	83	0.6	2.0	1.9	1.6	1.1	1.9	0.6	1.4
	84	1.1	2.8	2.9	2.8	2.4	3.1	1.1	2.3
	85	1.6	2.8	4.1	3.3	2.3	3.4	1.0	2.6
	86	1.7	2.7	4.7	3.3	1.3	2.9	0.1	2.4
	87	1.3	2.7	4.6	2.9	0.3	1.9	-0.8	1.8
USER COST OF CAPITAL	83	2.0	3.6	2.9	3.1	2.2	2.3	2.4	2.6
	84	2.1	4.1	3.3	4.7	2.9	2.8	2.5	3.2
	85	2.2	3.3	3.5	6.0	2.7	2.7	2.0	3.2
	86	2.3	2.6	4.2	7.2	2.5	2.7	1.6	3.3
	87	2.2	2.5	4.6	8.3	2.8	3.1	1.0	3.5
BUSINESS SECTOR EMPLOYMENT	83	0.4	0.0	-0.7	0.1	0.0	0.2	0.2	0.0
	84	-0.3	-0.4	-1.7	0.0	-0.6	0.1	-0.9	-0.5
	85	-0.5	-0.5	-2.4	-0.1	-1.5	-0.1	-1.3	-0.9
	86	-0.6	-0.4	-2.8	-0.3	-1.8	-0.1	-1.1	-1.0
	87	-0.6	-0.3	-3.1	-0.4	-1.6	-0.1	-0.6	-1.0
BUSINESS FIXED INVESTMENT	83	-0.7	-2.3	-2.2	-1.6	-1.4	-1.7	-0.7	-1.5
	84	-1.7	-6.0	-3.0	-3.5	-4.4	-2.2	-2.1	-3.3
	85	-1.5	-6.2	-2.2	-5.8	-5.9	-2.2	-3.5	-3.9
	86	-1.7	-3.9	-2.1	-8.2	-5.8	-2.1	-4.4	-4.0
	87	-2.2	-1.3	-2.4	-10.4	-4.7	-2.2	-4.4	-3.9
GDP/GNP REAL	83	-0.4	-1.6	-1.1	-0.5	-0.5	-0.4	-0.4	-0.7
	84	-1.0	-3.1	-1.8	-1.0	-1.4	-0.8	-1.4	-1.5
	85	-1.0	-3.3	-1.5	-1.6	-1.8	-1.0	-1.5	-1.7
	86	-1.0	-2.5	-1.5	-2.2	-1.6	-0.9	-1.4	-1.6
	87	-1.0	-1.5	-1.8	-2.6	-1.2	-0.8	-1.0	-1.4

The most important changes to the simulation properties of the model, due to the incorporation of the new price equations are as follows:

i) The problem of perverse inflation effects from changes in monetary policy, due to the cost effect of interest-rate changes dominating the demand effect, has been eliminated.

ii) The domestic price responses in oil price simulations are now more transparent, in closer accordance with historical experience and no longer include certain adverse features encountered in the previous model.

iii) The simulation response of the new supply-block-based measures of potential output and excess demand are more consistent with generally accepted *a priori* views.

iv) The response of prices reflects changes in important structural features of the seven major economies such as the degree of international and product-market competition, growing weights of foreign trade and the importance of domestic energy production.

These results have contributed to a considerable improvement of overall simulation properties of the model and strengthened its capability to analyse issues of current policy concern. The evolution of these simulation properties is discussed in greater detail in Richardson (1987).

Future work is likely to be focused on other sectors of the model, yet there are a number of areas where the price blocks might be improved. For example, increased consistency between the determination of export prices -- located in the foreign trade block -- and the rest of domestic price formation described in this paper, would be desirable. Another area is the price effect of indirect tax changes which, at present, is imposed by means of some simple simulation rules essentially ensuring a full and immediate pass-through to the final expenditure deflators. The crudeness of this approach reflects the difficulty of identifying well-behaved and statistically important effects of indirect tax changes.

Some of the major seven country desks have utilised the work reported here in Country Surveys; and a number of desks actively use the model in the preparation of their forecasts. Relatively little work has been done on the price blocks in the smaller country models. Work on the smaller country price blocks, perhaps with a smaller number of expenditure deflators, is likely, particularly if requested by country Desks.

NOTES

1. See e.g. Glassman and Stockton (1983), Lodh (1981) and Rao and Lodh (1983).

2. The previous specification of the price block is discussed in Helliwell et al. (1986).

3. The full-model simulation results reported in Table 1 assume fixed exchange rates, constant real government expenditure, and -- except for the interest rate shock -- constant money supplies. They are all in single-country mode.

4. A discussion of the capital cost concept, common to the old and the new model, can be found in Jarrett and Torres (1987).

5. For a detailed discussion of the supply block see Helliwell, et al. (1986) and Jarret and Torres (1987).

6. Dividing equation [6] by previous period's COST gives:

$$COST/COST_{t-1} = ETB/(QBV.COST_{t-1})WSSE + ENBV/(QBV.COST_{t-1})PENB + KBV/(QBV.COST_{t-1})UCC$$

or, expressing the factor prices relative to their previous-period values as well:

$$COST/COST_{t-1} = (ETB.WSSE_{t-1})/(QBV.COST_{t-1})WSSE/WSSE_{t-1} + (ENBV.PENB_{t-1})/(QBV.COST_{t-1})PENB/PENB_{t-1} + (KBV.UCC_{t-1})/(QBV.COST_{t-1})UCC/UCC_{t-1}$$

which in log-difference form gives equation [7] of the main text.

7. This is an important change from the previous version of the price block as discussed in Helliwell, et al. (1986).

8. Discussion with the Department's country Desks resulted in choosing the following minimum unemployment rates:

USA	JAP	GER	FRA	UKM	ITA	CAN
3.5	2.0	4.0	3.0	4.5	4.1	5.0

9. The composition of the (non-energy) tradeables sector is given by the percentage shares of the second semester 1983 which are as follows:

	USA	JAP	GER	FRA	UKM	ITA	CAN
Food	14.9	17.7	9.6	15.7	11.9	14.4	19.0
Raw materials	4.1	0.6	3.5	2.9	0.6	3.4	13.8
Manufactures	74.9	74.2	82.5	71.6	77.0	73.1	52.4
Services	6.1	7.9	4.5	9.7	10.5	9.2	14.8

10. On average of the years 1982-83, the measured shares of tradeables in total output (excluding energy) were as follows:

USA	JAP	GER	FRA	UKM	ITA	CAN
33.5	42.0	45.0	41.0	30.5	39.5	33.5

11. Sometimes it is proposed to enter an import-price measure with a negative sign (see, for example, Brayton and Mauskopf (1985)). Apart from likely multicollinearity between import prices and foreign competitors' prices, this approach neglects the behaviour of profit margins in the export sector. This would be acceptable, if export prices were exclusively determined by domestic costs. However, in INTERLINK export price formation includes an autonomous influence from foreign competitors' prices. The terms-of-trade measure used in the aggregate output-deflator equation includes only this autonomous contribution to export prices, while the variable "COST" covers the domestic cost contribution to export prices.

12. Where net energy imports are very large, the domestic energy output proxy ENBV+XEV-MEV can become negative. Therefore, in implementing these equations domestic energy output was assumed to remain constant in proportion to energy imports in countries without important domestic energy sectors (Japan, Germany, France and Italy).

13. The definition of domestic energy sectors reflects the degree of disaggregation in national statistics. It includes coal-mining, crude petroleum and natural gas production in the United States, France and Canada; coal-mining in Germany; and mining and quarrying in Japan and the United Kingdom. These sectors are virtually non-existent in Italy. Also included are 75 per cent of electricity, gas and water supplies in all countries, 25 per cent of chemical industry output in the United States and Canada, and 15 per cent in Japan, Germany, France and Italy. The part of the chemical industry included rises from 15 to 25 per cent in the United Kingdom during the 1973-1979 period, parallel to the development of North Sea oil.

14. This was also suggested by some discouraging experience with more complicated response patterns which had contributed to some of the problems in full-model simulations discussed in Section I.

15. A government investment deflator does not exist for the United States.

16. The previous model included a composite index of exogenous costs comprising INTERLINK's five import categories (food, raw materials, manufactures, energy and services) as well as price indices for domestic food and domestic energy. The new model includes domestic food and energy in domestic value added, while the remaining import price influences are highly dominated by manufactures and energy. Considerations of data maintenance suggested to distinguish only between non-energy and energy import prices.

17. This technique was developed by Theil and Goldberger (1961) and Theil (1963). It has previously been used by the Secretariat in its modelling work on international financial linkages and exchange rates (Holtham, 1984). The extraneous information consists in the mean of a parameter and in the variance around this mean. The mixed regression technique considers the extraneous information for each of the parameters as an additional observation before applying the generalised least-squares method to the extended sample. This ensures that the pooling of actual data and a priori information (each with different variances) does not introduce heteroskedasticity. The tighter the variance, the closer one moves towards imposing the prior mean on the parameter. As the "estimated" variances are largely imposed, t-ratios will say little about the statistical significance of the parameters. However, even with "tight" priors it still is important to establish whether sample and prior information are compatible. For this purpose, Theil proposed a compatibility statistic which is asymptotically distributed as $\chi^2(k)$, k being the number of explanatory variables. If the test statistic exceeds the critical value, prior and sample information are incompatible.

18. The availability of consistent energy data constrained estimation samples to end in 1983II.

19. The user costs of capital which enter the definition of normal long-run costs (CNORM) are defined as follows (leaving tax influences aside):

UCC′ = PIB(IRLRE + XRSCRBT)

where PIB = deflator of business fixed investment
IRLRE = expected real rate of return
XRSCRBT = scrapping rate.

This definition differs from the user cost of capital (UCC) appearing elsewhere in the model and presented in Jarrett and Torres (1987), by using an "optimal scrapping rate" (XRSCRBT) instead of an exogenous one (XRSCRB). The "optimal scrapping rate" is consistent with the structure of the supply block and given by:

XRSCRBT = (XRSCRB(KBSTAR(-1)/QBSTAR(-1))QBV(-1))/KBV(-1)

where XRSCRB = exogenous scrapping rate
KBSTAR = cost-minimising capital stock
QBSTAR = expected output.

As a result, capital costs reflect to some extent changes in the optimal capital/output ratio without following cyclical fluctuations in the actual capital/output ratio. The rationale for this concept is to stabilize the behaviour of capital costs and to dampen possible counter-cyclical price effects.

20. The prior estimates for Canada were the same as for the United States.

21. The focus here lies on the implications for the simulation properties of the model. An indicator of the forecasting performance of the new PQBNE equations, can be found in the root mean square error in per cent which for the two out-of-sample periods 1984-1985 and 1984-86 was as follows:

	USA	JAP	GER	FRA	UKM	ITA	CAN
1984-85	0.6	0.6	0.6	0.8	0.9	1.4	0.8
1984-86	1.3	1.1	0.7	1.2	0.7	1.9	0.7

The deteriorating forecasting performance in the cases of the United States, Japan, France and Italy in 1986 mainly reflects a significant over-estimation of the impact of falling world energy prices or, in other words, an under-estimation of the short-run boost which profit margins in these countries have received from falling oil prices. Through the forecast period 1987-88, the equation predictions tend to return to inflation rates similar to current actual rates.

22. The most recent version of the wage equations incorporated in the model are discussed in Chan-Lee et al. (1987).

23. The shock applies to the variable itself and not to the add-factor. Thus, wages are actually 2 per cent higher throughout the simulation period suppressing otherwise possible feedback effects.

24. The results for Italy are obtained with a slightly more recent version of the Italian model including some relatively minor parameter changes compared to the model used in Richardson (1987). These changes tend to weaken somewhat the impact of foreign competitors' and import prices.

Annex I

DERIVATION OF THE BASIC AGGREGATE PRICE EQUATION

Under atomistic competition, prices to individual producers are given. In an oligopolistic market, firms' demand curves are negatively sloped, and firms are assumed to "know" their demand curves. Profit maximization then requires not only an output decision but a joint output and pricing decision. Reduced output will, ceteris paribus, increase prices; profits are maximized at prices which are a mark-up on minimum average costs.

To determine minimum average costs, a convenient starting point is a three-factor Cobb-Douglas production function with constant returns to scale, similar to the one used in INTERLINK:

$$QBV = A.(ETB.ELEFF)^{\alpha}.KBV^{\beta}.ENBV^{\gamma} \qquad [1]$$

where $\alpha + \beta + \gamma = 1$,
A = scalar
ETB = business sector employment
ELEFF = index of Harrod-neutral, labour-saving technical progress
KBV = business sector capital stock
ENBV = business sector intermediate energy consumption.

Production costs are defined as the sum of the factor inputs multiplied by the factor prices:

$$C = WSSE.ETB + UCC.KBV + PENB.ENBV \qquad [2]$$

where WSSE = compensation per employee
UCC = user cost of capital
PENB = deflator of business sector energy consumption.

Minimum long-run average costs are obtained by minimizing the cost function subject to the constraint of the production function. The first-order conditions for cost-minimization are:

$$\lambda = (WSSE.ETB)/(\alpha.\overline{QBV}) = (UCC.KBV)/(\beta.\overline{QBV}) = (PENB.ENBV)/(\gamma.\overline{QBV}) \qquad [3]$$

implying:

$$\beta.WSSE.ETB - \alpha.UCC.KBV = 0 \qquad [4]$$

$$\gamma.UCC.KBV - \beta.ENBV.PENB = 0 \qquad [5]$$

Solving [2], [4] and [5] for ETB, KBV and ENBV:

$$ETB = (\alpha.C)/WSSE \qquad [6]$$

$$KBV = (\beta.C)/UCC \quad [7]$$

$$ENBV = (\gamma.C)/PENB \quad [8]$$

Substituting these expressions into the production function [1] and solving it for C gives the following definition of minimum total costs:

$$C = (1/A.\ \alpha^{\alpha}.\beta^{\beta}.\gamma^{\gamma})(WSSE/ELEFF)^{\alpha}UCC^{\beta}.PENB^{\gamma}.\overline{QBV} \quad [9]$$

Using equation [1] to replace $\overline{QBV}$:

$$C = b(WSSE.ETB)^{\alpha}(UCC.KBV)^{\beta}(PENB.ENBV)^{\gamma} \quad [10]$$

where $b = 1/(\alpha^{\alpha}.\beta^{\beta}.\gamma^{\gamma})$

or expressing C per unit of output and in logarithmic form (where C/QBV equals COST as used in the main text):

$$\ln(C/QBV) = b + \alpha.\ln(WSSE.ETB/QBV) + \beta.\ln(UCC.KBV/QBV) + \gamma.\ln(PENB.ENBV/QBV) \quad [12]$$

This definition of minimum average costs can then be combined with the determinants of the mark-up factor as discussed in the main text, i.e. with measures of excess demand and of international price competitiveness. Taking the first-difference form, one obtains:

$$dln(PQB) = a_1.dln(WSSE.ETB/QBV) + a_2.dln(PENB.ENBV/QBV) + (1-a_1-a_2).dln(UCC.KBV/QBV) + a_3.\ln(QBV/QPOT) + a_4.\ln(PMQ_{t-1}/PQB_{t-1}). \quad [13]$$

which is the basic equation of the price model used in the text.

Annex II

MULTICOLLINEARITY IN THE OUTPUT-DEFLATOR EQUATIONS

The basic equations for the aggregate output deflator suffer from multicollinearity to such an extent that standard regression techniques were not considered useful. This note reports two measures of non-orthogonality in the data matrices of these equations for the seven major economies. These are summary statistics and cannot be used to test for near-multicollinearity, but they can be helpful in detecting specific variables which are responsible for major departures from orthogonality.

There is no unique measure of multicollinearity. In general, the accuracy of the coefficient vector of the equation in question is used to evaluate the degree of ill-conditioning, but different approaches are available which often come to conflicting conclusions. None of the criteria generally used is invariant to rescaling of the data. Here, the degree of non-orthogonality in the data matrices of the output-deflator equations was assessed on the basis of both condition numbers and the length of the parameter error vector (Table A1).

The condition number is defined as the ratio of the largest characteristic root in the data matrix to the smallest one (see Chapter 12 of Judge, et al ., 1980). This statistic is an indicator of ill-conditioning since it can be shown by spectral decomposition that relatively small eigenvalues dominate the variances of the coefficient vector. Condition numbers for the data exactly as they are used in estimation and measured as deviations from mean are also presented below.

The error vector approach compares the actual length of a coefficient vector with its hypothetical length in the abscence of any multicollinearity (Gilbert, 1978). The C^2-statistic, which is equal to the difference between the two lengths, may be taken as a measure of ill-conditioning in the data matrix. The efficiency implicit in the matrix is $(100/C^2)$ per cent. Perfect orthogonality gives $C^2 = 1$, and hence 100 per cent efficiency. The greater the degree of collinearity, the higher the C^2-statistic and the lower the efficiency. It is also possible to use the C^2 collinearity measure to identify the source of ill-conditioning by comparing the length of the error of individual parameters (c^2). The sum of these lengths, plus unity, gives the C^2-statistic.

The following table gives condition numbers and C^2-statistics for the data matrices used in estimating the aggregate output-deflator equations. The contribution of each of the individual variables to multicollinearity, judged on the basis of the C^2-statistics is also shown. The table illustrates how different criteria and different scaling can affect the judgement about ill-conditioning. Both approaches indicate that the data measured as deviations from mean, seems most collinear for the United Kingdom and least

Table A1

MEASURES OF MULTICOLLINEARITY (a)

	Condition number		Error vector		Contribution to collinearity					
	CN1	CN2	C^2	Efficiency per cent	CNORM	COST	QBV/QBPOT	$\frac{PMQNE_{t-1}}{PQBNE_{t-1}}$	TOT	$\frac{COST_{t-1}}{PQBNE_{t-1}}$
United States	765800.0	1536.0	4.04	24.7	0.64	0.58	0.49	0.88	0.08	0.37
Japan	314496.6	459.8	5.15	19.4	1.19	1.35	0.27	0.48	0.26	0.60
Germany	461448.5	229.9	3.37	29.6	0.31	0.51	0.15	0.46	0.25	0.70
France	211600.0	84.8	2.88	34.6	0.18	0.25	0.38	0.53	0.43	0.11
United Kingdom	231938.7	5251.9	11.20	8.9	2.19	1.60	2.64	2.30	0.55	0.75
Italy	91324.8	149.4	5.48	18.3	1.40	1.72	0.23	0.11	0.09	0.64
Canada	535677.6	645.0	4.25	23.6	0.33	0.80	0.18	0.91	0.12	0.90

Notes: CN1 is the condition number for the raw data.
CN2 is the condition number for the data measured as deviation from mean.
C^2 and c^2 are based on the data measured as deviation from mean.

a) The names of the variables are the same as in the main text. CNORM stands for long-run normal unit costs, COST stands for actual short-run unit costs.

collinear for France. According to the C^2 measure, the efficiency implicit in the sample is only 8.9 per cent for the United Kingdom, and 34.6 per cent in the case of France. These statistics suggest that standard OLS techniques are likely to result in very poorly-determined coefficients. No clear pattern emerges about the contributions of individual variables to collinearity. In three countries the measure of foreign price competition (PMQNE/PQBNE) seems the prime source of ill-conditioning, and its contribution is also significant in the other four countries. The terms-of-trade variable (TOT) seems in general the least responsible for multicollinearity.

Annex III

SUPPORTING MATERIAL ON THE ESTIMATION OF EQUATIONS FOR THE GROSS OUTPUT DEFLATOR OF THE DOMESTIC NON-ENERGY SECTOR

Table A2 reports estimation results providing the parameters for the definition of total unit costs shown in Table 2 of the main text.

Table A3 shows some unconstrained estimation results of the impact effects of disequilibrium influences on PQBNE on which the prior estimates shown in Table 3 of the main text are based.

Table A2

DETERMINATION OF THE NORMAL COST STRUCTURE

(Ordinary least square estimates, t-ratios in parentheses)

$$\text{dln PQBNE} = a_0 + a_1.\text{dln LC} + a_2.\text{dln EC} + (1-a_1-a_2)\text{dln CC} + a_4(\text{QBV/QBPOT}) + a_5\text{dln (QBV/ETB)}$$

	a_1	a_2	$1-a_1-a_2$	Adj. R^2	SEE	DW
United States	0.8154 (5.21)	0.0626 (2.46)	0.1220	0.639	0.008	1.70
Japan	0.7884 (12.14)	0.1149 (4.14)	0.0967	0.968	0.017	1.35
Germany	0.7892 (17.42)	0.1100 (4.35)	0.1008	0.974	0.006	2.07
France	0.7461 (5.37)	0.0829 (2.45)	0.1700	0.661	0.009	2.02
United Kingdom	0.7293 (10.53)	0.1197 (2.48)	0.1510	0.839	0.012	1.84
Italy	0.7049 (6.59)	0.1164 (4.05)	0.1787	0.571	0.017	1.48
Canada (a)	0.8003	0.0988 (7.06)	0.1009 (1.70)	0.892	0.014	1.27

The length of the half-yearly estimation sample varies across countries. It always goes to 1983II, in most cases beginning in the mid-sixties.

a) Including dummy variables for the periods 1976II: -0.0357 (-2.33); 1979I: 0.0271 (1.88).

Table A3

DISEQUILIBRIUM INFLUENCES ON THE GROSS OUTPUT DEFLATOR
FOR THE NON-ENERGY SECTOR

(Ordinary least square estimates, t-ratios in parentheses)

	Constant	CNORM	Cyclical productivity (a)	QBV/ QBPOT	PMQNE(-1) / PQBNE(-1)	TOT	Adj. R^2	DW	SEE
United States	-0.043 (2.31)	--	-0.303 (3.01)	0.040 (2.22)	0.265 (5.10)	0.572 (1.42)	0.75	1.34	0.007
Japan	-0.004 (0.89)	--	-0.834 (2.54)	--	0.153 (1.34)	1.218 (1.52)	0.40	0.68	0.022
	-0.151 (1.73)	--	--	0.150 (1.69)	--	--	0.06	0.70	0.020
Germany	-0.135 (3.05)	0.773 (4.66)	--	0.134 (3.48)	0.096 (i)	0.595 (3.48)	0.70	1.92	0.007
France	0.015 (3.20)	0.643 (4.08)	-0.329 (2.14)	--	0.233 (2.23)	--	0.65	2.21	0.010
	-0.147 (1.15)	0.522 (2.90)	-0.381 (2.45)	0.165 (1.27)	0.233 (i)	--	0.73	2.14	0.010
	-0.147 (32.1)	0.521 (3.40)	-0.382 (2.55)	0.165 (i)	0.208 (2.05)	--	0.63	2.14	0.010
	-0.147 (32.6)	0.521 (3.46)	-0.382 (2.60)	0.165 (i)	0.233 (i)	--	0.71	2.14	0.010
	-0.009 (1.61)	1.0	-0.378 (1.28)	--	--	0.506 (1.65)	0.24	2.25	0.012
United Kingdom	-0.115 (2.00)	0.526 (2.11)	-0.529 (1.47)	0.133 (2.20)	--	0.735 (2.17)	0.67	1.92	0.017
	0.015 (1.16)	0.339 (1.19)	-0.538 (1.40)	--	0.208 (1.76)	0.508 (1.32)	0.65	1.86	0.017
Italy	-0.179 (2.26)	--	--	0.128 (1.86)	0.213 (1.63)	0.766 (2.28)	0.57	2.06	0.017
Canada	-0.007 (0.29)	1.0	--	--	--	0.867 (3.25)	0.28	1.27	0.013

The half-yearly estimation sample goes from various periods in the mid-sixties to 1983II.

a) Actual current-period growth in labour productivity minus the labour productivity growth entering into CNORM.

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