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Technical Series

No 9

Some properties of the Bank model

by

G P Dunn, N H Jenkinson, I M Michael and G Midgley

March 1984

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The object of this Technical Series of Discussion Papers is to give wider circulation to econometric research work predominantly directed towards revising and updating the various Bank models. Any comments should be sent to the authors at the address given below.

The authors are grateful for helpful comments made by colleagues at the Bank but the views expressed are their own and not necessarily those of the Bank of England. The authors would like to thank Mrs A Hosymer for typing the manuscript.

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Chapter I INTRODUCTION

This technical paper is a collection of four largely separate papers each illustrating different ways in which a model can be tested. None are robust and, for reasons outlined later, few would be much use in comparing models. An annex provides an overview of the main equations in the model and indicates how well individually these track the past.

Chapter II illustrates the marginal properties of the model with the aid of a number of simulations. The effects in the model of changes in fiscal instruments, interest rates, world activity and prices, UK money wages and the exchange rate are described. The sensitivity of the results to the wage and exchange rate responses is illustrated. In addition, attention is drawn to various system properties such as the extent and origins of crowding-out, the long-run effect of devaluation on output, the extent to which the law of one price holds and the stability of the model.

These simulations were run purely as exercises in model testing. In other analytical work, the results obtained are often adjusted ex ante and/or ex post for known deficiencies in the model; but this was not done here.

It should also be noted that the model assumes a number of implicit policy reactions. These need to be borne in mind when both interpreting the results reported here and comparing them with results obtained elsewhere. For example, it is the volume of public expenditure on goods and services and the real value of current grants to persons that are treated as exogenous; they are validated irrespective of the level of prices. There is no public sector reaction to potential under- or overspend on cash limits. Also direct and ad valorem indirect tax rates are generally held constant, whilst personal allowances, lower and upper earnings limits for the determination of National Insurance contributions and rates of specific duties are indexed to the past rate of consumer price inflation. These fiscal rules are followed irrespective of the level of public borrowing to which they lead, or the resulting evolution of the public debt/national income ratio. Equally, interest rates are not set to achieve target rates of growth of the monetary aggregates. In the foreign exchange market, the authorities are assumed to 'lean against the wind' when intervening.

Chapter III examines the relationship between the impact of a step change in a single exogenous variable, in this case the income tax rate, and the size of the step. Individual equations in a model may be highly non-linear - examples in the Bank model are to be found in interest rates and the exchange rate sectors. In the overall system of equations, however, their influence may be sufficiently dilute for the system to be broadly linear. Although of interest in itself, linearity is also a convenience in that it may allow the users to economise on the number of simulation results it is necessary to keep. Of importance here too is symmetry; is the model's response to a tax increase the equal and opposite of that to the equivalent tax decrease?

Chapter IV discusses the historic tracking performance of the model between 1974 and 1982. It is in two parts: the first examines critically the usefulness of running historic dynamic simulations as a guide to model testing and model comparison, whilst the second presents results for the tracking performance of the Bank model. To undertake this exercise, the model was simulated over the past, conditional on the actual values for all the exogenous variables in the system, and the simulated values of the endogenous variables were compared with the historical outturns. From an examination of the tracking performance of the system, and how errors are accumulated, it may be possible to identify weak areas of the model.

It is tempting to place substantial reliance on an examination of how successfully a model copes with the vagaries of recent historical experience. Our results indicate that the success or failure of the model to track output and inflation was critically dependent upon the period chosen. The primary aim of the exercise was to examine how system errors developed within the model, given the simultaneous 'shocks' to exogenous variables which had occurred historically. This is, of course, an extension of the multiplier analysis of the marginal properties of the model contained in

Chapter II: in a multiplier study the properties of the model are typically derived with respect to the change in one exogenous variable; in an ex post simulation exercise the properties of the model are derived with respect to actual movements in all the exogenous variables.

The main limitations of the approach stem from the assumptions regarding the determination of the exogenous variables, and these are discussed.

Chapter V presents further analysis of the residuals in the individual equations of the model, and the cross correlations between the single equation static residuals of the main behavioural equations were calculated. The reasons why residuals on separate equations may be correlated are discussed. Loosely following procedures outlined in Harvey and Phillips (1982), the significance of relationships between residuals is examined.

Much attention has been given in the economic literature to various ways of testing and validating large scale macroeconomic models (see particularly McNees (1981), Ormerod (1979), and Klein (1979)). Testing similar to that reported in this paper can show individual model builders the problems that exist in their particular model. What does or does not constitute a problem in model structure is often subjective rather than objective. The decision that certain marginal properties are undesirable in that they run counter to the model builders' intuition is a subjective one; there is sufficient licence within a given set of objectively chosen single equations to achieve a range of desired marginal properties. The results given in Chapter II on crowding out are an illustration of this provided it is accepted that the data supports a broad range of wage and exchange rate equations (see Henry (1984) for wages, and Hacche and Townend (1981) for exchange rates as examples of the difficulties of discriminating between different hypotheses).

In large models, there will often be some aspects of behaviour that have been fully considered and others that have not, often dealing with the second group requires a renewed look at the first. The research work in support of modifications to the model itself takes time to complete. A snap-shot of a model at any particular time need not then be truly representative of the model builders' views on the structure of the economy as a whole. Models then are rarely used in the naive sense of Chapter II on marginal properties. This model is no exception.

A difficulty for model builders is that although they might wish to capture the structure of the economy in their equations, in practice they model the CSO's data. The criteria used for assessing the model, 'sensible' marginal properties say, need not necessarily be sensibly applicable to the data that has to be used. For example, relative prices rather than the absolute price level have a strong role in most models; making all price equations homogenous (in the long run) in other prices (costs) is an important route through which the presence of counter intuitive system properties can be avoided. However, whilst such long run homogeneity might be valid for the price concepts in the economic structure, these concepts are not necessarily those that are measured. Their proxies in the data need not produce homogeneity - should it be imposed even though the data rejects it? Is it the data or the economy that is being modelled?

The long run, however, may be sufficiently distant to be in practice unimportant. What matters then is our ability to capture adequately the dynamics of disequilibrium processes. In this model, for example, it is the speed of response of wages to both prices and output relative to how quickly output responds to competitiveness that, for an external price shock, determines how long the gain or loss to UK output is sustained. The period of adjustment can be a number of years (see Chapter II).

Nomenclature

Errors on the equations in the model can be derived under different assumptions, and the work reported in Chapters IV and V is primarily concerned with these various definitions. Consider a two equation model where Y_1 and Y_2 are endogenous variables and X_1 and X_2 are exogenous. The equations for Y_1 and Y_2 are assumed to be:

$$\text{for } Y_{1t}, \quad \alpha o + \alpha_1 Y_{1t-1} + \alpha_2 Y_{2t} + \alpha_3 X_{1t}$$

$$\text{for } Y_{2t}, \quad \beta o + \beta_1 Y_{2t-1} + \beta_2 Y_{1t} + \beta_3 X_{2t}$$

Errors are defined as the difference between actual and solution values. The solutions of the equations can be arrived at in several ways.

1 Single equation static error

Here the equations are solved with all the variables in the defining equations taking their actual values.

2 Single equation dynamic error

Here all variables take their actual values with the exception of lagged dependent variables where the previously solved values are used.

3 One step ahead system errors

Here only exogenous variables and lagged endogenous variables take their actual values when the equations are solved. Current endogenous variables use the solution values from their own defining equations.

4 System dynamic errors

When the equations are solved, only actual values for the exogenous variables are used. Solution values are used for current and lagged endogenous variables.

For example if solved values for endogenous variables are denoted by Y, and the actual value by Y, then the errors for variable Y_1 are calculated by $Y_{1t} - \hat{Y}_{1t}$,

where for a single equation static solution,

$$\hat{Y}_{1t} = \alpha_o + \alpha_1 Y_{1t-1} + \alpha_2 Y_{2t} + \alpha_3 X_{1t}$$

for a single equation dynamic solution,

$$\hat{Y}_{1t} = \alpha_o + \alpha_1 \hat{Y}_{1t-1} + \alpha_2 Y_{2t} + \alpha_3 X_{1t}$$

for a one-step ahead system solution,

$$\hat{Y}_{1t} = \alpha_o + \alpha_1 Y_{1t-1} + \alpha_2 \hat{Y}_{2t} + \alpha_3 X_t$$

for a system dynamic error

$$\hat{Y}_{1t} = \alpha_o + \alpha_1 \hat{Y}_{1t-1} + \alpha_2 \hat{Y}_{2t} + \alpha_3 X_t$$

CHAPTER II - MARGINAL PROPERTIES

This chapter reports the response of the model to imposed step changes in single variables or groups of related variables. The following are considered:

(a) an increase in general government consumption.

(b) an increase in world trade and output.

(c) an increase in UK interest rates.

(d) a reduction in the standard rate of income tax.

(e) a reduction in the rate of value added tax.

(f) an increase in world prices.

Shocking the model provides useful insights into overall model properties, but it is acknowledged that such simulations can be unrealistic. For example, world prices and world activity are unlikely to be independent of each other; neither need interest rates and fiscal policy be unrelated.

The results obtained in the simulations are very sensitive to the specification of the determination of money wages and the exchange rate. These are, however, areas of great uncertainty. For this reason, it is often more useful to look at the range of possible outcomes under different assumptions about wage and exchange rate behaviour. The first group of simulations reported below illustrate the sensitivity of public expenditure multipliers to the assumed wage and exchange rate response.

Public expenditure simulations

A step increase in general government consumption volume (G) is considered under four alternative regimes: wages and exchange rate fixed; wages fixed; exchange rate fixed; and wages and the exchange rate free. The effects of this on output and inflation in each case are shown in charts 1 and 2, and the behaviour generating the results obtained is analysed below. The assumptions made about wages and the exchange rate turn out to be crucial in determining the marginal properties of the model.

Chart 1

Step change in public consumption – output effects

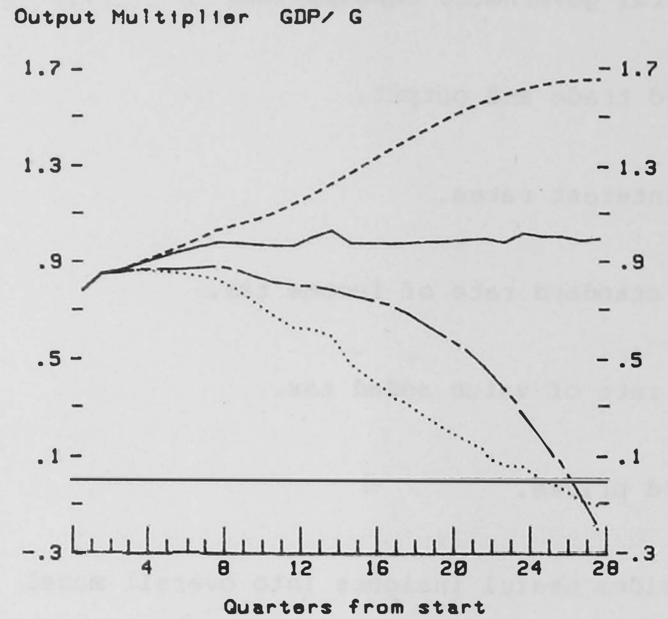
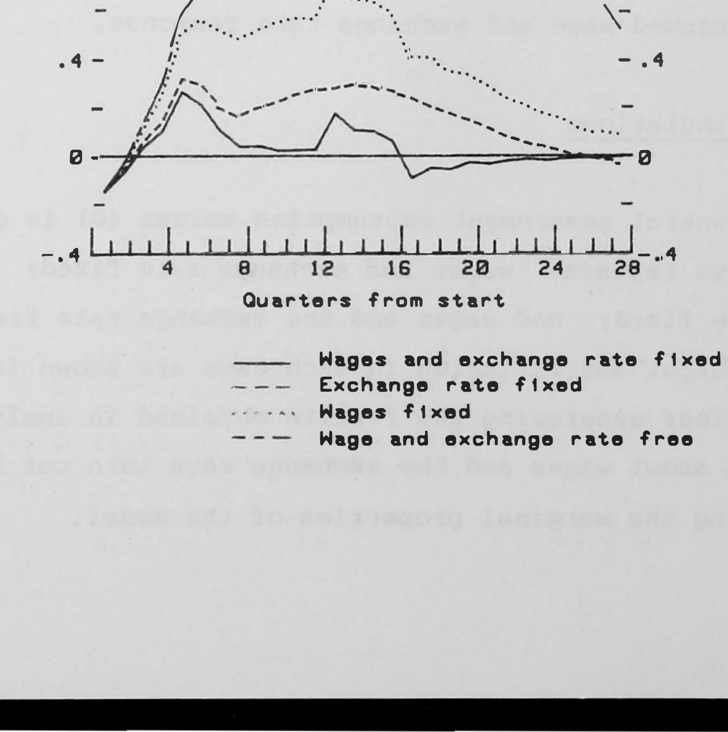


Chart 2

Step change in public consumption – inflation effects



With wages and the exchange rate both made exogenous, the output multiplier reaches a long run value of unity after two years. Prices are largely unchanged, there being no direct pressure of demand effects in the price equations.

With the exchange rate remaining exogenous but wages free to change, the peak effect on raising output is reached after one year: complete crowding out is reached after six years*. Inflation is still marginally higher at that point.

With wages made exogenous and the exchange rate free to change, substantial crowding in is produced: the output multiplier rises to 1.6 after six years. With no wage response permitted, the effect on inflation is small, peaking at 1/2% per annum.

With both wages and the exchange rate fully endogenous, the peak boost to output is reached after two years (peak multiplier about 0.9) and complete crowding out is reached after 6 1/2 years. The peak effect on inflation is reached during the 5th year.

The complete spectrum of results from full 'crowding out' to substantial 'crowding in' is possible depending upon the particular mix of exchange rate and wage response that is assumed.

In the simplest case, with both wages and the exchange rate fixed, an increase in government spending adds directly to demand and output†. There is then a second round effect through additional employment leading to higher private consumption, some of which is met by imports, some through additional domestic output. With no wage or exchange rate response allowed, and no pressure of demand effects directly on margins, there is no impact on inflation.

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*It is likely that if it is run for long enough, the model would produce output cycles in this simulation.

†The model assumes that the split of <u>marginal</u> government consumption between direct employment and procurement is roughly the same as the average composition (a ratio of around 60:40 respectively). If a higher proportion of marginal spending were on direct employment, the simulated boost to output (and employment) would be greater. Equally, because marginal government consumption is specified to have a large direct labour content, a change in this has a more powerful effect on output (and employment) than an equivalent change in public fixed investment.

Once the models wage equations are allowed to operate, the fall in unemployment acts to raise wages. This initial rise is amplified by wage-wage spirals (competitive bargaining between groups of workers in the earnings league) built into the wages sector of the model. For example, an ex ante stimulus of 1% per annum to all three wage variables produces an ex post rise in the level of 5 1/2% on average after three years assuming an unchanged exchange rate. Higher real personal incomes then feed through to higher consumption, but higher wages also mean worse competitiveness. It is the adverse effect of worse competitiveness on exports and imports that eventually dominates the increase in both public and private consumption. The end result is to leave whole economy output no higher after six years but with a rise in non-traded output at the expense of traded output.

With the exchange rate equations allowed to operate but the wage system switched off, the opposite result, 'crowding in', is produced. This is because the model assumes that part of the rise in public expenditure will be monetised and that this will then lead to a fall in the exchange rate (thus improving competitiveness and stimulating further traded output). Both elements in the overall relationship between public expenditure and the exchange rate are the consequence of a series of imposed relationships. The change in sterling M3 is largely derived as the residual instrument in reconciling each sector's financial transactions with its sector surplus or deficit; the bank lending and public sector debt sales relationships are key in this but both sets of equations are frequently overridden. Also the international monetarist view which is predominant in the determination of the exchange rate in the model has little empirical support (Hacche and Townend [1981]). Moreover, even if this view were correct, it is still the case that there is little evidence for the particular set of coefficients used in the model.

The table below shows percentage changes from base in sterling M3, TFE at current prices and the effective exchange rate in a simulation in which government consumption is raised by 75 £ 200 million per quarter with wages fixed.

Sterling M3, TFE at current prices, and effective exchange rate
G + 200 simulation, wages fixed

Differences from base (%)

Year	K£M3	TFE	Effective Exchange Rate
1	+0.8	+0.7	-0.1
2	+2.1	+0.9	-0.6
3	+3.2	+1.1	-1.6
4	+3.6	+1.4	-2.2
5	+3.8	+1.7	-2.6
6	+3.8	+1.8	-2.5

The change in money is substantially greater than that in nominal activity and this contributes to pushing the exchange rate down. It could be argued that in the longer run money should grow at the same rate as nominal activity; the current system does not incorporate that property.

With both the wage and exchange rate equations operating, the main additional feedbacks introduced are those from wages onto the exchange rate (via consumer prices, total final expenditure at current prices, and money) and those from the exchange rate to wages (via import and, hence, consumer prices). As chart 2 shows the peak effect on inflation is then considerably greater. Moreover, the peak is reached some six months later in this simulation than in that with wages free but the exchange rate fixed, reflecting the greater buoyancy of output and the greater number of mechanisms tending to entrench inflation.

For output, the key question is whether when both wages and the exchange rate are free to move, the latter depreciates sufficiently to offset the effect of higher wages on competitiveness. As the table below shows, the dynamics are such that in the first 4 years of the simulation, competitiveness remains broadly constant. However, subsequently the exchange rate fall relative to base first slows and is then partly reversed. Given that wages continue to rise strongly compared to base, a substantial loss of competitiveness is then induced; this explains the rapid decline in the multiplier in the last 2 1/2 years of the simulation. The movement of the exchange rate also explains the equally rapid attenuation of the boost to inflation.

Competitiveness and the effective exchange rate
G + 200 simulation, wages and exchange rate free

End year, differences from base (%)

Year	Competitiveness*	Effective exchange rate
1	0.2	-0.3
2	0.1	-1.2
3	-0.3	-2.7
4	0	-3.8
5	1.2	-4.1
6	3.1	-3.5

The fact that the multiplier starts to decline considerably before this point reflects declines in the initial boosts to consumers' expenditure, fixed investment and stocks. Higher inflation tends to raise saving and the levels of capital investment and stocks become adjusted to higher output (both are related to output by accelerator type relationships).

Within this type of model then, the degree of crowding out exhibited depends on the change in effective competitiveness induced (and, to a lesser extent, on the change in inflation, since the latter affects the personal saving ratio). It does not arise from such sources as lower corporate fixed investment and stockbuilding induced by higher interest rates or reduced 'availability' of finance; this is both because the scale of public borrowing does not have a large effect on interest rates, and because interest rates have little effect on fixed investment† or on stockbuilding. (Neither are these expenditures constrained by the 'availability' of funds).

A further feature of the simulations with wages endogenous is that the lagged adjustment of employment to output, of wages to unemployment and of net trade to competitiveness imply that at the point when output is pushed down to base levels, unemployment is still below base and effective competitiveness is still deteriorating. The implication then is that output will be pushed below base levels for a time, and it is likely that the profile of output generated will exhibit cycles.

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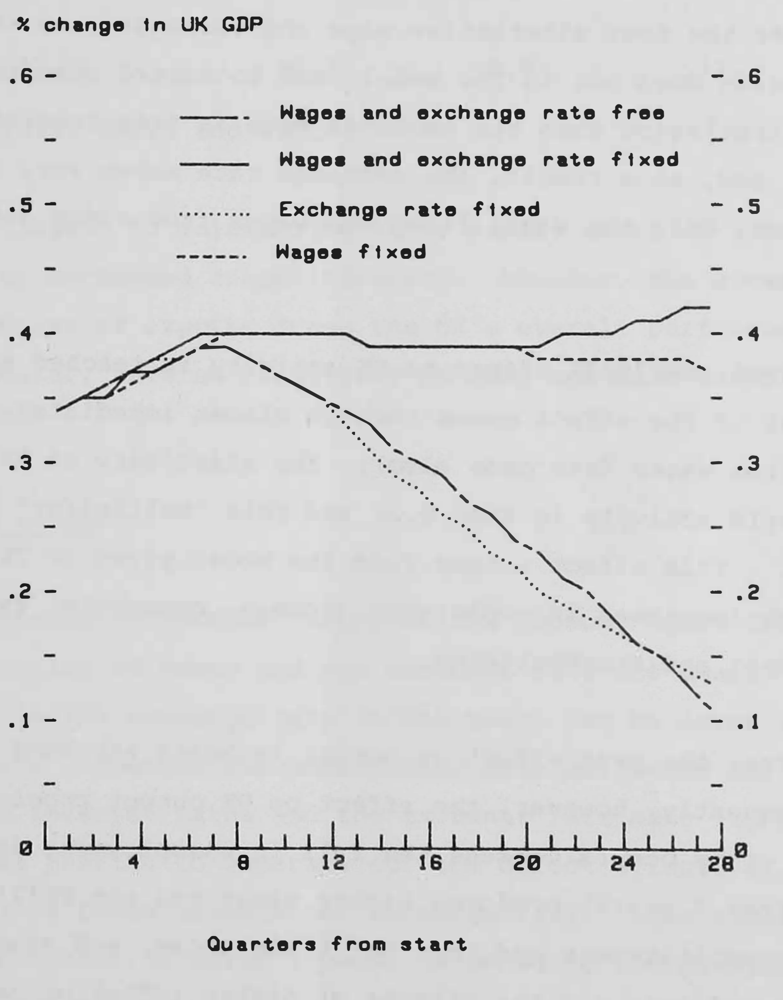
*Relative normalised unit labour costs: increase represents deterioration.

†Except on private residential investment - see later.

. Chart 3

2% higher world activity - output effects



World activity simulations

Such crowding out behaviour, dependent as it is on the wage equation in the model, is not restricted to changes in public expenditure. The response of the model to changes in world activity provides a similar picture.

World activity enters the model through three variables: OECD industrial production, both naturally weighted and UK trade weighted, and the volume of world trade in manufactures (UK weighted). These variables directly affect UK exports. For the purpose of model testing an equiproportionate expansion in all three variables was explored with world prices held at base values. Chart 3 shows the effects of a 2% step change in world activity on UK output under the four alternative wage and exchange rate regimes. An external stimulus does not in the model lead to marked changes in the velocity of circulation when the exchange rate is free (whether wages are fixed or not) and, as a result, the exchange rate moves very little compared to base. Thus, only the wages fixed and wages free cases need be distinguished.

With wages fixed, the full effect on UK activity is reached after 2 years (although most of the effect comes through almost immediately, a feature exhibited by the wages free case also); the elasticity of UK activity with respect to world activity is then 0.2, and this 'multiplier' is maintained subsequently. This effect arises from the boost given to UK exports, and the consequent increases in employment incomes, consumers' expenditure, fixed investment and stockbuilding.

With wages free, the peak effect on output is again attained after 2 years; subsequently, however, the effect on UK output progressively evaporates. This occurs because the fall in unemployment induced initially (of 50,000 after 3 years) produces higher wages via the Phillips curve; this makes competitiveness and then net trade worse, and also depresses consumers' expenditure via the effects of higher inflation on saving behaviour. After 7 years, only 25% of the peak gain to output remains.

Thus, in the model, the elasticity of UK activity with respect to a balanced expansion of world activity and trade is, at its peak, only 0.2. This relatively low value reflects an elasticity of total exports with respect to world activity of only around 0.6 after 2 years. This implies that, as the world economy expands, the UK loses market share in its export markets, for given competitiveness.

The table below gives the effects of world activity on selected individual categories of exports after 2 years.

Effects of 2% higher world activity on selected categories of UK exports, wages and exchange rate fixed

End second year, differences from base (%)

Manufactures	Services	Fuel	Other*	Total
+1.6	+1.1	+0.1	+0.9	+1.2

* Food, basic materials, SNAPS and SITC9.

Manufacturers come closest to maintaining their market share in a world activity expansion at unchanged competitiveness; however, the movement of the remaining categories of exports drags the UK's overall performance down, (services, in particular, have an elasticity of only one-half which may be too low).

Effects of interest rates

In the model, the effects of interest rates on the economy apart from through the determination of money and the exchange rate are small. The effects of a change in the exchange rate in the model can be large in the short-run (see later). However the uncertainty that surrounds the relationship between interest rates and the exchange rate make it, perhaps, more useful for model testing to separate out the direct effects of interest rates on the model from those through the exchange rate. The simulation considered here then is one in which 1 point is added to the pivotal interest rate (the end quarter Local Authority 3 month rate, RLAE) with the exchange rate and wages fixed at base levels. All other interest rates were allowed to be determined endogenously.

The effects of changing interest rates can be examined under two heads: first, the simulated macroeconomic effects generally, and second, the simulated implications for interest flows within the model. The macroeconomic effects are listed below.

Macroeconomic effects of adding 1 point to the end quarter LA 3 month rate, wages and exchange rate fixed

	Differences from base £1975 million (% in brackets)				Percent	
Quarter	Output	Of which Stocks	Private Residential Investment	Consumers' Expenditure on Durables	Private Residential Investment Deflator	GDP deflator
1	- 1(0)	- 2	- 3(-0.6)	- 1(0)	-0.01	0
2	- 3(-0.01)	- 3	-10(-2.1)	- 2(-0.1)	-0.04	0
3	- 7(-0.03)	- 2	-17(-3.6)	- 5(-0.3)	-0.07	0
4	-11(-0.04)	0	-22(-4.7)	- 9(-0.5)	-0.14	0
5	-16(-0.06)	- 1	-26(-5.4)	-11(-0.7)	-0.26	-0.01
6	-19(-0.08)	- 2	-29(-5.9)	-13(-0.7)	-0.45	-0.01
7	-23(-0.09)	- 3	-31(-6.3)	-12(-0.7)	-0.71	-0.01
8	-26(-0.10)	- 3	-33(-6.7)	-12(-0.7)	-1.05	-0.02
9	-28(-0.11)	- 4	-35(-7.1)	-11(-0.7)	-1.45	-0.03
10	-31(-0.12)	- 4	-37(-7.4)	-11(-0.7)	-1.91	-0.04
11	-33(-0.13)	- 4	-39(-7.8)	-11(-0.7)	-2.42	-0.05
12	-34(-0.13)	- 3	-41(-8.2)	-11(-0.7)	-2.98	-0.07

The reduction in output is mainly due to lower housebuilding. This in turn is a consequence of a fall in house prices which in the model are very sensitive to the level of mortgage rates. The response of stocks to raised interest rates is very small, a simulation property regarded as implausible - especially for 'large' changes in interest rates. This is part of a more general problem in the model where changes in company sector income have implausibly little impact on their expenditure[†]. The higher cost of credit and the greater opportunity cost of holding consumer durables rather than interest bearing financial assets, does however produce some, albeit small, fall in consumers' expenditure on durables.

[†] The latest version of the model incorporates stronger interest rate and liquidity effects on stockbuilding.

The effects on the distribution of income among sectors arise from three main sources: receipts of rent; payments of dividends and interest by domestic sectors to domestic sectors; flows of interest, profits and dividends to/from domestic sectors from/to overseas.

The effect of changing interest rates on interest flows between domestic sectors is set out below.

Effect of adding 1 point to the LA 3 month rate on net interest flows between domestic sectors (before tax), wages and exchange rate fixed

Differences from Base, £ million

Quarter	Public net interest payments*	ICCs' net interest payments	Persons' net interest receipts	Financial companies net interest receipts	of which building societies
1	9	23	19	1	- 6
2	29	72	64	- 3	-19
3	36	101	92	- 9	-25
4	35	105	84	- 1	-24
5	37	110	76	12	-26
6	43	116	79	17	-38
7	51	121	77	30	-30
8	58	126	75	41	-32
9	63	132	78	46	-35
10	68	137	78	55	-38
11	73	144	78	64	-40
12	79	150	82	70	-43

*Includes some change in public sector interest paid abroad.

Although not much credence can be given to the exact magnitudes in the table, industrial and commercial companies can be seen to be substantially worse off; this loss, however, is not in the model translated directly into cutbacks in company spending on either stocks or investment for example and some would argue that this is a shortcoming of the model.

Effects of changes to tax instruments

The two tax simulations considered are a 5 point reduction in the standard rate of income tax, and a 5 point reduction in the rates of VAT. It should be evident by now that in the full model, exogenous stimuli to demand (whatever the source) tend to crowd out other expenditures to some extent although it may be a considerable number of periods before output is returned to its original level[†]. The mechanism is as follows: the initial rise in output produces lower unemployment and thence higher wages; these lead to higher private consumption but this effect is finally outweighed by that of worse competitiveness on trade performance. The exchange rate does not generally depreciate fast enough to fully offset the deterioration in competitiveness.

However, the wage equations incorporate other behaviour which can offset the effects of changes in unemployment. Without this, tax reductions would produce a pattern of model responses on output similar to those for public expenditure increases; the results again would be crucially dependent upon the mix of exchange rate and wage responses. However, if, as in the model, bargainers are assumed to be concerned with the real post tax* wage rather than the pre-tax wage, where real wages are defined in terms of consumer prices, then it is possible through changes in direct and indirect taxes to change the wedge between real take home pay per head, and own product real wages. The former directly affects consumers expenditure, the latter competitiveness and net trade. In the case of tax reductions, this additional wedge permits output to remain above base for a much longer period than for equivalent public expenditure increases.

Income Tax

A simulation in which the basic rate of income tax is reduced by 5 points with only the exchange rate fixed provides an indication of the relative

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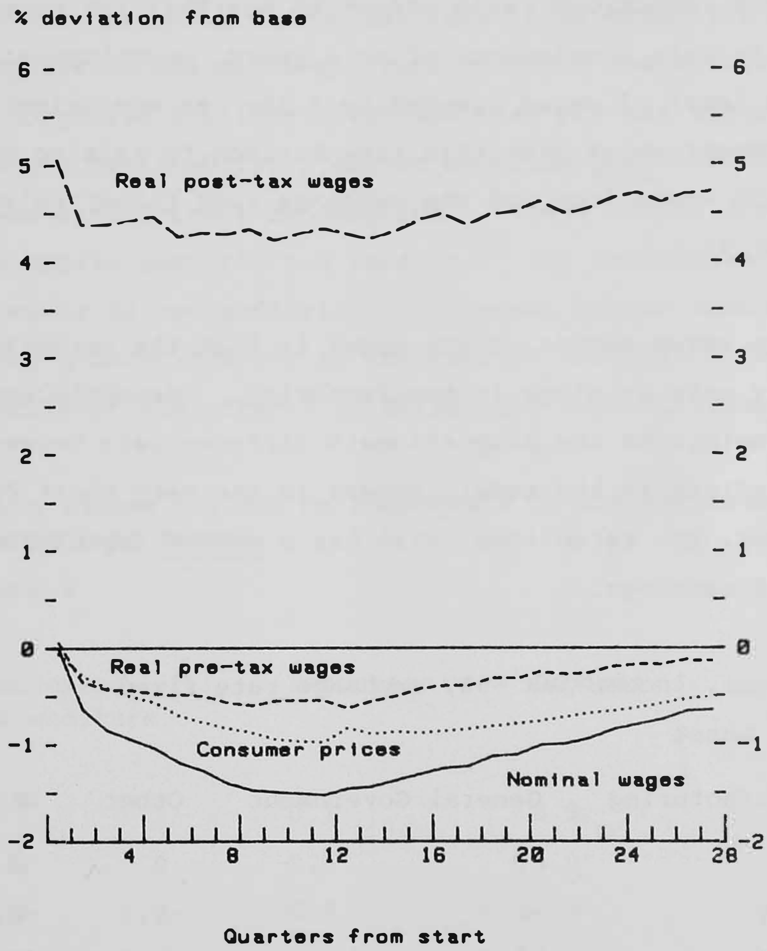
[†] What is not clear is whether cycles are set up and whether a single long run solution exists.

* Tax here includes both income tax and national insurance contributions.

Chart 4

Reducing the basic rate of income tax by 5 points, with the exchange rate fixed



power of the retentions ratio (ratio of net to gross pay) to depress wages growth and that of the Phillips curve to boost it. As chart 4 shows, the retentions ratio effect outweighs the Phillips curve: the economy-wide index of average earnings is reduced below base throughout the simulation. The build-up of this from a 1% reduction in wages after one year to 1.5% after 2 years reflects lags in the manufacturing wages equation (the only wage to respond directly in the model to the retentions ratio) and in the transmission of changes in this wage to other wages in the economy. After the first 3 1/2 years of the simulation, the reduction of wages below base is attenuated by falling unemployment, brought about by both the fiscal expansion and the gains to effective competitiveness made by then.

The power of this retentions ratio offset to the Phillips curve is considerable: in this simulation, after 4 years, unemployment is reduced by 120,000 and the level of wages lowered by 1.3%; an equivalent reduction in unemployment brought about over this time horizon by raising government consumption (with wages free and the exchange rate fixed) raises the level of wages by over 3%.

A feature of the wages sector of the model is that the retentions ratio affects directly only earnings in manufacturing. Nevertheless, the wages sector closely maintains the proportionate differentials between the three main earnings indices in the model, except in the very short run. As the table below shows, the retentions ratio has a system impact then on all three classes of earnings.

Earnings by sector, income tax -5%, exchange rate fixed
Difference from base%

Quarter	Manufacturing	General Government	Other	Whole Economy
1	0	0	0	0
2	-0.9	-0.1	-0.7	-0.6
3	-1.1	-0.4	-1.0	-0.9
4	-1.0	-0.7	-1.0	-1.0
5	-1.0	-1.0	-1.1	-1.1
6	-1.2	-1.2	-1.2	-1.2

The initial effect of reducing the personal direct tax rate is to depress nominal wages below base. Because wages in the model affect domestic prices with a lag, and wages do not have a unit weight in their determination, real pre-tax wages fall also. After 3 years, the Phillips curve starts to dominate the direct tax influence (as well as that of consumer prices falling below base) and nominal wages start to move back towards their base level (although they are still 0.6% below base after 7 years). As prices respond to wages with a lag, then, in this latter phase the losses to real pre-tax wages made previously are increasingly recovered. Real post-tax wages are boosted throughout the simulation by around 4.5%; the offset of taxes on nominal wages is only partial.

In the model, then, the personal direct tax rate is an effective instrument in 'painlessly' depressing nominal wages (which affect competitiveness and, hence, output and corporate profitability) and real pre-tax wages (which again affect corporate profitability) whilst boosting post-tax real wages, which are what feeds into private consumption. These wedges are driven at the expense of the public sector's tax revenue. The improvement in competitiveness however is not sufficient to prevent higher consumers' expenditure inducing a deterioration in the current account. The table below shows the time profile of the effects on output and expenditures.

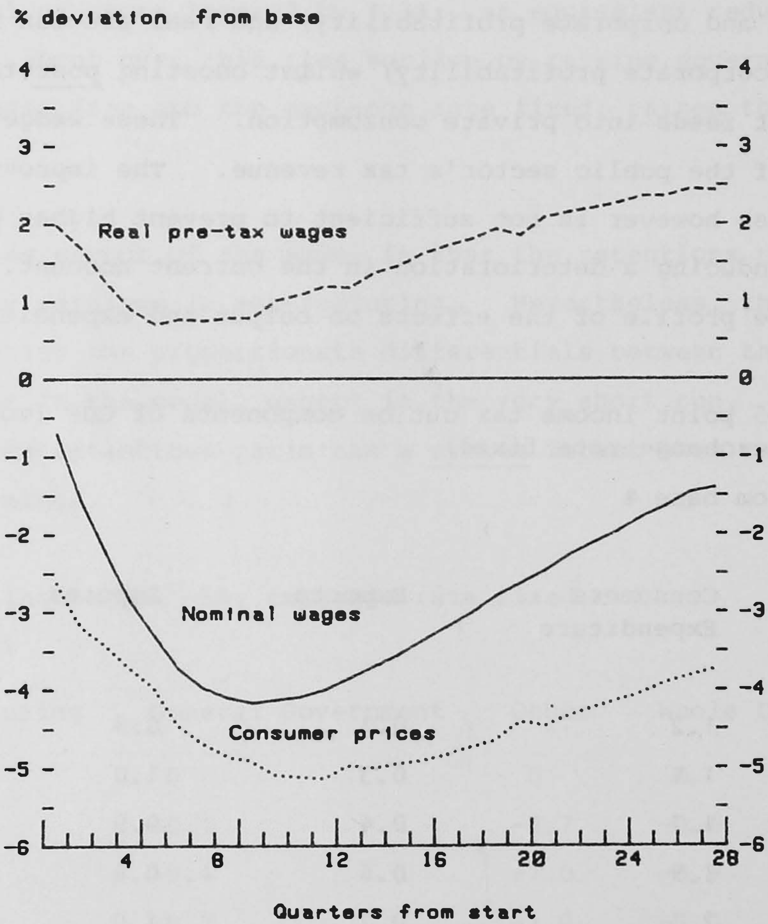
Effects of a 5 point income tax cut on components of GDP (volumes)
(Wages free, exchange rate fixed)

Difference from base %

Quarters	Consumers Expenditure	Exports	Imports	GDP
4	1.2	0.1	0.9	0.5
8	1.5	0.3	1.0	0.7
12	1.7	0.4	0.9	0.9
16	1.9	0.6	0.9	1.0
20	2.1	0.7	1.0	1.1
24	2.3	0.7	1.0	1.1
28	2.4	0.6	1.1	1.1

Chart 5

Reducing the rate of VAT by 5 points, with the exchange rate fixed



If the same simulation is repeated with both wages and the exchange rate fixed, then the real post tax wage rises by around 8%. The rise in persons' real disposable income is however rather similar to that with wages free; in that case, although wages per head are lower, incomes still rise as output and employment are higher. A wages fixed simulation does highlight the rather slow feed through of real incomes to consumer spending, as can be seen from the table below. An approximately step change in RPDI (ex post) takes over 6 years to have its full effect on consumers' expenditure.

Effects of a 5 point tax cut on components of GDP (volumes)
- wages and exchange rate fixed

Differences from base

75 £ mn (%)

Quarters	RPDI	Consumers Expenditure	Imports	GDP
4	520(2.5)	220(1.2)	90(1.0)	100(0.4)
8	480(2.3)	250(1.4)	100(1.1)	130(0.5)
12	470(2.2)	300(1.6)	110(1.1)	150(0.6)
16	470(2.3)	340(1.8)	120(1.1)	170(0.6)
20	500(2.4)	390(2.1)	140(1.2)	190(0.7)
24	500(2.4)	430(2.3)	150(1.3)	210(0.8)
28	510(2.4)	470(2.4)	170(1.4)	220(0.8)

Value added Tax

A simulation in which the VAT rate is reduced by 5 points with wages free (but the exchange rate fixed) provides an indication of the response of nominal and real wages to consumer prices in the model. Chart 5 shows that the initial step fall in the consumer price level due to the VAT cut is followed by a decline in money wages relative to base; subsequently prices fall further again followed by wages. As a result the 1% rise in the real wage established by the third quarter of the simulation is roughly maintained during the next three years.

Changing the VAT rate in itself has rightly no direct effect on competitiveness in the model which depends, for given sterling world prices, on nominal UK labour costs. The fall in these generates an improvement in net trade which, together with the boost to RPDI coming from a higher real wage generated by lower consumer prices, produces a rise in output of some 1.6% after three years. This reduces unemployment and puts upward pressure on the nominal and real wage: after five years, the real wage is 2% above base, compared with 1% after three.

Effects of 5 point VAT rate cut on components of GDP
(wages free, exchange rate fixed)

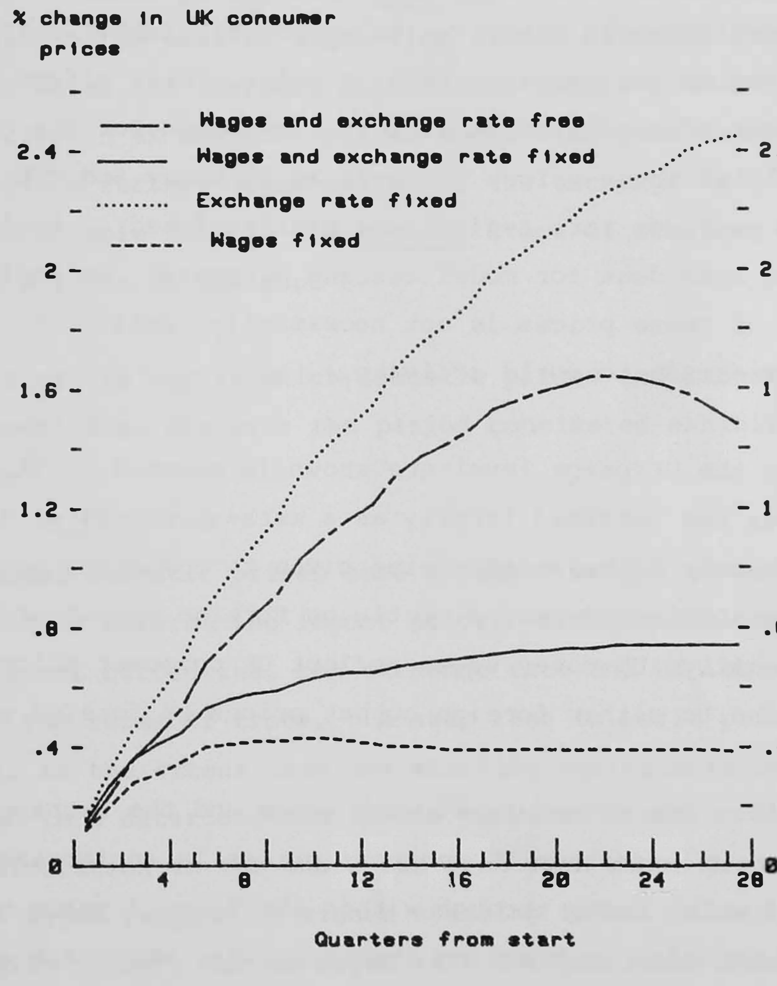
Difference from base %

Quarters	Consumers' Expenditure	Fixed Investment	Exports	Imports	GDP
4	1.5	0.5	0.2	1.0	0.9
8	1.9	1.3	0.6	1.2	1.4
12	1.9	1.4	1.0	0.8	1.6
16	2.0	0.9	1.4	0.6	1.7
20	2.1	0.7	1.5	0.5	1.7
24	2.2	0.6	1.5	0.6	1.7
28	2.3	0.5	1.2	0.7	1.6

[Note Investment receives a substantial boost in the VAT simulations whereas it apparently does not in the income tax simulations. In both simulations, there are ex ante pressures for interest rates to rise. Higher mortgage rates would in the model lead to lower house prices, and lower residential investment. Indeed, this is what happens when the rate of income tax is cut - the effect on mortgage rates being amplified post tax by an implied reduction in the mortgage subsidy. However, in the VAT simulations, the overall impact lowering wages and prices is sufficient to produce lower nominal interest rates ex post and this sets up the reverse pattern of higher house prices and more residential investment. These effects may be too big; they dominate the effects of the change in output on non-residential investment.]

. Chart 6

2% higher world costs & price - inflation effects



World price simulations

A wide variety of world prices are identified in the model. These are: world unit labour costs (WULC), the prices of world manufactured exports (PXWM) and of 'competing exports' (PCOM), the price of crude oil (PFO$), an index of CAP food prices in terms of European Units of Account (PCAP), and four UN commodity price indices [those of food (UNFD); non-food agricultural products (UNAN); metal ores (UNMO) and non-ferrous metals (UNME)]. In addition, for use in the exchange rate sector of the model, three variables designed to measure monetary conditions in the United States are included: a measure of the US money stock (M2US); the US consumer price deflator (PCUS); and US TFE at current prices (EFUS).

These world prices impinge on the model via import and export deflators, by affecting competitiveness directly (as world unit labour costs does), and by directly bearing on the exchange rate. Below, their effect on the UK price level, the terms of trade and UK output is examined for the case of a 2% step increase in all of these prices (as well as US money and TFE). All four wage and exchange rate regimes are distinguished. Again, this simulation has been done for model testing purposes: an equiproportionate change in all of these prices is not necessarily 'realistic' and no adjustments were made to world activity.

The effects on the UK price level are shown in chart 6. In the model domestic prices are obtained largely as a mark-up on <u>costs</u>, (domestic and imported) with only a low weight being given to competing prices. Hence, UK output prices do not depend directly on foreign output prices in a common currency. Equally, UK money wages reflect UK consumer prices and are not directly related to either foreign output prices or foreign wages.

When world prices are raised by 2% with wages and the exchange rate fixed then, the long-run effect on UK consumer prices is an increase of only around 0.75% (most of which comes through within the first 3 years of the simulation). This reflects the rise in sterling import prices, which are amongst the cost terms driving domestic deflators.

With the exchange rate free, the long-run effect on UK consumer prices is halved, reflecting an appreciation of the rate during the first 3 years of the simulation. This is caused by the 2% increase in US consumer prices, money and TFE at current prices imposed at the start of the simulation. Although these changes do not directly alter the equilibrium effective exchange rate, they do lead to upward pressure on the rate.

Freeing just wages produces a much larger effect on UK prices. After the first 4 1/2 years of the simulation, the UK price level is more than homogenous in the world price level. This effect is largely a consequence of higher activity lowering unemployment and raising wages via the Phillips curve.

The profile of UK consumer prices with both wages and the exchange rate free is similar to that in the case of wages free alone, although the exchange rate appreciation mutes the increase in consumer prices somewhat. The downturn in the rise in UK consumer prices above base towards the end of the simulation reflects a further appreciation of the exchange rate due to a particularly questionable fall in the nominal stock of sterling M3 below base in the last 2 years of the run.

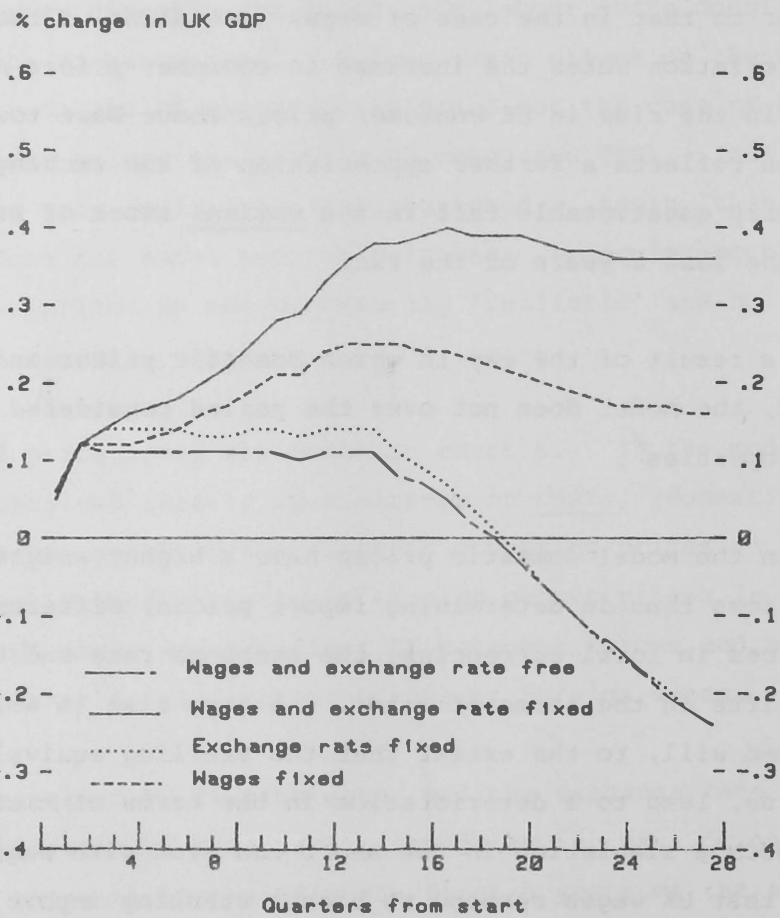
Thus, as a result of the way in which domestic prices and labour costs are specified, the model does not over the period considered exhibit 'law of one price' properties[†].

Because in the model domestic prices have a higher weight in determining export prices than in determining import prices, differential movements in world prices in local currencies, the exchange rate and UK labour costs will set up shifts in the terms of trade. A step rise in world prices with UK wages fixed will, to the extent that the sterling equivalents of world prices rise, lead to a deterioration in the terms of trade. The same is true of such a simulation in the short run even with wages free (reflecting the fact that UK wages respond to higher sterling import prices only indirectly and with a lag), but as wages rise further above base, the position is reversed, and the terms of trade recover. This is illustrated in the table below.

[†] It may in the long run as wages overshoot and output is pushed back towards base levels.

Chart 7

2% higher world costs & prices - output effects



Terms of trade (goods and services) in 2% step increase in world prices simulations

Differences from base (%)

Years	Wages and exchange rate fixed	Exchange rate fixed	Wages fixed	Wages and exchange rate free
1	-0.4	-0.4	-0.3	-0.3
2	-0.4	-0.3	-0.3	-0.3
3	-0.4	-0.2	-0.3	-0.2
4	-0.4	-0.1	-0.3	-0.1
5	-0.4	0	-0.3	0
6	-0.4	0	-0.2	0

The effects of a 2% step change in world prices on output are shown in chart 7. The impact effect of this change is a gain to competitiveness. This arises directly via higher world unit labour costs (WULC) in the equations for exports of manufactures (XGMA) and imports of finished manufactures (MGFM). There are also improvements in export price competitiveness which in the model is important for services credits. Import price competitiveness also benefits initially. These relative price movements arise from the less than unit weight given to world prices in domestic output prices and most export deflators, as well as the lags between these prices and world prices.

In the wages and exchange rate fixed case, a steady rise in output above base is produced for the first 4 years of the simulation, reflecting the long lags in the model between changes in actual and effective competitiveness (and the much shorter lags between world prices and trade deflators). A broad plateau in the effect on output is subsequently attained. A similar profile is evident when the exchange rate is free, but with a lower boost to output at each point, reflecting the appreciation in the exchange rate in the first 3 years of the simulation. When wages are free, the response of output is similar whether the exchange rate is free or not, with the initial boost to competitiveness being eroded as UK wages respond to both prices and higher output. As in the public expenditure simulations, the slow adjustment of employment to output ensures that wages overshoot and output is eventually pushed below base.

In the model, the exchange rate is used to convert world prices into sterling equivalents. This implies that a given proportionate increase in world prices with the exchange rate fixed is roughly equivalent to an equiproportionate depreciation of the exchange rate. World price simulations are, however, more interesting from a model testing viewpoint since they allow runs to be undertaken in which the exchange rate is endogenously determined.

CHAPTER III LINEARITY OF THE MODEL

A thorough examination of the linearity and symmetry properties of the model would involve shocking a fairly exhaustive set of exogenous variables, one at a time with shocks varied with respect to both size and sign. This would generate a huge volume of results. A more limited exercise, concentrating on responses to changes in the income tax rate, is reported here. The income tax rate was chosen because it has both demand and supply side effects within the model and should be a convenient single tool for the investigation of linearity.

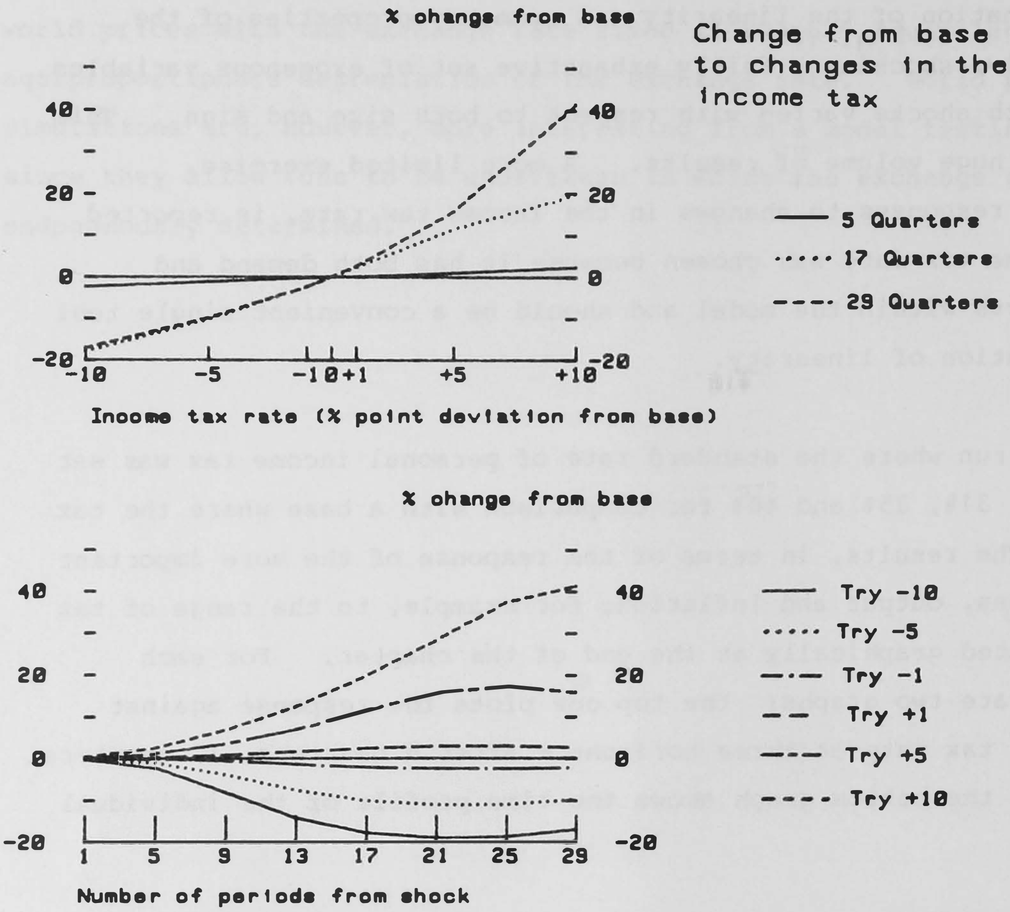
Simulations were run where the standard rate of personal income tax was set at 20%, 25%, 29%, 31%, 35% and 40% for comparison with a base where the tax rate was 30%. The results, in terms of the response of the more important economic aggregates, output and inflation, for example, to the range of tax rates, are presented graphically at the end of the chapter. For each aggregate, there are two graphs: the top one plots the response against the change in the tax rate at three horizons - after 5 quarters, 17 quarters and 29 quarters; the bottom graph shows the time profile of the individual responses[+].

In the simulations both wages and the exchange rate sectors were endogenous. The exchange rate sector, in particular, is likely to produce non-linearities; but this sector and that which determines sterling M3 are areas of the model that are frequently overriden. The responses of the exchange rate (effective rate EER), interest rates (banks base rate RCBR) and sterling M3 (KM£S) are shown first. To the extent that non-linearity is present, it becomes most apparent towards the end of the simulations (after 5 years or so). Asymmetric responses are most striking in the exchange rate sector*. These are not present in the response of sterling M3 though, suggesting that the imposed public sector reaction functions for intervention and interest rates are mostly responsible.

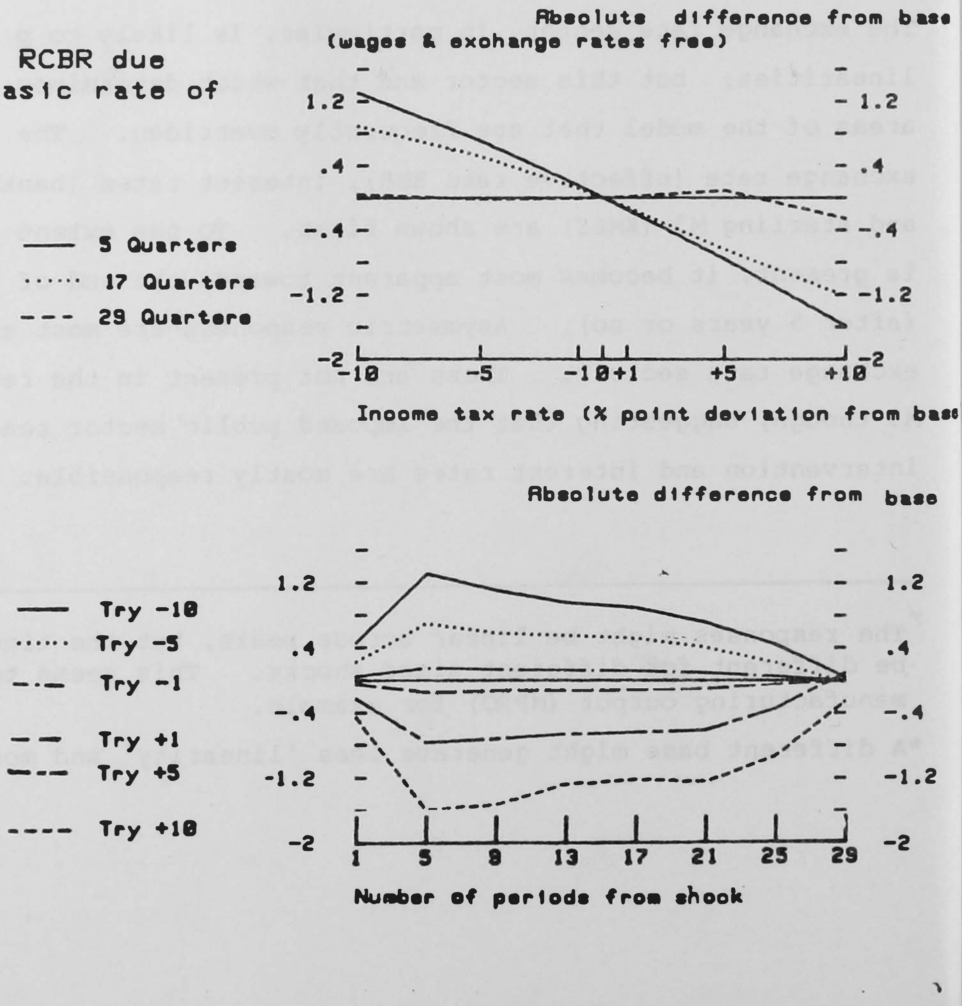
[+] The responses might be linear across peaks, but the time profiles might be different for different sized shocks. This seems to be the case for manufacturing output (MPRO) for example.

*A different base might generate less 'linearity' and more 'symmetry'.

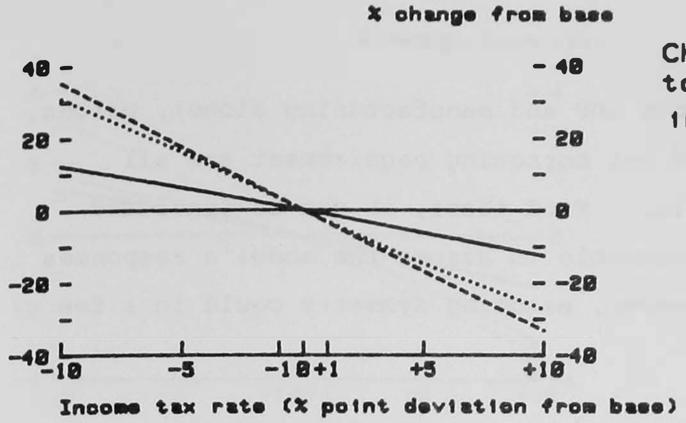
Change from base for EER due to changes in the basic rate of income tax

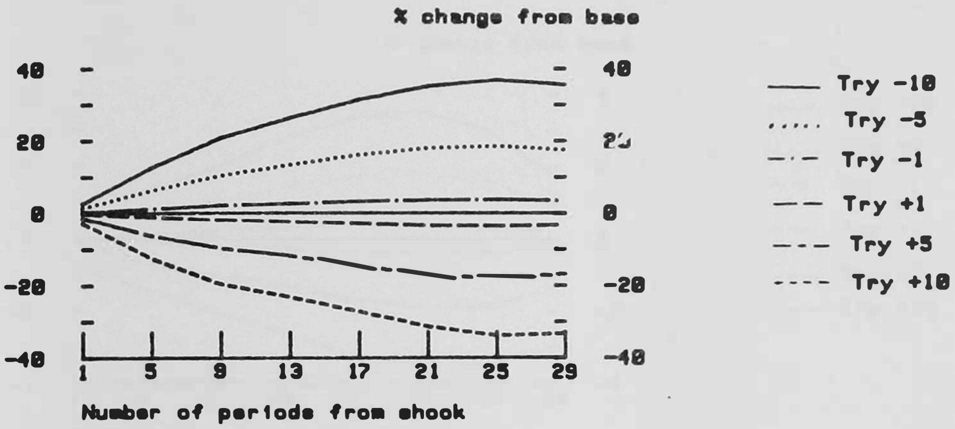


Change from base for RCBR due to a change in the basic rate of income tax

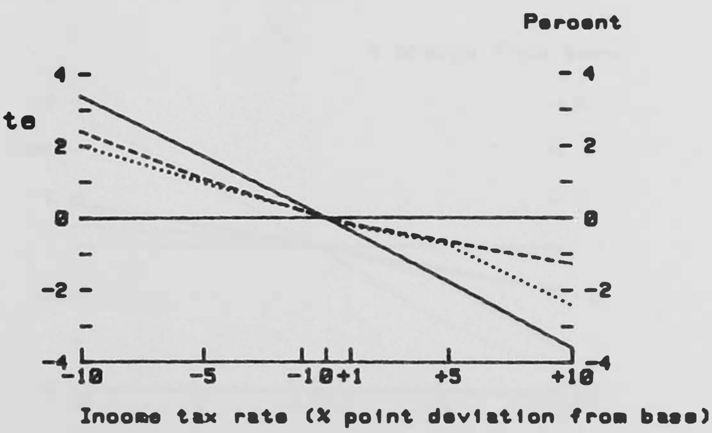


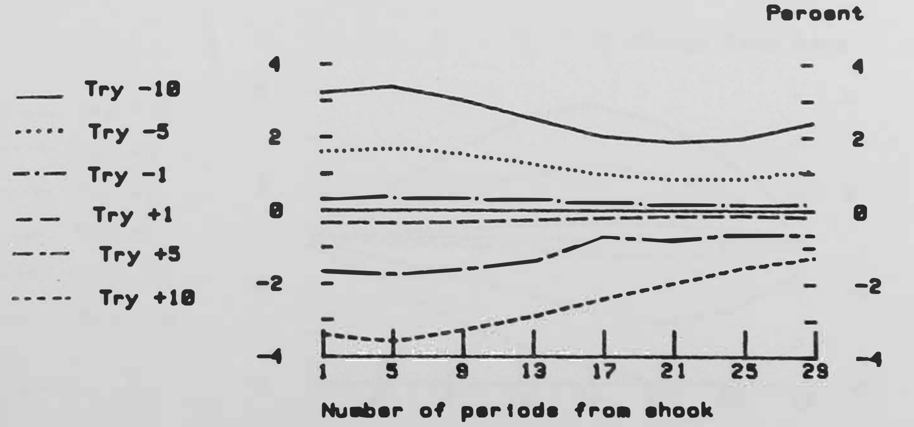
Change from base for KM£S due to changes in the basic rate of income tax





Change from base for PSBR (% of GDP) due to a Change in the income tax rate

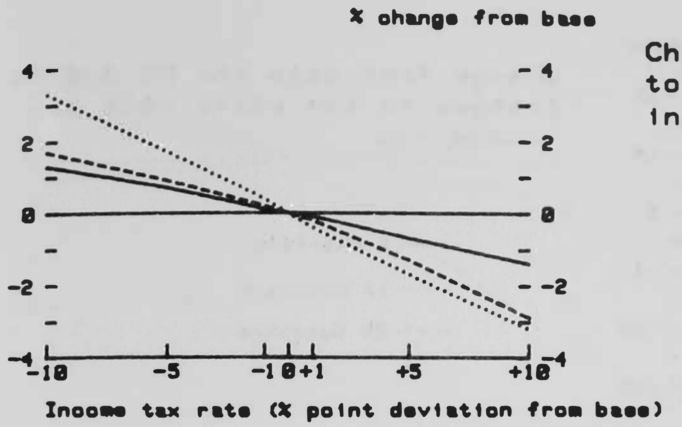


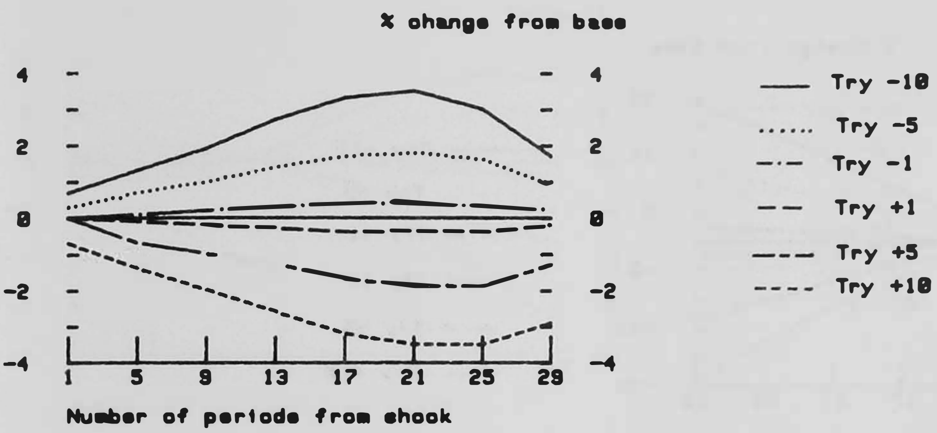


Asymmetry can also be seen in the response of the PSBR, but this is probably associated with the exchange rate asymmetry and its consequence for oil taxes.

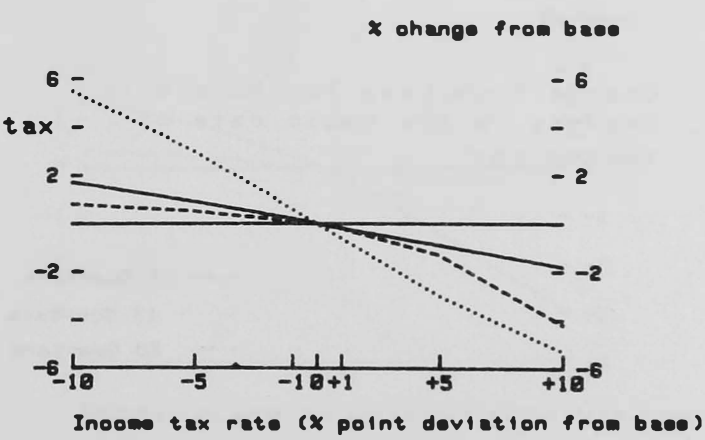
Finally, the response of output (both GDP and manufacturing alone), prices, wages, the current balance and ICCs net borrowing requirement are all broadly linear and broadly symmetric. From these, it can be concluded that, for many variables, it is reasonable to assume the model's responses to be linear in the short-run; however, assuming symmetry could in a few instances be misleading.

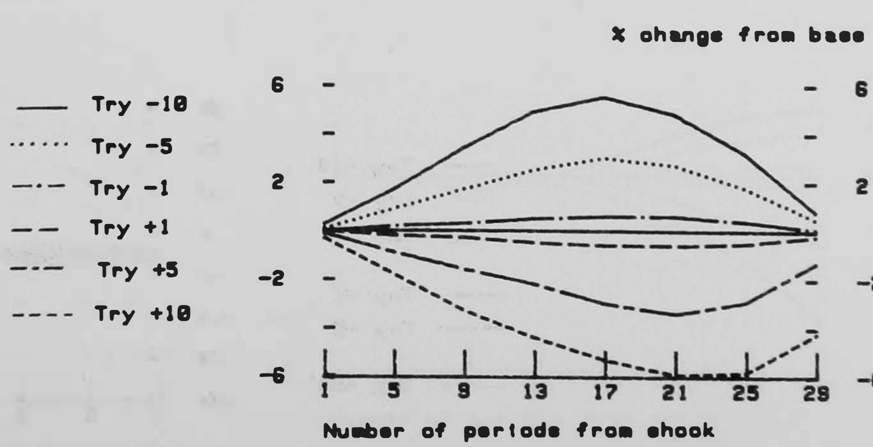
Change from base for GDPE due to changes in the basic rate of income tax



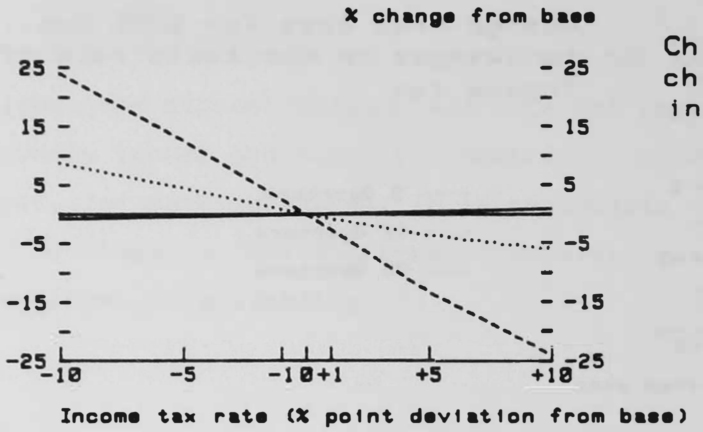


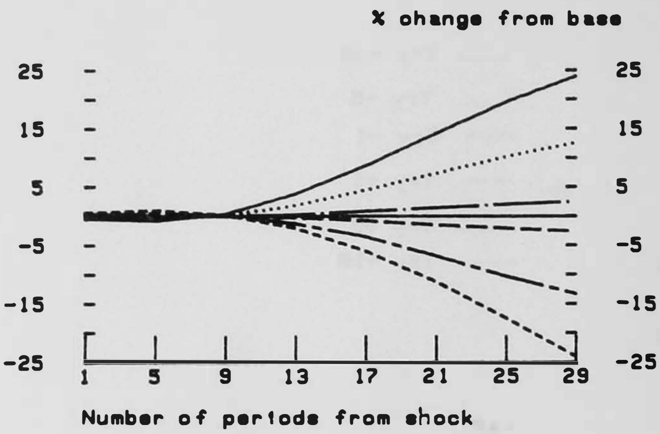
Change from base for MPRO due to changes in the basic rate of income tax



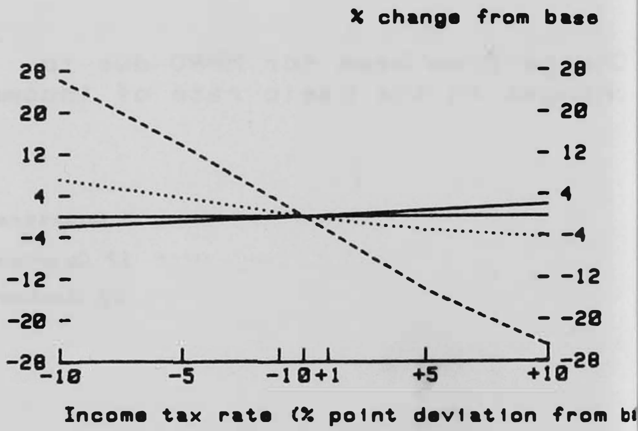


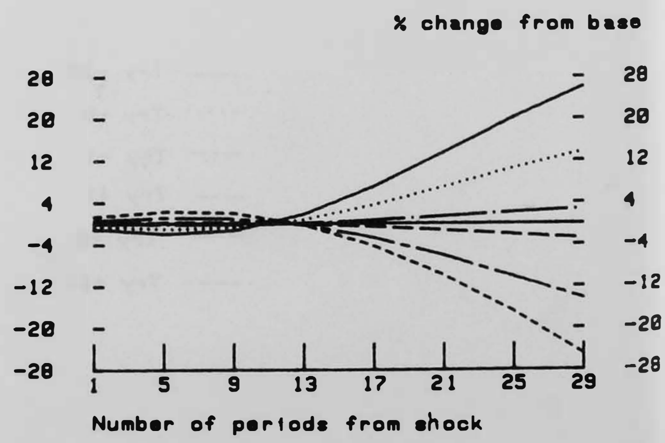
Change from base for PC due to changes in the basic rate of income tax



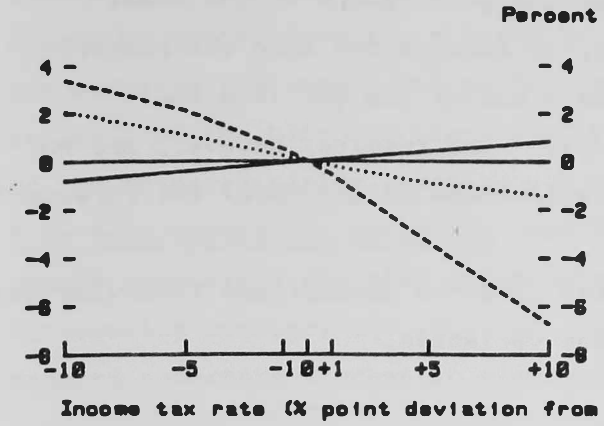


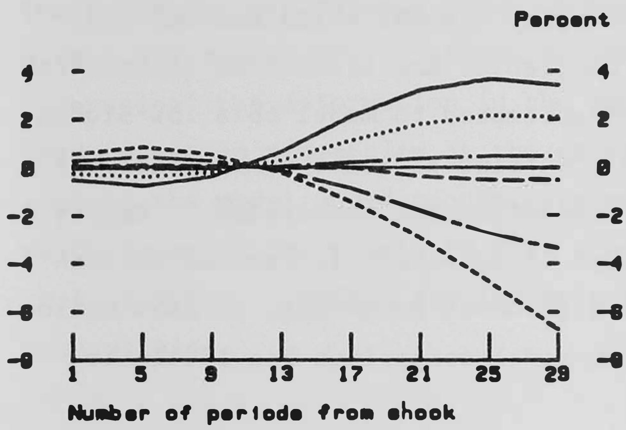
Change from base for WS due to changes in the basic rate of income tax



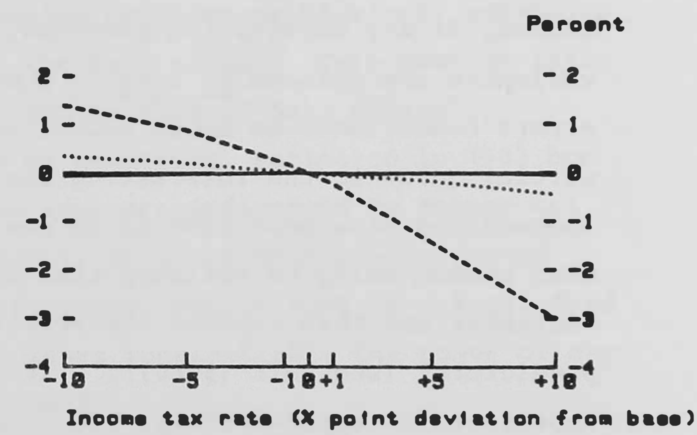


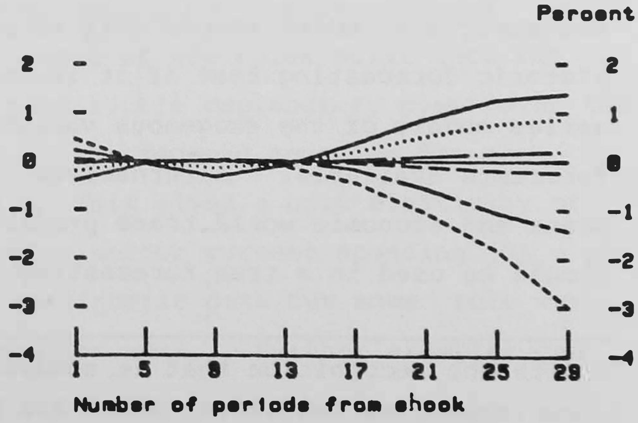
Change from base for BAL (% of GDP) due to a change in income tax rate





Change from base for INBR (% of TFE) due to a change in income tax rate





CHAPTER IV HISTORIC TRACKING

Introduction

This section discusses the historic tracking performance of the model between 1974 and 1982. Used carefully, an examination into the historic tracking performance of a model can give a useful insight into the development of system errors in the model. The results, however, are not likely to indicate much about the appropriateness of the model for forecasting.

The main limitations of the approach stem from the assumptions regarding the nature and determination of the exogenous variables.

First, it is clear that models with different degrees of exogeneity cannot be compared by this technique. For example, a model which assumed that stockbuilding was exogenous is likely to predict the historical outturn for GDP much more accurately than one which attempted to model this low signal high noise series, yet the latter model contains at least some additional information which might be useful in forecasting and simulation. Hendry and Richard (1982) have argued that, even if agreement is reached between rival modellers over which variables are strongly exogenous, an examination of dynamic tracking errors as a guide to model comparison has little to commend it.

Second, in any forecasting exercise, the future values of the exogenous variables are unknown ex ante. Consequently an examination of system errors conditioned on known values of the exogenous variables acts as only a partial guide to the forecasting characteristics of the model. Various suggestions have been made as to how this difficulty might be overcome, the most common being to estimate time series models for all the exogenous variables and then replace the actual values of the variables by time series predictors* (see Fair (1980)). If the model is linear (as the Bank model appears to be approximately, see Chapter III), then this translation turns the whole model into a large time series model, and consequently the structural model should only outperform a time series model on an historic forecasting test if it is nonlinear (see McNees (1979)). But time series models of the exogenous variables are not necessarily the best forecasts available. Alternatives, such as published public expenditure plans and economic world trade projections may be better. It is these that should be used in a true forecasting test.

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* With the recognition that is somewhat inappropriate for some policy variables, eg tax rates, which are best left at their historic values.

The stochastic nature of economic time series is also important. In the present study, the stochastic part of the economic model was ignored. Theoretically, this is incorrect - in a time series forecasting model if no errors or innovations are allowed to enter the historic simulation, then if the model is stationary the projections will simply tend to the mean of the series, and the historic track will eventually explain none of the variance of the observed series, even though the time series model may well be the true data generating mechanism (see Hendry and Richard (1982)). This result emphasises the need for stochastic simulations if true estimates of forecasting accuracy are required (see Fair (1980)). No attempt has been made to undertake stochastic simulations on the Bank model.

There are further caveats too. A historic tracking exercise carried out within the sample period of the estimation of the model runs the risk of 'overusing' the information in the data - if extensive regard may have been paid to system properties at the estimation stage. A more powerful test of the model would concentrate more heavily on out of sample performance of the model, to give a better guide to predictive accuracy (Fair (1980)). Models are far more likely to break down out of sample than within.

Even if historic tracking is reserved for periods formally outside sample, a similar caveat may remain. The forecasting performance of single equations is typically checked on ex post data in the Bank model. Care must be taken then to avoid what Fair describes as a "subtle form of data mining", whereby, for example, the specification of equations, estimated in 1982 but over an estimation period ending in 1979 say, are influenced by recent out of sample experience. In building a model, it seems sensible to accord some weight to recent out of sample performance, but it must be acknowledged that using the data in this manner diminishes substantially the power of any ex post simulation checks on the whole model.

Furthermore, models are often designed primarily for forecasting and simulation exercises over the future. Some of the rules built into the model for these purposes are known to have little explanatory power over the past. An example from the Bank model is the imposed equation for non-trading public sector employment (LEG). This gives a unit elasticity of changes in employment to changes in public sector current spending (G) - no stable relationship could be found using historic data but some rule was judged to be better than none for simulation work. Further examples can be found in the modelling of the fiscal system, which is designed to incorporate only the essential features of the current tax regime - keeping details of several previous tax systems on the model can be costly in terms of maintenance and understanding of the whole model.

Finally, models designed and validated over historical periods may be poor guides for future behaviour if there is then a substantial shift in the determination of the exogenous variables (particularly policy variables) outside the scope of the model.

Methodology

Dynamic simulations were run on four different versions of the model from the first quarter of 1974 to the second quarter of 1982. The simulations were then replicated starting in the first quarter of each succeeding year, until the first quarter of 1981 - thus eight simulations were available for one to six step ahead forecasts, seven for seven to ten step ahead and six for eleven to fourteen step ahead forecasts. Summary statistics for the forecasting errors of key variables in the model were then calculated. An examination of the one step ahead error variances was also undertaken for different versions of the model, using the whole available set of thirty four one step ahead errors. The system errors were compared with the single equation errors for several key variables.

The simulations were done with all the single equation static residuals set to zero. Given that in forecasting and policy simulation exercises, residuals or 'constant adjustments' are frequently applied to behavioural equations to reflect known deficiencies in the model, setting residuals to zero in this manner overstates the difficulty the model might have in tracking the past. An alternative methodology would be to incorporate some judgmental residual setting rule, such as the average of the past eight static residuals (as in Artis 1982) but this was not done. Dummy variables were, however, retained - arguments can be made both ways for the validity of this assumption. In the few cases where autocorrelated error structures are incorporated in the model, they were substituted out by taking the appropriate transformation of the variables included in the equation.

As stressed in the previous section, all the results of a dynamic tracking exercise are conditioned on the exogenous variables. In the Bank model, these are mainly world variables - world trade, oil prices, commodity prices and foreign interest rates - and public sector variables - public expenditure and tax rates. However, given both the difficulties in estimating stable equations for the exchange rates and wages, and their importance in the determination of the system properties, it was decided to undertake the tracking exercise on versions of the model with these exogenous as well as on the full model. // In practice, solving the full model dynamically from 1974 Q1 resulted in it failing to solve by 1980 (the price expectations series in the interest rate equation were driven so far off track that interest rates came out far below their historical outturn and an explosive rise in house prices was triggered[ø]). Housing apart, the effects of interest rates on the model are weak, and the need to exogenise price expectations, as the results confirmed, was not considered to be important. The four versions of the model considered were therefore:

Model 1	Full model
Model 2	Model 1 but with price expectations exogenous
Model 3	Model 2 with the exchange rate sector exogenous also
Model 4	Model 3 with, in addition, the wages sector exogenous

Results

This section is divided into three parts: the first outlines briefly the properties of the system when simulated one step at a time; the second looks at the tracking performance of the model when simulated over various subperiods of the available dataset; and the third describes the dynamic track of the model over the whole historic period from the first quarter of 1974 to the second quarter of 1982.

One period results

Equations are typically selected for models on the basis of their statistical performance over some historical estimation period, together

[ø] However the model now appears more stable than in the previous historic tracking exercise on the Bank model. (Brierley [1979]).

TABLE 1: A comparison of one step ahead single equation errors and system errors for major variables* - 1974:1 to 1982:2

	Single Equation		Full System	
	Mean percentage error (MPE)	Root Mean Square percentage error (RMSPE)	MPE	RMSPE
Consumer spending:				
Non-durables (CND)	0.1	0.6	-0.1	0.7
Durables (CD)	-0.7	3.8	-1.0	4.1
Total (C)	0	0.7	-0.2	0.8
Fixed investment:				
Private industrial (IND)	2.6	4.3	2.9	4.6
Private residential (IHP)	0.5	8.0	0.5	7.9
Total (IF)	1.2	2.1	1.3	2.2
Stockbuilding (II)	-62* (-0.2)≁	215* (0.9)≁	-70* (-0.3)≁	264* (1.1)≁
Exports:				
Manufactured goods (XGMA)	-1.1	3.9	-1.0	3.9
Oil (XG2)	19.0	31.3	23.0	37.7
Total (X)	0.4	3.2	0.4	3.1
Imports:				
Finished manufactures (MGFM)	-2.3	7.1	-5.0	15.5
Semi manufactures (MGSM)	-3.0	6.0	-3.7	7.0
Oil (MG2)	13.0	20.7	14.7	25.1
Total (M)	0.1	2.7	-0.9	4.9
Factor Cost Adjustment (FCA)	3.8	5.1	2.9	4.5
Gross Domestic Product (expenditure measure) (GDPE)	-0.3	1.3	-0.1	1.5
Wholesale output price in manufacturing (PIMO)	-0.2	0.8	-0.4	1.0
Non durable consumers' expenditure deflator (PCND)	0.4	1.2	-0.1	1.3
Average earnings in manufacturing (WAEM)	-1.3	2.4	-1.3	2.5
Pressure on the exchange rate (PERK)	-0.5ø	5.3ø	-0.5ø	5.8ø
Three month local authority interest rate (end quarter) (RLAE)	0.3ø	2.5ø	-0.2ø	2.4ø

* Mean error and root mean square error (£75 million).

≁ As % of mean GDP.

ø Mean error and root mean square error (% points).

TABLE 2: A comparison of one step ahead system errors under different assumptions of exogeneity 1974:1 to 1982:2

Model	Full model 1 1		2 1 + Price expectations exogenous		3 2 + Exchange rate sector exogenous		4 3 + Wage sector exogenous	
Variable[(a)]	MPE	RMSPE	MPE	RMSPE	MPE	RMSPE	MPE	RMSPE
C	- 0.2	0.8	- 0.2	0.8	- 0.2	0.8	- 0.2	0.8
IF	1.3	2.2	1.2	2.2	1.2	2.2	1.3	2.3
II	-70Ø	264Ø	-73Ø	264Ø	-64Ø	244Ø	-63Ø	244Ø
X	0.4	3.1	0.4	3.1	0.4	3.1	0.4	3.1
M	- 0.9	4.9	- 1.0	4.9	- 0.9	4.8	- 0.8	4.6
FCA	2.9	4.5	2.9	4.5	2.9	4.5	2.9	4.5
GDPE	- 0.1	1.5	- 0.1	1.6	0	1.6	- 0.1	1.5
Effective exchange rate (EER)	- 0.5	2.4	- 0.5	2.4	-	-	-	-
PIMO	- 0.4	1.0	- 0.4	1.0	- 0.4	1.0	- 0.3	0.9
Consumers' expenditure deflator (PC)	- 0.2	1.3	- 0.2	1.3	- 0.2	1.3	0.0	1.0
Average earnings (WS)	- 0.5	1.6	- 0.5	1.6	- 0.6	1.6	-	-
Total employment (LE)	4*	70*	4*	70*	5*	69*	4*	72*
RLAE	- 0.2/	2.4/	0.4/	2.2/	0.3/	2.5/	0.3/	2.5/
Stock of Sterling M3 (KM£S)	- 2.9	7.0	- 2.3	6.9	- 2.2	6.9	- 2.2	7.0

(a) See Table 1 for description of variables

* Thousands

/ Mean error and RMSE (% points)

Ø Mean error and RMSE (£75 million)

with an analysis of their theoretical properties. If the estimation technique chosen is a limited information or single equation technique, as is almost always the case, then no attention is paid to system efficiency, as would occur naturally if a 3SLS or SURE type estimator were used. Consequently, it is useful to examine the performance of the system and to compare the results with those obtained in estimation one equation at a time. Using different versions of the model with different degrees of exogeneity indicates how single equation errors in the exchange rate and wages sectors for example feed through to the rest of the model.[†]

Whereas it is relatively easy to compare the single equation static errors and system errors for variables which are the subject of an estimated equation, it is more difficult at the level of aggregate variables derived by identity such as GDP. To examine how successful GDP is tracked in a "single equation" sense, it is necessary to construct the "single equation" residual by summing the static residuals on all the component equations, but this procedure implies ignoring any relationships there may be between the errors on the individual demand component equations (see Chapter V).

Table 1 gives summary statistics for the system and single equation errors for the major behavioural equations in the model, and for the expenditure components of GDP. Table 2 shows how the system properties vary under different assumptions of exogeneity.

With the exception of imports, the results in Table 1 indicate a marked similarity between the one step ahead single equation and system errors. The system results have larger root mean square errors than the single equation ones, but the difference is generally not very great. The system error variance depends on the error variances of the individual equations and the covariance between them. Contemporaneous correlations between the single equation residuals are examined in Chapter V. The results here tend to indicate that the consequences of these correlations are small.

[†] Clearly other sectors could be made exogenous.

Two features of the results in Table 1 are noteworthy. First, the allocation of demand for finished manufactured goods between imports (MGFM) and domestic output (MPRM), performs much worse when the model's projections of demand rather than actual demand is used. This result is not surprising, given the complexity in modelling this area, in particular, the shortcomings of the data≠. Second, although the single equation estimate of the consumer price level for given wages, manufacturing prices and the exchange rate, tends to underpredict, the opposite is the case in the system, as wholesale prices and wages are overpredicted.

Turning to Table 2, the one step ahead system errors appear little affected by the errors in the exchange rate and wages sectors. This result tends to confirm the results from Table 1, and both suggest that to reduce the system variance further it is necessary to improve the properties of the other key behavioural equations. It should be noted that there are common sense limits on how far the minimum error variances can be pushed - care must be taken to avoid 'overfitting' equations. This is a matter of judgment, but one factor which needs to be borne in mind is the volatility of the series under scrutiny*. For example, given that consumer spending on durables tends to be much more erratic than expenditure on non-durables, the minimum variance could be expected to be somewhat higher.

Multiperiod results

The results for the multiperiod tracking performance of the model are shown in charts 1 and 2. Each graph shows the average root mean square percentage error for the first five quarters of each dynamic simulation, together with the average nine and thirteen step ahead errors. These averages were taken from the results of six simulations starting in the first quarter of each year from 1974 to 1979. They were calculated for three of the versions of the model referred to earlier.

≠ The errors in reconciling the expenditure and output measures of GDP feed into the model here.

* Equally, should we really expect to model an economic variable any better than the CSO would claim that their statistics measure it?

Chart 1

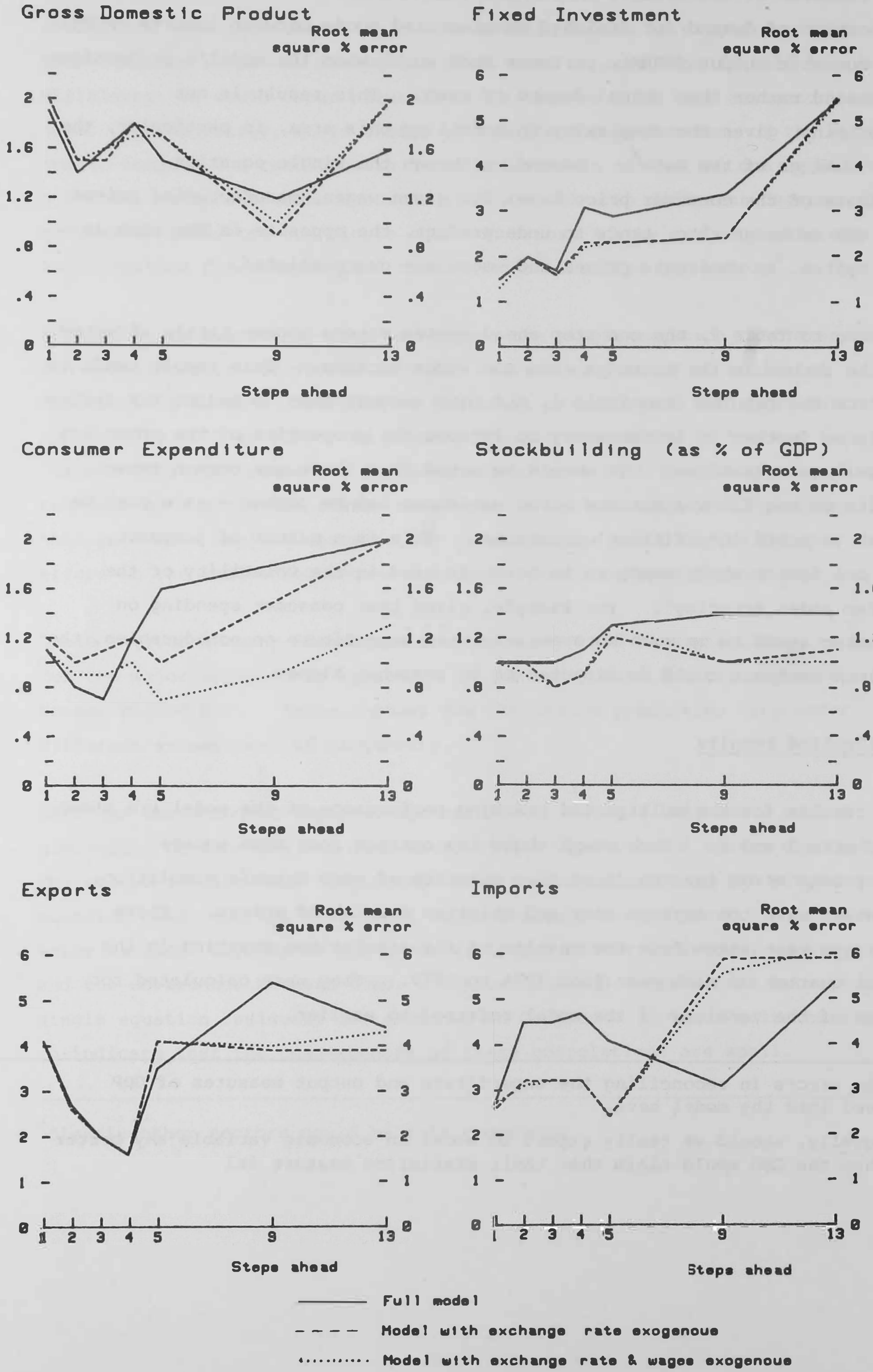
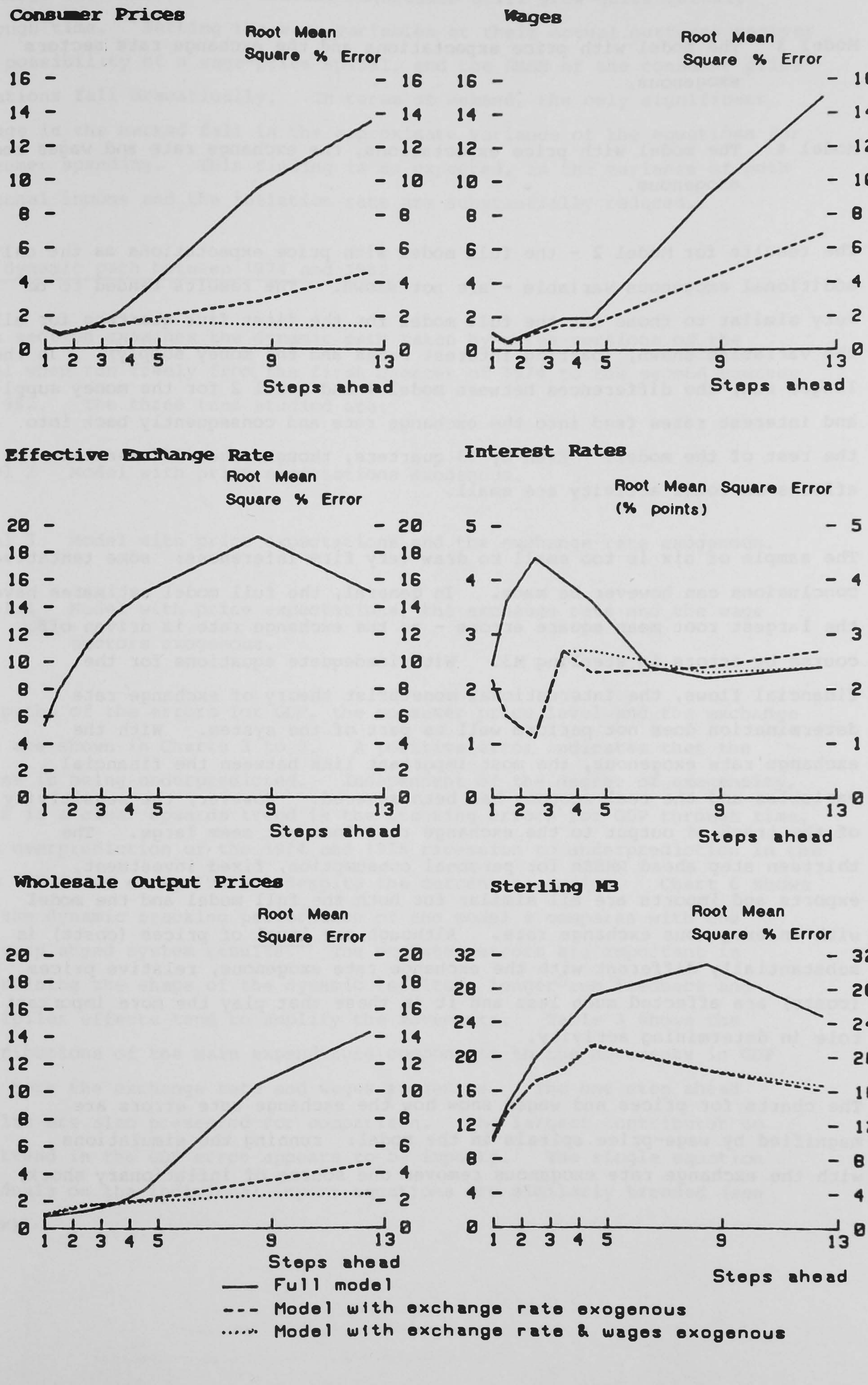

Gross Domestic Product
Root mean square % error
Steps ahead
Fixed Investment
Root mean square % error
Steps ahead
Consumer Expenditure
Root mean square % error
Steps ahead
Stockbuilding (as % of GDP)
Root mean square % error
Steps ahead
Exports
Root mean square % error
Steps ahead
Imports
Root mean square % error
Steps ahead
Full model
Model with exchange rate exogenous
Model with exchange rate & wages exogenous

Chart 2


Consumer Prices
Root Mean
Square % Error
Wages
Root Mean
Square % Error
Steps ahead
Effective Exchange Rate
Root Mean
Square % Error
Interest Rates
Root Mean Square Error
(% points)
Steps ahead
Wholesale Output Prices
Root Mean
Square Error
Sterling M3
Root Mean
Square % Error
Steps ahead
Full model
Model with exchange rate exogenous
Model with exchange rate & wages exogenous

Model 1 Full model

Model 3 The model with price expectations and the exchange rate sectors exogenous.

Model 4 The model with price expectations, the exchange rate and wages sectors exogenous.

The results for Model 2 - the full model with price expectations as the only additional exogenous variable - are not shown. The results tended to be very similar to those for the full model for the first five quarters for all the variables shown, (barring interest rates and the money supply). In the longer run, the differences between model 1 and model 2 for the money supply and interest rates feed into the exchange rate and consequently back into the rest of the model. Even by 13 quarters, though, the differential effects on total activity are small.

The sample of six is too small to draw very firm inferences; some tentative conclusions can however be made. In general, the full model estimates have the largest root mean square errors - as the exchange rate is driven off course by errors in sterling M3. With inadequate equations for the financial flows, the international monetarist theory of exchange rate determination does not perform well as part of the system. With the exchange rate exogenous, the most important link between the financial variables and the real economy has been severed. However, the sensitivity of the track of output to the exchange rate does not seem large. The thirteen step ahead RMSEs for personal consumption, fixed investment, exports and imports are all similar for both the full model and the model with an exogenous exchange rate. Although the level of prices (costs) is substantially different with the exchange rate exogenous, relative prices (costs) are affected much less and it is these that play the more important role in determining activity.

The charts for prices and wages show how the exchange rate errors are magnified by wage-price spirals in the model: running the simulations with the exchange rate exogenous removes one source of inflationary shock, although the RMSEs of the nominal magnitudes still grow quite quickly through time. Setting the wage variables at their actual outturns removes the possibility of a wage-price spiral, and the RMSE of the consumer price equations fall dramatically. In terms of demand, the only significant change is the marked fall in the approximate variance of the equations for consumer spending. This finding is as expected, as the variance of both personal income and the inflation rate are substantially reduced.

The dynamic path between 1974 and 1982

This section examines the dynamic path taken by three versions of the model when run freely from the first quarter of 1974 to the second quarter of 1982. The three runs studied are:

Model 2 Model with price expectations exogenous.

Model 3 Model with price expectations and the exchange rate exogenous.

Model 4 Model with price expectations, the exchange rate and the wage sectors exogenous.

The paths of the errors for GDP, the consumer price level and the exchange rate are shown in Charts 3 to 5. A positive error indicates that the series is being underpredicted. Independent of the degree of exogeneity, there is a clear upwards trend in the tracking errors for GDP through time, from overprediction of the 1974 and 1975 recession to underprediction in the late 1970s and early 1980s - despite the current recession. Chart 6 shows how the dynamic tracking performance of the model 4 compares with the one-step ahead system results. The one-step errors are important in determining the shape of the dynamic results; longer run feedback and multiplier effects tend to amplify the movements. Table 3 shows the contributions of the main expenditure components to the movements in GDP with both the exchange rate and wages exogenous. The one step ahead results are also presented for comparison. The largest contributor to the trend in the GDP error appears to be imports. The single equation residuals on the individual import equations are similarly trended (see annex).

Chart3:The Dynamic Tracking Errors of Gross Domestic Product (GDPE).

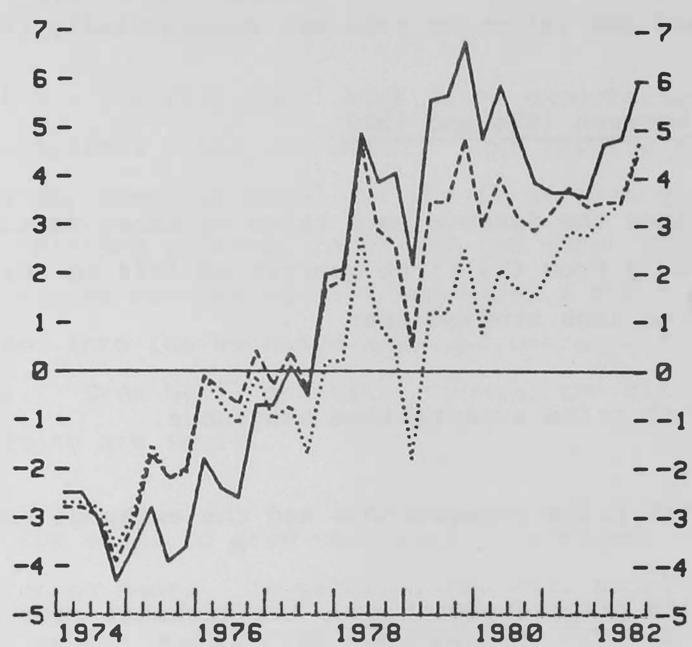


Chart4:The Dynamic Tracking Errors of the Consumers' Expenditure Deflator (PC).

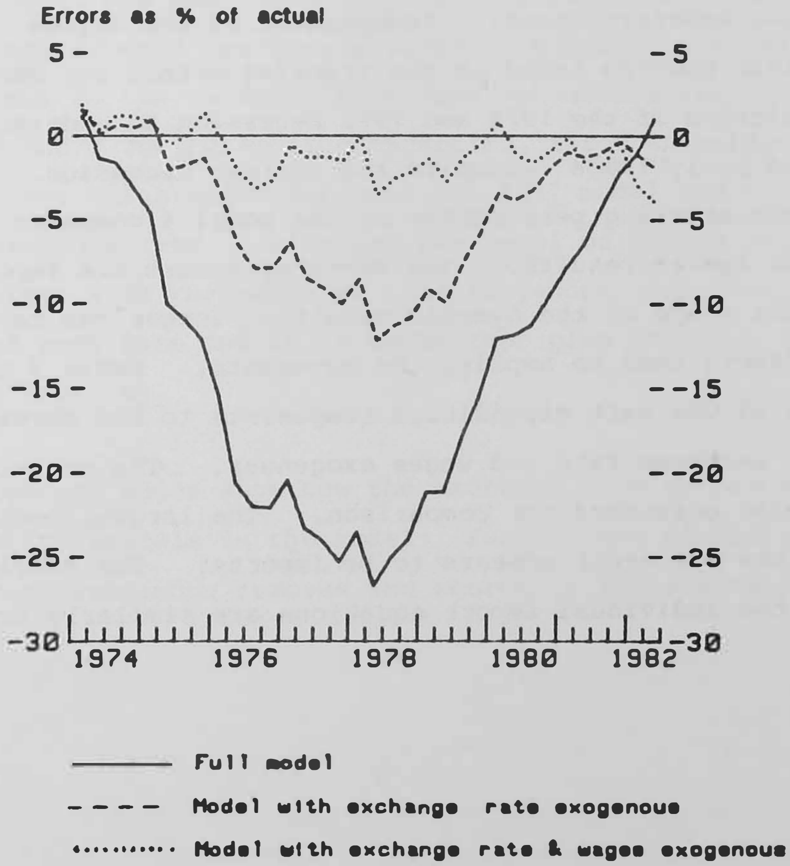


Chart5:The Dynamic Tracking Errors of the Effective Exchange Rate (EER).

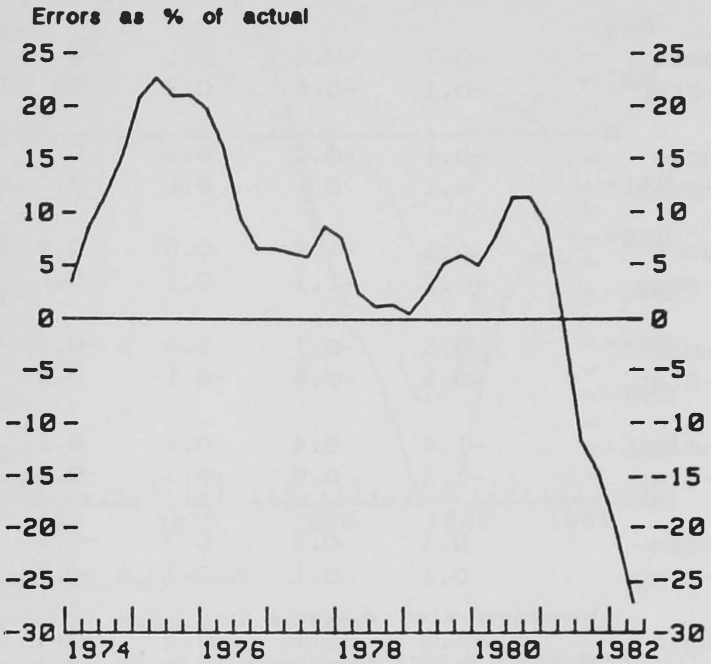


Chart6:A Comparison of the Tracking Errors of Gross Domestic Product (GDPE).

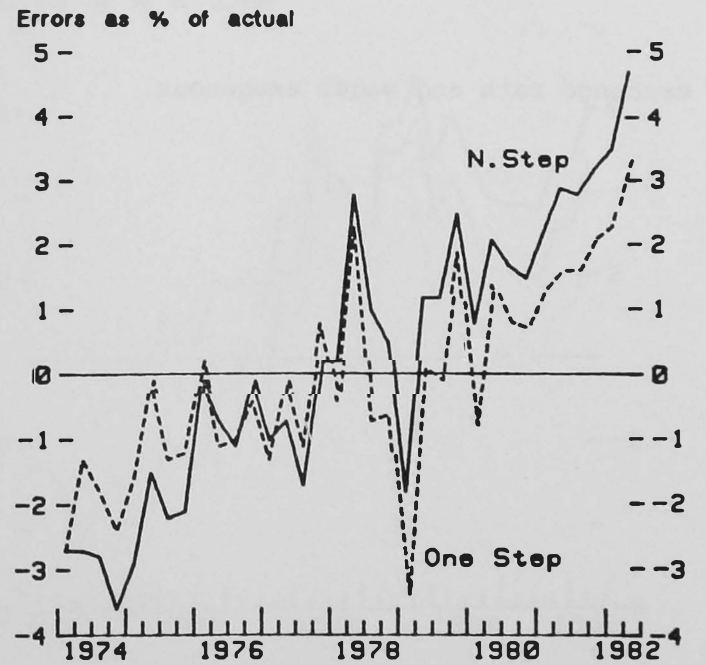


TABLE 3: CONTRIBUTIONS TO THE ERRORS IN GDP VOLUME*

Errors as % of GDP

		1974	1975	1976	1977	1978	1979	1980	198
Consumers' Expenditure:	Dynamic	-0.7	-0.4	0.1	-0.6	0.7	0.6	0.4	0.
	One-Step	-0.3	-0.4	0.2	0	0.2	-0.1	-0.2	-0.
Fixed Investment:	Dynamic	-0.1	-0.4	0.2	0	0.3	1.0	1.1	1.
	One-Step	0.1	0	0.1	-0.1	0.1	0.8	0.5	0.
Stockbuilding:	Dynamic	-0.5	-1.4	0.5	0.4	0.7	0.3	-1.4	-0.
	One-Step	-0.2	-1.3	-0.1	0.1	0.6	0.7	-0.9	-0.
Exports:	Dynamic	-0.5	-0.7	-0.4	-0.5	-0.8	-0.9	-0.5	-0.
	One-Step	-0.5	-0.4	-0.1	0.2	0.1	-0.1	0.1	0.
Imports:	Dynamic	-1.4	0.4	-0.7	0.1	0.8	0.2	2.4	2.
	One-Step	-1.3	0.9	-0.3	-0.3	-0.1	-1.1	1.4	2.
Factor Cost Adjustment:	Dynamic	0.3	0.3	-0.2	-0.1	-0.7	-0.5	-0.5	-0.
	One-Step	0.1	0.1	-0.3	-0.3	-0.7	-0.4	-0.5	-0.
GDP (expenditure estimate):	Dynamic	-3.0	-2.1	-0.5	-0.8	1.1	0.8	1.5	2.
	One-Step	-2.1	-1.0	-0.6	-0.4	0.1	-0.4	0.5	1.

* Price expectations, exchange rate and wages exogenous.

Chart7:The Dynamic Tracking Errors of Unemployment (LU).

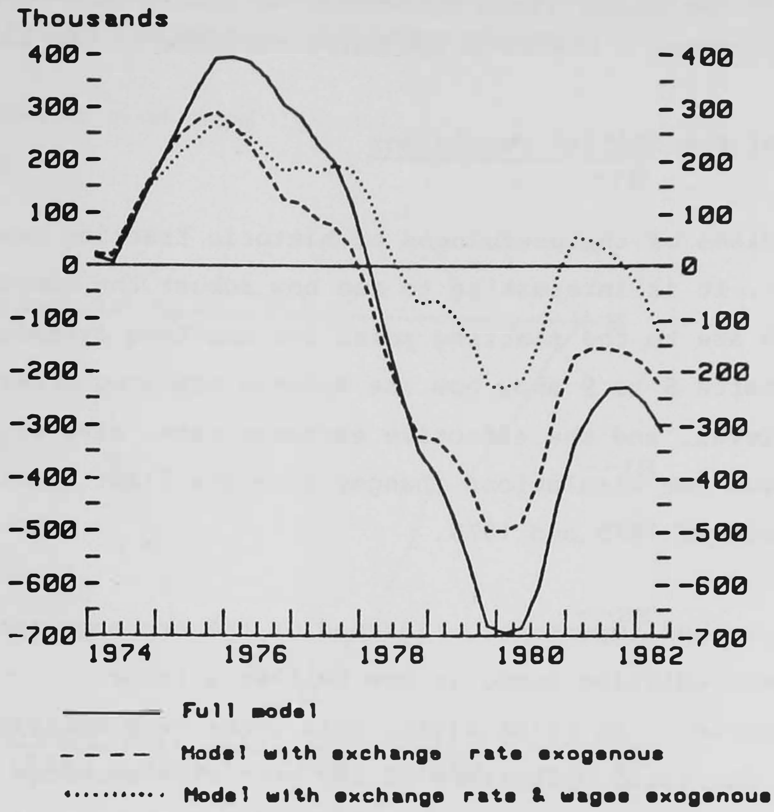
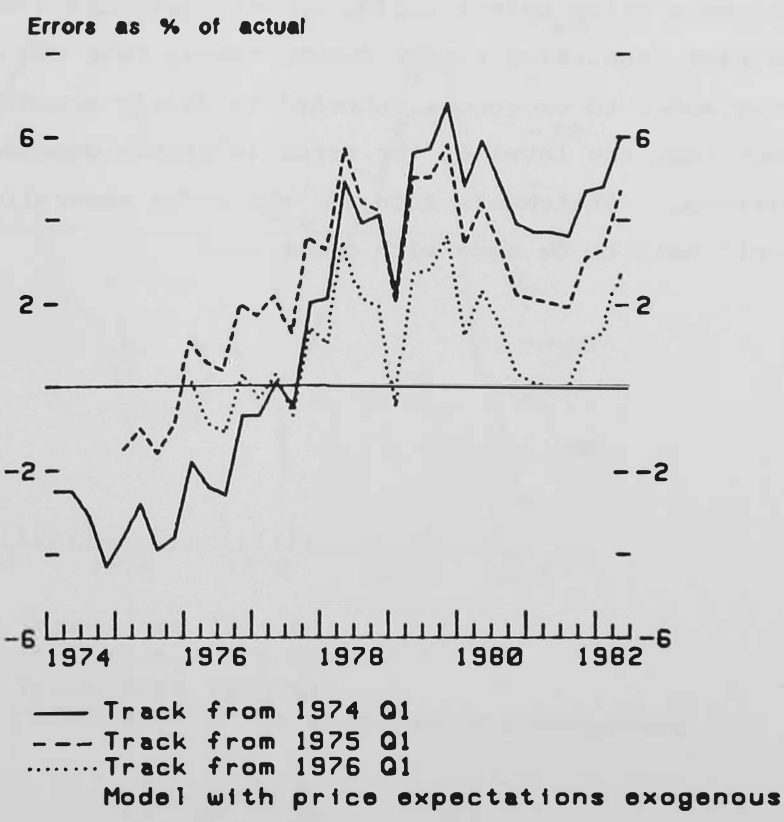


Chart8:The effect of different start dates on the dynamic errors of GDP*



The poor performance of the exchange rate (Chart 5) amplifies the errors in tracking GDP and is a cause of the large "overprediction loop" on prices (Chart 4). Although, even with the exchange rate taking its actual values, quite a strong loop is visible: the Phillips curve effects remain very important in shaping the overall path (see Chart 7, which shows the tracking errors for unemployment - the Phillips curve variable in the wage equations).

The importance of the initial conditions

Given the criticisms of the usefulness of historic tracking exercises outlined earlier, it is interesting to see how robust the conclusions of the previous section are to the starting point for the long dynamic track. Consequently, Charts 8 to 9 show how the dynamic tracking errors of GDP, the consumer price level, and the effective exchange rate, vary when the starting point for the simulations changes from the first quarter of 1974 to the first quarters of 1975 and 1976.

The results are rather important. Instead of the exchange rate starting off with an underprediction loop, it now follows a large overprediction cycle. At first sight, this looks very worrying, but, on the other hand, the first difference of the predicted exchange rate moves fairly similarly between the two runs, indicating that the reactions to factors leading to changes in the exchange rate do not depend too much on the initial conditions. The reaction on the price level is different, however, partly because the Phillips curve effect is somewhat nonlinear, but largely as the wage price spiral builds up very quickly. In terms of activity, the same conclusion can be drawn, namely that the direction of the reaction of the model to exogenous 'shocks' is fairly soundly based, as one would hope, but that the level of the error is highly dependent on the initial conditions. Statements such as 'the model generally overpredicts the price level' need to be made with great care.

Chart9 :The effect of different start dates on the dynamic errors of consumer prices

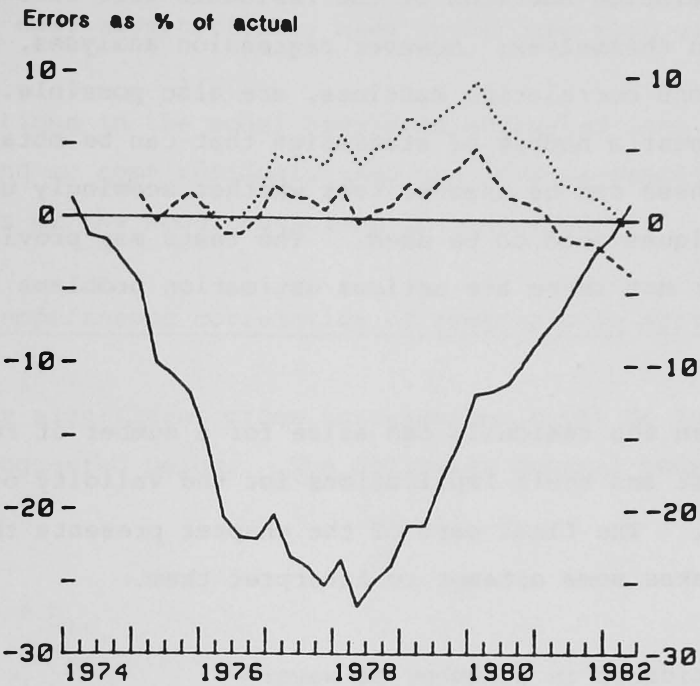
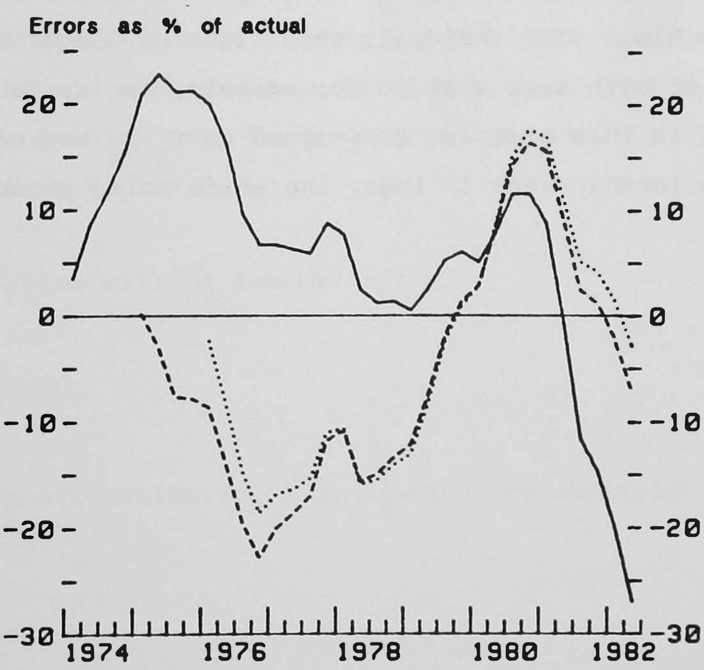


Chart10:The effect of different start dates on the dynamic errors of the effective exchange rate*



—— Track from 1974 Q1
- - - Track from 1975 Q1
······ Track from 1976 Q1
* Model with price expectations exogenous

CHAPTER V ANALYSIS OF RESIDUALS IN THE SHORT TERM MODEL

Introduction

This chapter reports a preliminary examination of the contemporaneous relationships between single equation static residuals of key equations in the model. Cross correlation matrices of the residuals were constructed; these are of interest in themselves; however regression analyses, suggested by inspection of the cross correlation matrices, are also possible. Harvey and Phillips (1982) suggest a number of statistics that can be obtained from these regressions and these can be used to test whether seemingly unrelated regression (SURE) techniques need to be used. The tests may provide some indication of whether or not there are serious estimation problems in the model.

Cross correlation between the residuals can arise for a number of reasons. These are discussed first and their implications for the validity of the model briefly discussed. The final part of the chapter presents the empirical results and makes some attempt to interpret them.

The approach can be criticised in a number of ways:

(i) The residuals used - the difference between actual and solution values for the level of the variable - may not correspond to those of the estimated relationship. The residuals then might no longer be normally distributed with zero mean. For example, for variable y_t the residuals used in this exercise correspond to $Y_t - \hat{Y}_t$ whereas if the estimated relationship were in logs, the white noise errors are $\log y_t - \hat{\log}\ y_t$.

(ii) Only contemporaneous correlations are considered. It may well be that lagged residual correlations exist. These could arise, for example, through misspecified dynamics in the equations.

(iii) Since only 30 observations of each residual were used, spurious correlations are inevitable and statistics whose distributions are known only asymptotically need to be used with caution.

(iv) Some equations in the model have been estimated less recently than others, and so some residuals used are 'out-of-sample' as far as estimation of the model equations is concerned.

<u>Sources of contemporaneous correlation of residuals in systems of equations</u>

Some reasons why significant cross correlations might be found in fitted residuals are suggested below. The following general model will be assumed throughout:.

(1) $AY_t = BX_t + U_t$

where Y_t is a (gx1) vector of observations on the g endogenous variables at time t. A is a (gxg) matrix of unknown coefficients except for the diagonal elements which are unity. X_t is a (kx1) vector of observations of all the exogenous variables at time t and B is a (gxk) matrix of unknown coefficients. U_t is a serially uncorrelated (gx1) vector of error terms observed at time t which have the multivariate normal distribution with $E[U_t] = 0$ and $E[U_t U'_t] = V$,

The estimated system will be denoted by:

(2) $aY_t = bX_t + e_t$

where a, b and e are estimates of A, B and U respectively.

(i) Simultaneity bias

If we write $A = I-A_1$ where I is the identity matrix and $A_1 = -A$ except that the diagonal elements are all zero.

Then (1) can be written as: $Y_t = BX_t + A_1Y_t + U_t$

$$\text{or:} \quad = B^* X_t^* + U_t$$

where now X_t^* contains endogenous as well as exogenous variables and B* now contains the coefficients of both. That is, we have a structural equation for each endogenous variable.

Now even if the variance covariance matrix (V) of the contemporaneous residuals (U_t), is a diagonal matrix (ie the true residuals are uncorrelated), then the fitted residuals (e_t) will be correlated if ordinary least squares (OLS) is used to estimate each of the structural equations[≠]. Then b*, the estimate of B* will be inconsistent, and e will be an inconsistent estimator of U. Tests of exogeneity may not be easy to apply; however, correlations in the fitted residuals are a warning that simultaneity bias may be a problem.

(ii) Seemingly unrelated regression equations (SURE)

If A is the identity matrix but V is not diagonal, then OLS can be used to estimate each equation separately, but the resulting estimate for B*, although unbiased, is not efficient (Zellner 1962). The fitted residuals will also be correlated and, indeed, can be used to provide a consistent estimator for V. If this is the source of cross correlations in the fitted residuals, more efficient estimates can be obtained by using maximum likelihood or Zellner (SURE) methods.

[≠] Provided, of course, that there are other endogenous variables in the equation ie A_1 is not empty and that the system of equations is not recursive.

(iii) Omitted variable

It is easily shown that, if a variable belongs in two equations but is omitted from both, then the fitted residuals will be correlated. This error will lead to biased and inconsistent estimates of the other coefficients in the equation.

This suggests that, even if the dependent variables for the two equations are considered to be structurally unrelated, there only need be one exogenous variable in common in the 'true' model, but omitted from both of the estimated equations, for the fitted residuals to be correlated. It may be unwise therefore, to assume any high correlation is simply spurious, no matter how unlikely is any relationship between the dependent variables.

(iv) Measurement error

If an explanatory variable is measured with error and the variable appears in more than one equation then, in general, the errors from the two equations will be correlated.

If a dependent variable is measured with error and this is used to construct another dependent variable (eg price indices which are used to deflate a value series to get a volume index), then the residuals on their equations will also be correlated.

(v) Spurious correlation

Thirty observations were available on each series of residuals, which may be considered adequate to calculate each correlation coefficient. However, when cross correlations are to be calculated across thirty series, the probability of observing a single high correlation when all the series are really independent could be large.

TABLE 1

EXCLUDING CORRELATIONS LESS THAN 0.3 PRICES x VOLUMES

PRICES

	CND	CD	IND	IHP	IIF	IIB	IIO	XGMA	XSOT	MPRM	MGSM	MGBM	MS	FCA
PCND		-0.47	0.49						0.52	0.54				
PCD		0.38		0.45				0.38						
PIND		0.44	-0.71						-0.61	-0.77	0.36	-0.41		-0.3[illegible]
PIHP								-0.33	-0.67					
PAHM							0.30							-0.3[illegible]
PS														
UXGM								-0.41						0.3[illegible]
PXS								-0.46	-0.41					
UMM$			-0.59						-0.38	-0.69		-0.31		
UMSM		0.42		0.34		-0.36			-0.55	-0.44	0.41			
UMBM														
PMS			0.32							0.39				
WAEM		0.48	-0.52	0.47	0.57				-0.35	-0.69	0.63			-0.4[illegible]
WOO						-0.58								
WAPS			0.43							0.58	-0.35		0.33	
PIMO		0.40			0.34	-0.31			-0.35		0.38			-0.3[illegible]

TABLE 2

EXCLUDING CORRELATIONS LESS THAN 0.3 VOLUMES x VOLUMES

	CND	CD	IND	IHP	IIF	IIB	IIO	XGMA	XSOT	MPRM	MGSM	MGBM	MS	FCA
CND	1			0.32										
CD		1			0.45				-0.32	-0.34				
IND			1							0.77		0.52		0.46
IHP				1	0.48	-0.35				-0.32	0.41			
IIF					1	-0.37					0.61	0.46	-0.49	
IIB						1	-0.44				-0.49			
IIO							1			-0.32	0.42			
XGMA								1						
XSOT									1	0.33	-0.36			
MPRM										1	-0.37	0.37		0.59
MGSM											1	0.39		
MGBM												1	-0.33	
MS													1	-0.47
FCA														1

TABLE 3

EXCLUDING CORRELATIONS LESS THAN 0.3 PRICES x PRICES

	PCND	PCD	PIND	PIHP	PAHM	PS	UXGM	PXS	UMM$	UMSM	UMBM	PMS	WAEM	WOO	WAPS	PIMO
PCND	1		-0.64	-0.47					-0.55	-0.55		0.37	-0.40			
PCD		1								0.45					-0.35	
PIND			1	0.52		0.38			0.73	0.57	0.40		0.66		-0.57	0.42
PIHP				1		0.48	0.55		0.45	0.56						0.34
PAHM					1			-0.33				0.36				0.50
PS						1			0.31	0.43			0.36		-0.41	
UXGM							1						-0.40	0.38	0.37	
PXS								1								
UMM$									1	0.67	0.69	-0.39	0.37		-0.46	
UMSM										1	0.40		0.39		-0.38	
UMBM											1					
PMS												1				
WAEM													1		-0.47	
WOO														1		0.32
WAPS															1	
PIMO																1

Results

Correlation matrices

Table 1 shows the cross correlation matrix between the residuals on the main price and volume equations. For clarity, only correlations of 0.3[†] or above are entered. Similarly, Table 2 gives the correlation matrix between residuals on the volume equations alone and Table 3 shows the equivalent matrix for prices. All variables are defined in the variable listing at the end of the paper.

There are a number of high correlation coefficients in the matrices. The previous section suggested a number of reasons how these could arise.

Regression Analysis

In an attempt to identify the non-spurious correlations and perform significance tests, some regression analysis was carried out. The procedure used was to start with Table 1 and regress each price residual on all of the volume residuals that had a correlation coefficient greater than 0.3 with that price residual. Similarly, each volume residual was regressed on all the price residuals with correlation coefficients greater than 0.3. All the equations were then re-estimated omitting residuals whose t-value was less than 1.0. In a similar way, regressions between price residuals and between volume residuals were set up using the information from Tables 2 and 3. Again, residuals with t-values less than 1 were excluded. For each residual, two equation, one with price residuals as regressors, the other with volume residuals as regressors were obtained. A single equation was then estimated with both volume and price residuals as regressors. The final equations are shown in Table 4.

Harvey and Phillips (1982) showed that the usual F-statistic calculated in these regressions is still valid and that the degrees of freedom can be approximated* as (K, N-K) where K is the number of regressors and N is the number of observations.

[†] It is acknowledged that this cut off point is arbitrarily chosen.

*The exact degrees of freedom take into account the number of regressors in each of the original equations that produced the residuals; however, they found that the approximate test performed well.

Price equations

$$PIND = \underset{(1.7)}{0.19}\ PIND_{-1} - \underset{(3.5)}{0.0003}\ XSOT - \underset{(5.6)}{0.0004}\ MGBM + \underset{(4.0)}{0.0001}\ FCA$$

$$+ \underset{(4.7)}{0.76}\ \text{UMM\$} - \underset{(2.8)}{0.29}\ UMSM + \underset{(4.1)}{0.007}\ WAEM - \underset{(3.0)}{0.0005}\ WAPS + \underset{(4.0)}{1.03}\ PIMO$$

$R^2 = 0.96 \quad F = 73.8$

$$PIHP = \underset{(6.9)}{0.84}\ PIHP_{-1} + \underset{(2.4)}{0.52}\ PS$$

$R^2 = 0.70 \quad F = 32.9$

$$WAEM = \underset{(1.7)}{0.002}\ IIF + \underset{(4.3)}{0.013}\ MGSM - \underset{(5.4)}{93}\ PCND + \underset{(4.4)}{109}\ PS - \underset{(6.0)}{0.7}\ UXGM - \underset{(1.6)}{12.1}\ UMSM$$

$R^2\ 0.87 \quad F = 32.0$

$$\text{UMM\$} = \underset{(2.5)}{0.009} - \underset{(4.2)}{0.0001}\ MPRM + \underset{(3.1)}{0.19}\ UMSM + \underset{(4.4)}{0.27}\ UMBM - \underset{(1.2)}{0.0015}\ WAEM$$

$R^2 = 0.79 \quad F = 27.9$

$$UXGM = \underset{(5.3)}{49.6}\ PIHP - \underset{(2.6)}{0.2}\ WAEM + \underset{(1.8)}{0.03}\ WOO + \underset{(2.5)}{0.03}\ WAPS$$

$R^2 - 0.68 \quad F = 16.1$

$$WOO = - \underset{(4.3)}{0.08}\ IIB + \underset{(2.9)}{2.9}\ UXGM$$

$R^2 = 0.49 \quad F = 14.6$

$$UMSM = - \underset{(1.6)}{0.0002}\ XSOT - \underset{(1.9)}{0.91}\ PCND + \underset{(1.5)}{0.25}\ PCD - \underset{(1.3)}{0.24}\ PIND$$

$$+ \underset{(1.9)}{1.23}\ PS + \underset{(2.4)}{0.75}\ \text{UMM\$}$$

$R^2 = 0.65 \quad F = 10.0$

$$PCND = -\ 0.00006\ CD - 0.14\ PIND + 0.09\ PMS$$
(1.19) (3.03) (1.19)

$R^2 = 0.47 \quad F = 9.4$

$$PAHM = -\ 0.38\ PXS + 0.21\ PMS + 0.87\ PIMO$$
(3.0) (2.2) (3.9)

$R^2 = 0.47 \quad F = 9.1$

$$PMS = 0.67\ PAHM - 0.59\ UMM\$$$
(3.0) (3.5)

$R^2 = 0.36 \quad F = 8.6$

$$PCD = 0.01 - 0.53\ PCD_{-1} + 0.0001\ CD + 0.00008\ XGMA + 0.42\ UMSM$$
(1.8) (3.7) (1.4) (2.7) (3.4)

$$-\ 0.0005\ WAPS$$
(1.5)

$R^2 = 0.56 \quad F = 8.1$

$$PIMO = 0.09\ PIND + 0.26\ PAHM + 0.0002\ WOO$$
(2.8) (2.9) (1.8)

$R^2 = 0.43 \quad F = 8.1$

$$PXS = -\ 0.00006\ XGMA - 0.0002\ XSOT - 0.39\ PAHM$$
(2.8) (3.1) (2.5)

$R^2 = 0.41 \quad F = 7.4$

$$WAPS = -\ 4.7 - 0.05\ IND + 0.1\ MPRM + 0.11\ MS - 105\ PIND$$
(1.3) (1.5) (2.6) (2.4) (1.3)

$$-\ 462\ PS + 3.4\ UXGM + 2.2\ WAEM$$
(1.9) (2.3) (1.6)

Volume equations

$$IND = \underset{(10.4)}{0.8}\ IND_{-1} + \underset{(2.9)}{0.6}\ MGBM$$

$R^2 = 0.89 \quad F = 124.7$

$$MPRM = \underset{(4.3)}{0.5}\ MPRM_{-1} + \underset{(2.5)}{644}\ PMS + \underset{(1.7)}{0.8}\ WAPS + \underset{(3.5)}{0.3}\ FCA - \underset{(2.0)}{0.5}\ IHP + \underset{(1.3)}{0.2}\ IND$$

$R^2 = 0.95 \quad F = 86.0$

$$MGSM = \underset{(3.0)}{12.1}\ WAEM - \underset{(1.5)}{0.9}\ WAPS + \underset{(2.5)}{1773}\ PIMO + \underset{(3.6)}{0.7}\ MGBM + \underset{(3.7)}{0.2}\ IIO$$

$R^2 = 0.74 \quad F = 17.6$

$$MS = \underset{(5.0)}{0.64}\ MS_{-1} - \underset{(1.2)}{0.05}\ FCA$$

$R^2 = 0.53 \quad F = 16.6$

$$MGBM = \underset{(2.4)}{0.4}\ MGBM_{-1} + \underset{(1.4)}{0.1}\ MGSM + \underset{(2.9)}{0.18}\ IND$$

$R^2 = 0.60 \quad F = 14.8$

$$IIF = \underset{(4.1)}{30.3}\ WAEM - \underset{(2.1)}{0.5}\ IIB + \underset{(3.0)}{1.5}\ MGBM - \underset{(2.8)}{1.3}\ MS$$

$R^2 = 0.61 \quad F = 12.2$

$$FCA = 73 + \underset{(4.6)}{11.0}\,UXGM - \underset{(1.9)}{1751}\,PIMO - \underset{(2.3)}{0.7}\,MS + \underset{(3.4)}{0.32}\,MPRM$$
(4.6) (1.9) (2.3) (3.4) (3.5)

$R^2 = 0.58$ F = 11.1

XSOT = 21.9 - 268 PIND - 749 PIHP - 560 PXS - 0.10 MGSM
(2.6) (2.2) (2.5) (2.4) (1.3)

$R^2 = 0.58$ F = 10.9

XGMA = - 35.2 + 2264 PCD - 2549 PIHP - 2692 PXS
(1.5) (3.8) (2.6) (3.0)

$R^2 = 0.47$ F = 9.5

IIB = - 58.3 - 4.1 WOO - 0.3 IIO - 0.1 IIF - 0.6 IHP
(1.9) (4.2) (2.0) (1.8) (1.5)

$R^2 = 0.53$ F = 9.27

CD = - 12.8 - 1048 PCND + 463 PCD + 1102 PIMO + 0.07 IIF
(1.5) (2.4) (2.2) (1.8) (1.8)

$R^2 = 0.44$ F = 6.7

IHP = - 0.2 IHP_{-1} + 393 PCD - 0.1 CND
(1.1) (2.6) (2.2)

$R^2 = 0.27$ F = 4.2

CND = 0.856 IHP
(1.9)

$R^2 = 0.11$

The procedure used here differs from that proposed by Harvey and Phillips in that a constant is included in the regressions, and lagged dependent residuals are also included in an attempt to differentiate between autocorrelation and cross correlation[†].

The equations presented in the table are all significant if the approximate F-test is used. [Note that at the 5% level F (5,25) = 2.6 and F (1,29) = 4.19.] The first list presents the volume residual equations in order of decreasing F-values, the second presents the price residual equations.

Inevitably some of the relationships thrown up by this sort of 'data-mining' approach will be highly implausible. Nevertheless, if two unlikely variables appear to be related, it may simply be that they both depend on a common variable which has been omitted from the original equations.

The residuals on the price (PIND) and volume (IND) equations for industrial investment provide an interesting example. The residuals on the price equation have a correlation of -0.71 with those on the volume equation. This could be explained either by measurement error - the price volume split is incorrect, or by economic behaviour - volumes varying inversely with price. In the regression analysis, neither set of residuals turn out to be significant in the equation for the other. If the problem is the price volume split this might be expected since measurement error would lead to downward bias of the coefficient (even reversal of the sign) Both the IND and PIND residual equations have significant lagged dependent variables and both depend on MGBM but with opposite sign. In addition the PIND residuals depend on a number of other residuals, mainly those on cost variables - wages, import prices, manufacturing output prices and the factor cost adjustment (FCA). Misspecification in the model equations may also be suggested by these results.

[†] This is important as the residuals used were constructed without using any lagged error terms that might have been significant in the originally estimated price and volume equation (levels).

The presence of the residual on basic material imports (MGBM) in the IND residual equation may indicate that the activity variables in the original model equations are inadequate (Manufacturing output appears in both). The presence of the FCA residual may suggest that the treatment of indirect taxes in the model PIND equation, is not adequate.

PIND residuals are also highly and negatively correlated with those for manufacturing output (MPRM) and yet, once again, neither residual was significant in the equation for the other. Any assumption that the negative correlation between PIND and IND must be connected with incorrect price-volume split is questioned by the fact that the correlation between MPRM and PIND is even larger and negative: both may well be spurious.

A different example can be found in imports; the residuals for basic material imports (MGBM) and semi manufactures imports (MGSM) are positively related and this is supported in the regression work. Negative correlation might have been caused by errors in the split between basic materials and semi-manufactures, but positive correlation is found. One possibility is that, as with investment, manufacturing output, which appears in both original model equations is an inadequate activity variable. Perhaps also, there is some degree of complementarity between the two variables. The model equation for semis contains UK wholesale prices (PIMO) relative to semis import prices (UMSM) as a competitiveness term. PIMO appears with a positive sign in the model equation but is constrained to have equal and opposite sign to UMSM. The appearance of the residual for PIMO in the residual MGSM equation may be indicating that the restriction is not valid. One suggestion might be that although in the long run there is only a relative price effect, the dynamic response to PIMO might differ from that to UMSM.

Conclusion

One of the primary objectives in econometrics is to produce a model which approximates as closely as possible the true relationships generating the data. It would be comforting if any correlation between the residuals from an estimated model could be shown to be purely spurious. This does not necessarily require the model to be a good predictor; if the data are genuinely 'noisy" then they cannot be well predicted and even if the model has predicted well in the past, it may be the case that undetected effects have simply not been large.

The tables of cross correlation coefficients presented above suggest that the residuals are far from independent and contain a lot of information. The regression work, however, rejects many of the relationships suggested by cross correlation matrices. Those that are confirmed however may need to be considered both as suggesting lines of future research and in projecting future residuals as is done when producing forecasts.

ANNEX

The model used for short-term forecasting within the Bank of England was previously described in Discussion Paper No 5 in 1979. That paper sought to make the general public aware of the Bank's modelling activities by providing a detailed description of the equations in the model. Four years on, some areas of the model - consumption, wages and employment for example - have changed substantially whereas others - the exchange rate, and most of the financial sector - remain largely unchanged (or not modelled) despite considerable research effort.

The model used in this paper was that in use up to March 1983. Its broad structure is similar to that described in the 1979 Discussion Paper, and is illustrated in Chart 1. The main equations and their recent tracking performance are described in the remainder of this annex. A full listing of the model used in the exercises is available on request. The model is currently being updated to a 1980 price basis; the model used in this paper was estimated on data at 1975 prices.

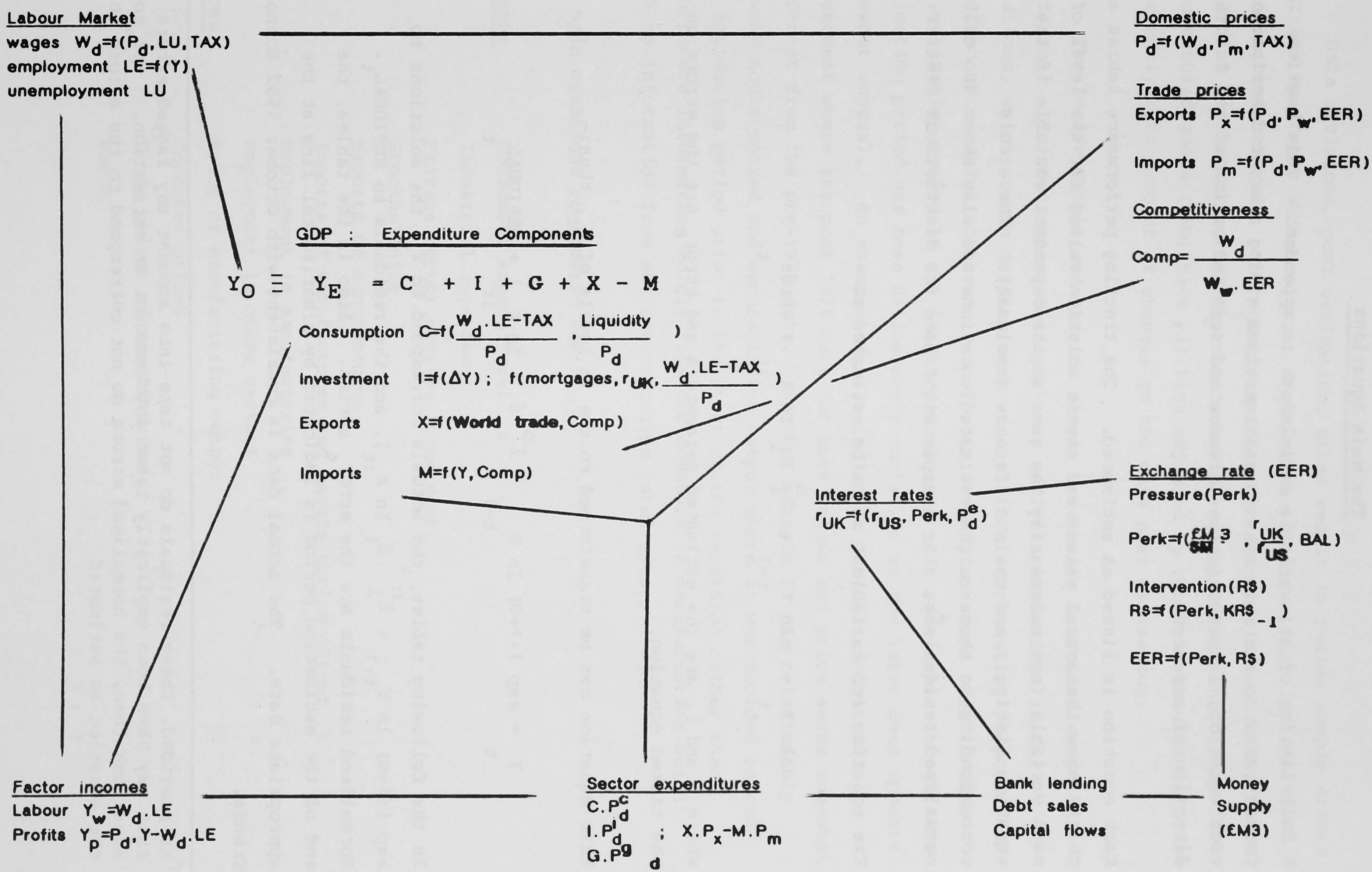


CHART 1: A schematic outline of the model; exogenous variables **embolded**

The Main Equations

A full listing of all variable definitions is appended. This section concentrates on the main behavioural equations giving a brief description of each equation, its tracking performance and some indication of the future direction of research.

Each equation is listed as estimated. The tracking performance tables and charts show the actual values and static solution values for the level of each variable (not necessarily the same as the dependent variable in the equation listing), and their difference (residual). The errors corresponding to those on the estimated equations are also shown (so called normalised residuals†). An example might make the distinctions clearer:

The equation for variable Y might be estimated as

$$\Delta \ln Y_t = \alpha \ln Y_{t-1} + \Sigma_i^n \beta_i \ln X_{it} + error_t$$

where α and β_i are the estimated parameters and $error_t$ are the errors on the fitted equation.

This equation can be transformed to one in levels of Y_t, thus:-

$$Y_t = \exp [(1+\alpha) \ln Y_{t-1} + \Sigma_i^n \beta_i \ln X_{it}] + RESIDUAL_t$$

In the following tables, the actuals correspond to Y_t, the solutions to $\exp [(1+\alpha) \ln Y_{t-1} + \Sigma_i^n \beta_i \ln X_{it}]$, and the residuals to $RESIDUAL_t$. Normalised residuals are the $error_t$ series. Also in the tables, the end of the estimation period is indicated by a horizontal line at the appropriate date. The actual data is consistent with October 1982 Economic Trends.

† As provided, these residuals do not take into account any lagged errors that may have been explicitly taken into account in estimation. For some equations then, the normalised errors do not correspond to the errors on the equation as estimated.

The following should be borne in mind:

(1) Data revisions, post estimation, often result in inside sample errors that are no longer white noise. Revisions to data can also include minor definitional changes. The equations for other stockbuilding, (IIO), hours worked in manufacturing (HMFT), manufacturing output (MPRM) and demand for manufactured goods (MND) have all been adjusted by constant amounts in order to crudely take account of changes to the data post estimation.

(2) The inside sample and outside sample errors are sometimes very different. In most cases, this probably reflects weaknesses in the equations, which remain despite much effort. For forecasting purposes, it is often more useful to have a run of outside sample errors than to extend the estimation period to the latest data point. In some cases though, the estimation period has been deliberately curtailed as the later data appears somewhat unusual. An example of this is in the data for industrial investment where the post 1978 data for both volume and price seems somewhat different from the pre-1978 data. Another example is the relationship between hours worked and manufacturing output where it was decided to end the estimation period prior to the start of the recession rather than incorporate information solely from the downturn in manufacturing output with no information from any corresponding later upturn.

The main equations considered are:

Volumes	Consumers expenditure
	Industrial investment
	Private sector housing investment
	Stockbuilding
	Exports of manufactures
	Imports of manufactures and manufacturing output
	Employment in manufacturing
	Employment in other sectors
Prices	Price of manufacturing output
	Consumer prices
	Trade prices of manufactures
	Wages

CONSUMERS' EXPENDITURE

At constant prices

Non-durable items, total

$$\ln \frac{CND}{CND^*} = \underset{(15.0)}{0.3779} \ln \frac{YDLA}{YDLA^*} - \underset{(3.7)}{0.12442}\, \Delta \ln \frac{YDLA}{YDLA^*}$$

$$- \underset{(3.5)}{0.10861} \ln \frac{CND^*}{YDLA^*} + \underset{(4.0)}{0.03623} \ln \frac{(NLAJ/PCND)^*}{YDLA^*}$$

$$- \underset{(3.8)}{0.04531} + \underset{(2.3)}{0.01179} \left[D681 - \frac{(D681_{-1} + D681_{-2} + D681_{-3} + D681_{-4})}{4} \right]$$

$$+ \underset{(3.5)}{0.01829} \left[D731 - \frac{(D731_{-1} + D731_{-2} + D731_{-3} + D731_{-4})}{4} \right]$$

$$+ \underset{(3.3)}{0.01708} \left[D79 - \frac{(D79_{-1} + D79_{-2} + D79_{-3} + D79_{-4})}{4} \right]$$

$\bar{R}^2 = 0.843$ SE = 0.006 DW = 2.1 1966 III - 1980 IV

where: $CND^* = (CND_{-1} * CND_{-2} * CND_{-3} * CND_{-4}) ** 0.25$

$YDLA^* = (YDLA_{-1} * YDLA_{-2} * YDLA_{-3} * YDLA_{-4}) ** 0.25$

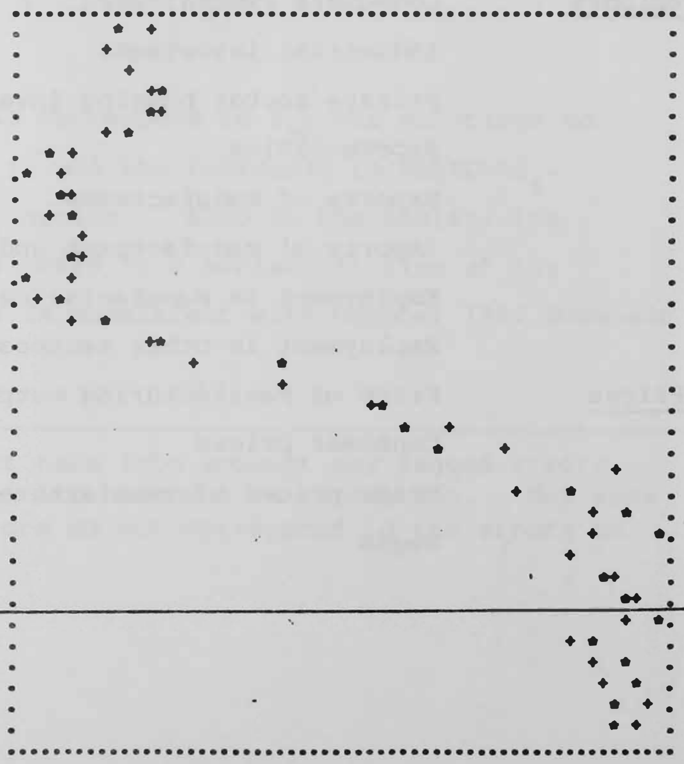
$$(NLAJ/PCND)^* = \left[\left[\frac{NLAJ}{PCND}\right]_{-1} * \left[\frac{NLAJ}{PCND}\right]_{-2} * \left[\frac{NLAJ}{PCND}\right]_{-3} * \left[\frac{NLAJ}{PCND}\right]_{-4} \right] ** 0.25$$

$$(158) \quad YDLA = \frac{YD}{PCND} - \left[\left(\sum_{i=o}^{8} \frac{PCND - PCND_{-1}}{PCND_{-1}} \right)_{-i} / \ 8.0 \right] \frac{NLAJ}{PCND}$$

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 14645.00 TO 16491.00

1	ACTUAL CND *	SOLUTION CND +	RESIDUALS	NORMALIZED
1974 1	14892.000	15004.238	-112.238	-0.008
1974 2	14885.000	14866.277	18.723	0.001
1974 3	14952.000	14952.281	-0.281	-0.000
1974 4	15018.000	14987.098	30.902	0.002
1975 1	14991.000	15021.859	-30.859	-0.002
1975 2	14937.000	14871.414	65.586	0.004
1975 3	14700.000	14774.145	-74.145	-0.005
1975 4	14657.000	14750.895	-93.895	-0.006
1976 1	14729.000	14779.066	-50.066	-0.003
1976 2	14760.000	14718.336	41.664	0.003
1976 3	14813.000	14800.914	12.086	0.001
1976 4	14764.000	14815.918	-51.918	-0.004
1977 1	14645.000	14769.121	-124.121	-0.008
1977 2	14758.000	14663.691	94.309	0.006
1977 3	14864.000	14778.738	85.262	0.006
1977 4	15026.000	15010.117	15.883	0.001
1978 1	15384.000	15145.379	238.621	0.016
1978 2	15391.000	15379.410	11.590	0.001
1978 3	15693.000	15535.430	57.570	0.004
1978 4	15754.000	15862.676	-108.676	-0.007
1979 1	15849.000	16024.039	-175.039	-0.011
1979 2	16373.000	16352.000	21.000	0.001
1979 3	16240.000	16079.996	160.004	0.010
1979 4	16387.000	16282.164	104.836	0.006
1980 1	16491.000	16300.430	190.570	0.012
1980 2	16237.000	16244.707	-7.707	-0.000
1980 3	16319.000	16346.863	-27.863	-0.002
1980 4	16399.000	16411.746	-12.746	-0.001
1981 1	16475.000	16383.359	91.641	0.006
1981 2	16310.000	16243.066	66.934	0.004
1981 3	16381.000	16280.676	100.324	0.006
1981 4	16414.000	16343.012	70.988	0.004
1982 1	16353.000	16452.758	-99.758	-0.006
1982 2	16367.000	16413.047	-46.047	-0.003



MSE= 0.000 RMS= 0.006 RHO= 0.233

MEAN ERR= 0.0008 MEAN= 15535.5273

UNNORMALISED ERRORS, MEAN = 13.6216 RMSE = 92.2937

Consumers' Expenditure

The equations relating consumers' expenditure to its determinants are a pivotal section of the model. Consumption of non-durable goods (CND) forms about 90% of aggregate consumption. The equation implies that the level of consumption is related to its average level over the previous four quarters modified,

(a) by changes in persons disposable income (YD) deflated by prices (non-durable consumption deflator PCND) and adjusted for inflation losses on persons net liquid asset holdings (NLAJ);

(b) by whether income was accelerating (negatively);

(c) by the relationship between consumption and income over the previous year (negatively); and

(d) by the ratio of consumption to income in all previous periods, as proxied by the real net liquidity to income ratio (positively).

Determinants (a), (c) and (d) correspond to derivative, proportional and integral control mechanisms, which act to correct the short run path of consumption towards a long run equilibrium path where the consumption/income ratio is stably related to income growth, price inflation and the net liquidity/ income ratio. Income is adjusted in this equation by the subtraction of inflation losses on net liquid asset holdings, thereby negating the apparent increases in income which occur during inflationary periods due to increasing interest payments, and which in fact are accelerated capital repayments and not extra real income. All of the lags in the equation are averaged over four quarters. For further discussion of this and the specification more generally, see Davis (1982).

Durable goods

$$\ln \frac{CD}{CD^*} = -0.75319 \ln \frac{CD^*}{YDLA^*}$$
$$(6.5)$$

$$+0.19286 \sum_{i=0}^{2} (3-i)\ \Delta\ln\left(\frac{YDLA}{YDLA^*}\right)_{-i}$$
$$(5.1)$$

$$-0.14017\ \Delta\ln RMD$$
$$(2.8)$$

$$+0.05973 \sum_{i=0}^{2} \ln\left(\frac{LZNA + LHBB + LHPG}{PCD}\right)_{-i}$$
$$(5.3)$$

$$-0.20244 \sum_{i=0}^{2} \left(\ln\left(\frac{1+RCBR}{100}\right) - \Delta_4 \ln PC_{-1}\right)$$
$$(3.3)$$

$$-3.12296 + 0.16264\ D681 + 0.14758\ D731$$
$$(6.2) \qquad (3.3) \qquad (3.0)$$

$$+ 0.21683\ D79$$
$$(4.4)$$

$\bar{R}^2 = 0.717$ SE = 0.047 DW = 1.5 1964 III - 1981 IV

where:

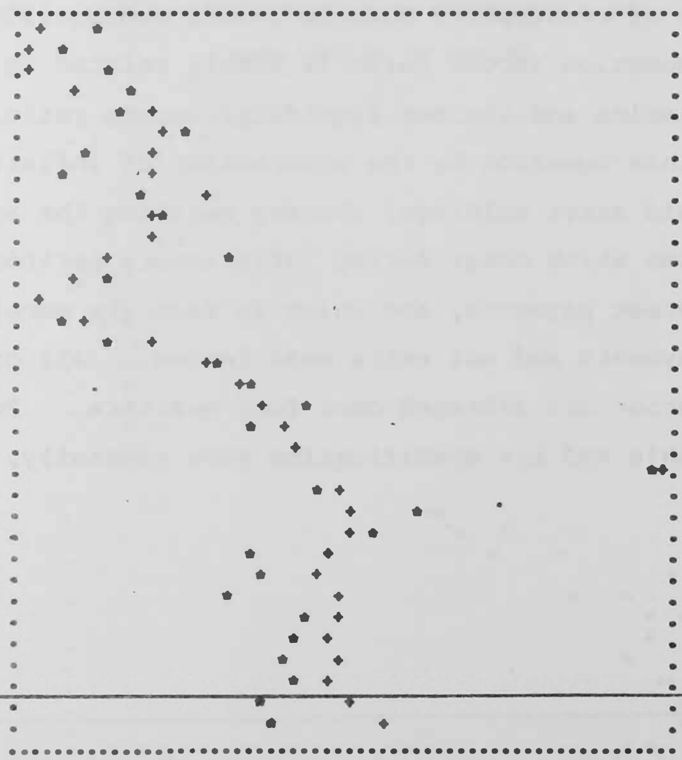
$$CD^* = (CD_{-1} * CD_{-2} * CD_{-3} * CD_{-4}) ** 0.25$$

$$YDLA^* = (YDLA_{-1} * YDLA_{-2} * YDLA_{-3} * YDLA_{-4}) ** 0.25$$

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 1246.64 TO 1959.71

2	ACTUAL CD ●	SOLUTION CD ◆	RESIDUALS	NORMALIZED	
1974 1	1319.000	1263.750	55.250	0.043	77
1974 2	1284.000	1246.812	37.188	0.029	78
1974 3	1336.000	1246.635	89.365	0.069	79
1974 4	1363.000	1295.524	67.476	0.051	80
1975 1	1351.000	1378.220	-27.220	-0.020	81
1975 2	1421.000	1395.571	25.429	0.018	82
1975 3	1315.000	1387.763	-72.763	-0.054	83
1975 4	1280.000	1382.062	-102.062	-0.077	84
1976 1	1376.000	1447.138	-71.138	-0.050	85
1976 2	1403.000	1381.283	21.717	0.016	86
1976 3	1386.000	1381.880	4.120	0.003	87
1976 4	1476.000	1339.105	136.895	0.097	88
1977 1	1335.000	1298.088	36.912	0.028	89
1977 2	1262.000	1263.680	-1.680	-0.001	90
1977 3	1289.000	1308.006	-19.006	-0.015	91
1977 4	1338.000	1385.597	-47.597	-0.035	92
1978 1	1456.000	1448.176	7.824	0.005	93
1978 2	1493.000	1486.055	6.945	0.005	94
1978 3	1556.000	1510.905	45.095	0.029	95
1978 4	1500.000	1528.197	-28.197	-0.019	96
1979 1	1547.000	1550.636	-3.636	-0.002	97
1979 2	1942.000	1559.713	-17.713	-0.009	98
1979 3	1576.000	1599.200	-23.200	-0.015	99
1979 4	1685.000	1611.196	73.804	0.045	100
1980 1	1629.000	1606.636	22.364	0.014	101
1980 2	1492.000	1585.146	-93.146	-0.061	102
1980 3	1512.000	1568.269	-56.269	-0.037	103
1980 4	1471.000	1590.773	-119.773	-0.078	104
1981 1	1557.000	1595.984	-38.984	-0.025	105
1981 2	1550.000	1588.046	-38.046	-0.024	106
1981 3	1534.000	1595.946	-61.946	-0.040	107
1981 4	1541.000	1589.396	-48.396	-0.031	108
1982 1	1504.000	1610.163	-106.163	-0.068	109
1982 2	1518.000	1644.920	-126.920	-0.080	110



MSE= 0.002 RMS= 0.043 RHO= 0.511
MEAN ERR= -0.0085 . MEAN= 1458.7351
UNNORMALISED ERRORS, MEAN = -13.9257 RMSE = 62.9703

Expenditure on durables, like non-durables, is principally determined by changes in persons real disposable income and the past ratios of consumption to income and real net liquidity to income. Income is again adjusted to allow for effects of inflation, and the lags are averaged over the previous four quarters. However, additional variables are also included: a measure of hire purchase controls, (RMD the effective minimum deposit on durables) and the level of real mortgage lending (by banks LHBB, building societies LZNA and the public sector LHPG) and of the real interest rate (banks base rate RCBR relative to consumer prices PC).

The flow of mortgages is intended to capture both the correlation of house purchase with durable purchase, and the fact that, at the time of property exchange houseowners are often able to extract equity from their houses. (The latter process is a realisation of accumulated illiquid wealth.) The level of the real interest rate is intended to represent the return to holding assets in financial, as opposed to real, form, and also the real price of credit.

Current developments

The success or failure of these specifications of consumption function in a model context depends upon (amongst other things) how net liquid assets are derived. In the model described here, net liquid assets rise on average by half current saving in each period. This is not satisfactory, and recent research has been aimed at producing an equation for net liquid assets relating this to wider definitions of wealth and to interest rates.

Omitted from both consumption functions is any explicit allowance for substitution between durables and non-durables. Within the same general framework, the relative prices of durables or non-durables to the aggregate consumer price deflator have been tried as regressors; the results so far only provide explicit evidence for such a substitution effect within the durables equation.

FIXED INVESTMENT

At constant prices

$$\frac{IND}{KND_{-1}} = \underset{(9.1)}{0.00821} + \underset{(3.5)}{0.00071} (D681_{-3} - D681_{-4})$$

$$+ \underset{(4.4)}{618.22708} \frac{1}{KND_{-1}} + \sum_{i=1}^{13} A_i \Delta \left[\frac{(MPRO + OOTH - OOPC - IIF)}{KND_{t-i-1}} \right]_{-i}$$

$$+ \underset{(3.1)}{0.43540} u_{-1}$$

$$A_{1-13} = \underset{(1.5)}{0.0509927}; \underset{(4.1)}{0.1070319}; \underset{(5.3)}{0.1492783}; \underset{(6.1)}{0.1786680};$$

$$\underset{(7.0)}{0.1961383}; \underset{(7.8)}{0.2026269}; \underset{(8.1)}{0.1990697}; \underset{(7.3)}{0.1864045};$$

$$\underset{(6.0)}{0.1655682}; \underset{(4.8)}{0.1374972}; \underset{(3.8)}{0.1031295}; \underset{(2.4)}{0.0634017};$$

$$\underset{(0.6)}{0.0192506}$$

$$\Sigma A_i = \underset{(7.1)}{1.7590542}$$

$\bar{R}^2 = 0.93$ SE = 0.0004 1967 IV - 1978 IV

(183) $KND = 0.99634\ KND_{-1} + IND$

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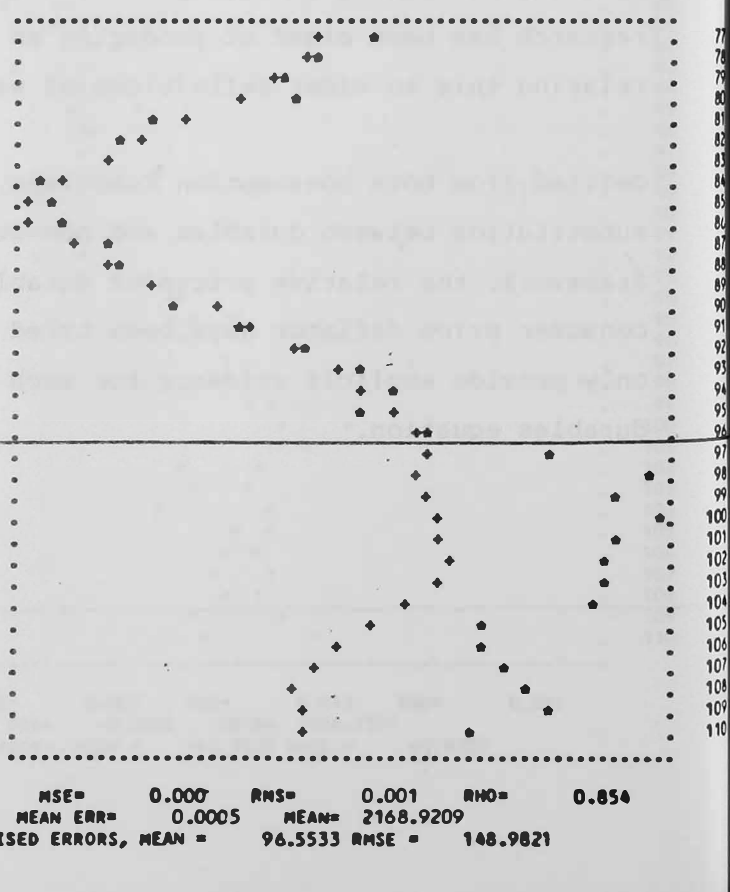
RANGE 1753.23 TO 2540.30

339	ACTUAL IND *	SOLUTION IND +	RESIDUALS	NORMALIZED
1974 1	2175.000	2118.773	56.227	0.000
1974 2	2107.000	2096.697	10.303	0.000
1974 3	2065.000	2055.018	9.982	0.000
1974 4	2079.000	2012.352	66.648	0.000
1975 1	1910.000	1952.907	-42.907	-0.000
1975 2	1870.000	1894.938	-24.938	-0.000
1975 3	1844.000	1843.604	0.396	0.000
1975 4	1773.000	1794.456	-21.456	-0.000
1976 1	1778.000	1756.550	21.450	0.000
1976 2	1801.000	1753.227	47.773	0.000
1976 3	1843.000	1802.672	40.328	0.000
1976 4	1857.000	1849.837	7.163	0.000
1977 1	1902.000	1908.044	-6.044	-0.000
1977 2	1936.000	1986.256	-50.256	-0.000
1977 3	2020.000	2031.397	-11.397	-0.000
1977 4	2092.000	2081.293	10.707	0.000
1978 1	2171.000	2136.551	34.449	0.000
1978 2	2209.400	2173.847	35.552	0.000
1978 3	2172.600	2205.177	-32.577	-0.000
1978 4	2246.500	2239.478	7.022	0.000
1979 1	2398.700	2255.811	142.889	0.001
1979 2	2530.500	2236.976	293.524	0.002
1979 3	2484.600	2254.630	229.970	0.001
1979 4	2540.300	2267.150	273.150	0.001
1980 1	2489.900	2266.912	222.988	0.001
1980 2	2466.600	2273.833	192.767	0.001
1980 3	2464.600	2264.565	200.035	0.001
1980 4	2463.300	2226.441	236.859	0.001
1981 1	2314.400	2184.651	129.749	0.001
1981 2	2321.100	2144.995	176.105	0.001
1981 3	2348.600	2109.077	239.523	0.001
1981 4	2373.400	2090.817	282.583	0.001
1982 1	2395.500	2099.450	296.050	0.001
1982 2	2300.400	2092.205	208.195	0.001



MSE= 0.000 RMS= 0.001 RHO= 0.854

MEAN ERR= 0.0005 MEAN= 2168.9209

UNNORMALISED ERRORS, MEAN = 96.5533 RMSE = 148.9821

Fixed Investment

Private non-residential fixed investment is divided into three categories:- industrial investment, North-Sea investment and a residual category. Industrial investment (IND) includes investment both by manufacturing industry and distribution and services, and is the main behavioural category. The equation is a simple accelerator relating investment to changes in private sector output (MPRO and OOTH adjusted for changes in finished goods stocks (IIF) and the output of public corporations (OOPC)) over thirteen quarters, via a cubic Almon polynomial, and the lagged capital stock.

The equation does not incorporate any financial influences on investment. The work relating investment to the valuation ratio q has not produced an equation which is superior to a conventional accelerator model. (Jenkinson 1981). Furthermore, since it has not been possible, so far, to derive a satisfactory means in the model to proxying q or its determinants, the accelerator approach has been maintained. None of this need imply that financial effects on investment are unimportant; merely that the specifications tried so far which utilise financial variables have proved no more successful than those that don't.

The equation has consistently under-predicted investment from 1979 onwards, by an average of 1975 £200 million a quarter. This under-prediction has yet to be explained. On the one hand, along with the recent performance of the employment equations, it is consistent with a rise in the aggregate capital-labour ratio; on the other, the equation for the deflator for industrial investment over-predicts from 1979 onwards, which may indicate changes at the micro-level in the type of investment being made or measurement problems.

where the index for the price of all houses adjusted for changes in the mix of houses sold and mortgaged by building societies is given by

$$
\begin{aligned}
\Delta \ln PAHM = {} & \underset{(2.8)}{19.44463}\ \Delta \ln PAHM^{3}_{-1} + \underset{(1.4)}{0.45720}\ \Delta \ln PAHM_{-2} \\
& + \underset{(3.4)}{0.27342}\ \ln (RPDI/(ROOT*19000))_{-1} \\
& + \underset{(3.4)}{0.08896}\ \ln ((KZNA + KHBB + KHPG)/PAHM)_{-1} \\
& - \underset{(3.6)}{1.21577}\ (RZMG/100.0*(1-TRY/100))_{-1} \\
& + \underset{(1.2)}{0.04398}\ (3\,\Delta \ln RPDI + 2\,\Delta \ln RPDI_{-1} + \Delta \ln RPDI_{-2}) \\
& + \underset{(0.1)}{0.05132}\ \Delta \ln ((KZNA + KHBB + KHPG)/PAHM)_{-2} \\
& - \underset{(2.8)}{1.39385}\ \Delta (RZMG/100*(1-TRY/100)) \\
& - \underset{(3.7)}{0.96789} - \underset{(0.4)}{0.00224}\ Q1 + \underset{(2.9)}{0.01620}\ Q2 \\
& + \underset{(4.6)}{0.02565}\ Q3
\end{aligned}
$$

$\bar{R}^2 = 0.791$ SE = 0.014 DW = 1.3 1969 II - 1981 IV

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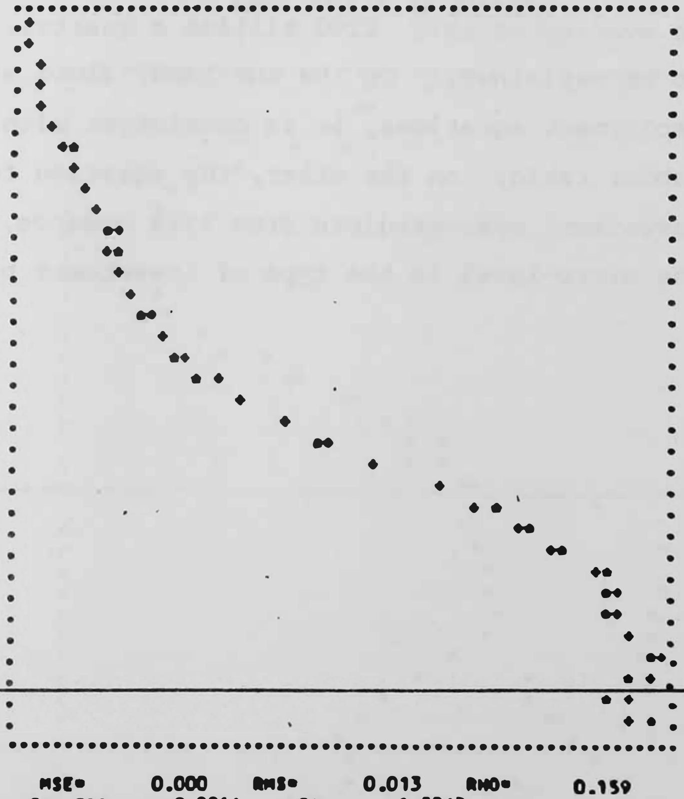
RANGE 0.93 TO 2.31

16	ACTUAL PAHM *	SOLUTION PAHM +	RESIDUALS	NORMALIZED	
1974 1	0.930	0.931	-0.001	-0.001	77
1974 2	0.940	0.936	0.004	0.005	78
1974 3	0.950	0.956	-0.006	-0.006	79
1974 4	0.960	0.951	0.009	0.010	80
1975 1	0.960	0.962	-0.002	-0.002	81
1975 2	0.990	0.985	0.005	0.005	82
1975 3	1.020	1.012	0.008	0.008	83
1975 4	1.030	1.031	-0.001	-0.001	84
1976 1	1.050	1.043	0.007	0.007	85
1976 2	1.080	1.078	0.002	0.002	86
1976 3	1.100	1.124	-0.024	-0.022	87
1976 4	1.120	1.110	0.010	0.009	88
1977 1	1.130	1.118	0.012	0.011	89
1977 2	1.150	1.147	0.003	0.002	90
1977 3	1.180	1.186	-0.006	-0.005	91
1977 4	1.220	1.216	0.004	0.003	92
1978 1	1.240	1.278	-0.038	-0.030	93
1978 2	1.300	1.331	-0.031	-0.024	94
1978 3	1.390	1.397	-0.007	-0.005	95
1978 4	1.490	1.481	0.009	0.006	96
1979 1	1.570	1.578	-0.008	-0.005	97
1979 2	1.690	1.685	0.005	0.003	98
1979 3	1.820	1.823	-0.003	-0.002	99
1979 4	1.940	1.912	0.028	0.015	100
1980 1	2.020	1.995	0.025	0.013	101
1980 2	2.100	2.083	0.017	0.008	102
1980 3	2.190	2.163	0.027	0.012	103
1980 4	2.190	2.225	-0.035	-0.016	104
1981 1	2.190	2.228	-0.038	-0.017	105
1981 2	2.250	2.244	0.006	0.003	106
1981 3	2.290	2.314	-0.024	-0.010	107
1981 4	2.250	2.296	-0.046	-0.020	108
1982 1	2.190	2.248	-0.058	-0.026	109
1982 2	2.290	2.234	0.056	0.025	110



MSE= 0.000 RMS= 0.013 RHO= 0.159
MEAN ERR= -0.0014 MEAN= 1.5062
UNNORMALISED ERRORS, MEAN = -0.0026 RMSE = 0.0231

Private: fixed residential

$$IHP = \underset{(7.9)}{0.66786}\ IHP_{-1} + \underset{(1.5)}{50.86511}(PAHM/(0.444\ PIMN + 0.556\ ULC))$$

$$-\underset{(4.4)}{10.4558}\ RCBR + \underset{(4.3)}{218.76759}$$

$\bar{R}^2 = 0.822$ SE = 35.8 DW = 2.1 1968 II-1981 IV

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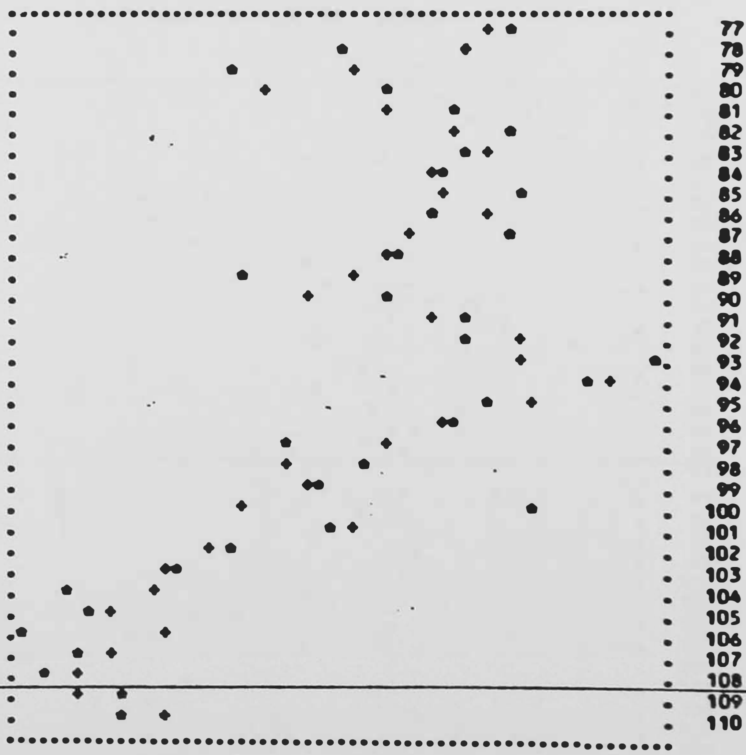
5	ACTUAL IHP •	SOLUTION IHP +	RESIDUALS	NORMALIZED
74 1	567.000	553.264	13.736	13.736
74 2	487.000	546.758	-59.758	-59.758
74 3	439.000	491.556	-52.556	-52.556
74 4	511.000	455.327	55.673	55.673
75 1	538.000	506.751	31.249	31.249
75 2	566.000	541.245	24.755	24.755
75 3	544.000	555.386	-11.386	-11.386
75 4	534.000	527.668	6.332	6.332
76 1	571.000	532.741	38.259	38.259
76 2	531.000	553.124	-22.124	-22.124
76 3	565.000	518.645	46.355	46.355
76 4	513.000	509.496	3.504	3.504
77 1	443.000	491.273	-48.273	-48.273
77 2	511.000	475.002	35.998	35.998
77 3	542.000	530.558	11.442	11.442
77 4	543.000	568.436	-25.436	-25.436
78 1	631.000	567.471	63.529	63.529
78 2	599.000	609.104	-10.104	-10.104
78 3	557.000	572.694	-15.694	-15.694
78 4	540.000	532.435	7.565	7.565
79 1	463.000	506.564	-43.564	-43.564
79 2	500.000	462.181	37.819	37.819
79 3	480.000	472.418	7.582	7.582
79 4	574.000	445.085	128.915	128.915
80 1	482.000	491.647	-9.647	-9.647
80 2	436.000	429.378	6.622	6.622
80 3	411.000	409.007	1.993	1.993
80 4	363.000	399.813	-36.813	-36.813
81 1	374.000	383.767	-9.767	-9.767
81 2	341.000	407.010	-66.010	-66.010
81 3	365.000	381.326	-16.326	-16.326
81 4	350.000	366.055	-16.055	-16.055
82 1	389.000	367.325	21.675	21.675
82 2	387.000	404.758	-17.758	-17.758

RANGE 341.00 TO 631.00



MSE= 1517.736 RMS= 38.958 RHO= -0.090
MEAN ERR= 2.4039 MEAN= 489.6174
UNNORMALISED ERRORS, MEAN = 2.4039 RMSE = 38.9581

Private sector residential investment

The importance of the housing sector of the model is that it is one of the few areas where interest rates have a direct effect on expenditure volumes. Residential investment (IHP) is related to a composite of house prices (PAHM) relative to builders costs (wages costs ULC and bought in costs PIMN, and an interest rate RCBR) included as a proxy for the profit that can be made from construction.

House prices (PAHM) are determined principally by real incomes (RPDI), the stock of mortgages (KZNA + KHBB + KHPG) relative to house prices, and interest rates (RZMG). The short run dynamics of the equation are quite complex because of the characteristic volatility of the market. This can have unfortunate repercussions for overall model properties (see Chapter II and IV).

Basic materials, fuels and work in progress

(453) $KIIB = KIIB_{-1} + IIB$

(450)
$$\begin{aligned} IIB = {} & \underset{(4.4)}{0.58506}\ MPRO^* + \underset{(1.0)}{0.15545}\ (MG2+MGIM-MGZ^*) + \underset{(4.5)}{0.5729}\ MPRO \\ & - \underset{(1.7)}{0.26935}\ MPRO^* \left[\frac{MPRO}{MPRO^*} - \frac{MPRO_{-1}}{MPRO^*_{-1}} \right] \\ & + \underset{(0.3)}{0.00602}\ MPRO^*.(-D741+0.75\ D741_{-1}+0.25\ D741_{-2}) \\ & - \underset{(0.8)}{0.12077}\ MPRO^* \left[\frac{1+0.01\ RLA}{1+0.01\ R^*} - \left\{ \frac{1+0.1\ RLA}{1+0.1\ R^*} \right\}_{-1} \right] \\ & + \underset{(1.1)}{0.04831}\ MPRO^* \left[\frac{YCTP_{-1} + RESE_{-1}}{YCR^*} \right] \left[2.432 - \frac{KIIB_{-2}}{MPRO^*_{-1}} \right] \end{aligned}$$

$\bar{R}^2 = 0.522$ SE = 122.2 DW = 1.7 1965 I-1978 II

where

$$MPRO^* = \left[\sum_{i=0}^{7} 0.95^i\ MPRO_{-i} \right] \Big/ \sum_{i=0}^{7} 0.95^i$$

$$YCR^* = \left[\sum_{i=0}^{7} 0.95^i\ (YCTP_{-1} + RESE_{-1})_{-i} \right] \Big/ \sum_{i=0}^{7} 0.95^i$$

$$MGZ^* = \left[\sum_{i=0}^{7} 0.95^i\ (MG2 + MGIM)_{-i} \right] \Big/ \sum_{i=0}^{7} 0.95^i$$

$$R^* = 100 \left[\frac{0.7\ (WS - WS_{-4})}{WS_{-4}} + \frac{0.3\ (PM - PM_{-4})}{PM_{-4}} \right]$$

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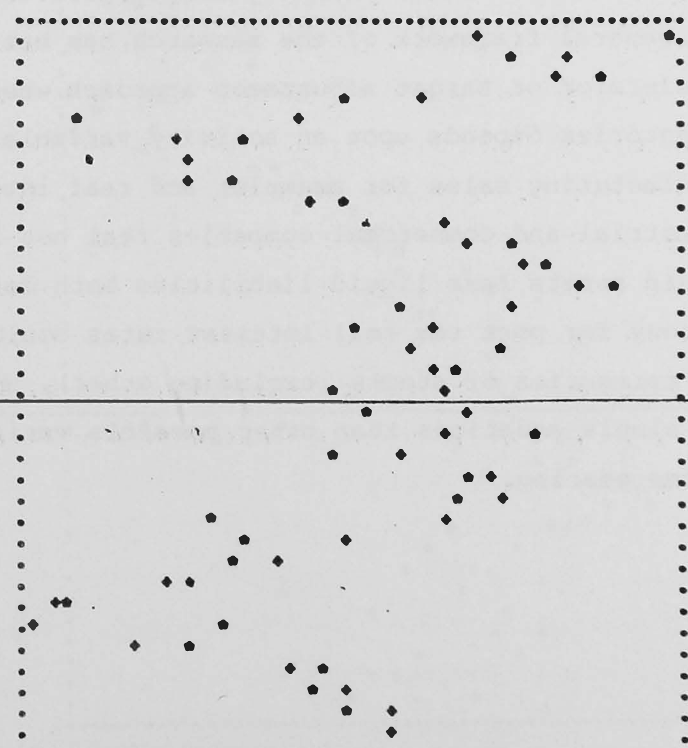
RANGE -444.31 TO 355.00

	ACTUAL IIB *	SOLUTION IIB +	RESIDUALS	NORMALIZED	
1	355.000	116.389	238.611	238.611	77
2	154.000	225.900	-71.900	-71.900	78
3	273.000	213.100	59.900	59.900	79
4	-47.000	50.450	-97.450	-97.450	80
1	-393.000	-102.777	-290.223	-290.223	81
2	-178.000	-255.650	77.650	77.650	82
3	-370.000	-248.106	-121.894	-121.894	83
4	-194.000	-245.351	51.351	51.351	84
1	-47.000	-100.076	53.076	53.076	85
2	-21.000	73.418	-94.418	-94.418	86
3	153.000	103.841	49.159	49.159	87
4	207.000	173.093	33.907	33.907	88
1	278.000	242.589	35.411	35.411	89
2	23.000	165.432	-142.432	-142.432	90
3	-35.000	61.665	-96.665	-96.665	91
4	139.000	30.409	108.591	108.591	92
1	86.000	56.600	29.400	29.400	93
2	-66.000	72.838	-138.838	-138.838	94
3	-25.000	109.248	-134.248	-134.248	95
4	180.000	74.947	105.053	105.053	96
1	-63.000	18.574	-81.574	-81.574	97
2	97.000	131.196	-34.196	-34.196	98
3	90.000	139.754	-49.754	-49.754	99
4	-219.000	69.105	-288.105	-288.105	100
1	-178.000	-48.861	-129.139	-129.139	101
2	-193.000	-130.505	-62.495	-62.495	102
3	-247.000	-273.381	26.381	26.381	103
4	-401.000	-410.746	9.746	9.746	104
1	-203.000	-444.309	241.309	241.309	105
2	-247.000	-315.439	68.439	68.439	106
3	-85.000	-120.890	35.890	35.890	107
4	-92.000	-48.143	-43.857	-43.857	108
1	-45.000	-1.445	-43.555	-43.555	109
2	3.000	8.677	-5.677	-5.677	110



MSE= 13907.289 RMS= 117.929 RHO= 0.041
MEAN ERR= -20.6631 MEAN= -38.5588
UNNORMALISED ERRORS, MEAN = -20.6631 RMSE = 117.9292

Stockbuilding

Stockbuilding is modelled at two levels of disaggregation. Whole economy stockbuilding is divided into finished goods; materials, fuel and work in progress held by manufacturers; and all others. Stocks of finished goods are then allocated between manufactures and distributors.

The equations for finished goods, and for materials and work in progress are of the inflows minus outflows approach. Inflows are modelled as a function of orders, which in turn depend upon trend demand or output, the deviation of stocks from a desired level (typically a trend stock output ratio) and on financial factors. Shocks in the supply of the orders are also considered. Outflows are modelled as a function of final expenditure in the case of finished goods and of manufacturing output in the case of materials stocks. Although financial factors are included their effects are small. A typical equation, that for materials and fuel and work in progress held by manufacturers (IIB), is shown opposite.

Current developments

It is thought that financial influences on stockbuilding are greater than captured in the current equations. Current research has concentrated on a different categorisation of stocks namely raw materials and fuels held by manufacturers; finished goods (including work in progress) held by manufacturers; stocks held by wholesalers and retailers and other stocks. The general framework of the research has been that of the flexible accelerator or target adjustment approach where the desired stock of inventories depends upon an activity variable (manufacturing output or manufacturing sales for example) and real interest rates or liquidity. Industrial and commercial companies real net liquidity (stock of gross liquid assets less liquid liabilities both deflated by the TFE deflator) and a proxy for post tax real interest rates could be included in equations for all categories of stocks (excluding other), and performed better there in the single equations than other possible variables such as net or gross income gearing.

EXPORTS

$$\ln XGMA = 0.78075 \ln WTX - 0.15991\ D674 - 0.5070056 \ln NULE$$
(5.9) (5.5) (2.4)

$$-0.14012\ D72A + 0.07739\ D72A_{-1} + 7.55108 - 0.01217\ TIME$$
(5.1) (2.8) (5.9) (2.3)

$$+0.00006060\ TIME^2$$
(2.2)

$\bar{R}^2 = 0.988$ SE = 0.026 DW = 1.8 1965 I-1978 IV

where the index of "effective" labour cost competitiveness is defined thus:

$$NULE = \exp \left[\left(\sum_{i=0}^{16} A_i \ln NULC_{-i} \right) / (-0.5070) \right]$$

A_{0-16} = -0.0282;	-0.0315;	-0.0342;	-0.0362;	-0.0377;	-0.0385;
(1.0)	(1.3)	(1.6)	(1.8)	(2.0)	(2.2)
-0.0387;	-0.0383;	-0.0373;	-0.0356;	-0.0333;	-0.0305;
(2.3)	(2.4)	(2.4)	(2.4)	(2.3)	(2.3)
-0.0269;	-0.0228;	-0.0180;	-0.0126;	-0.0066	
(2.3)	(2.2)	(2.2)	(2.1)	(2.1	

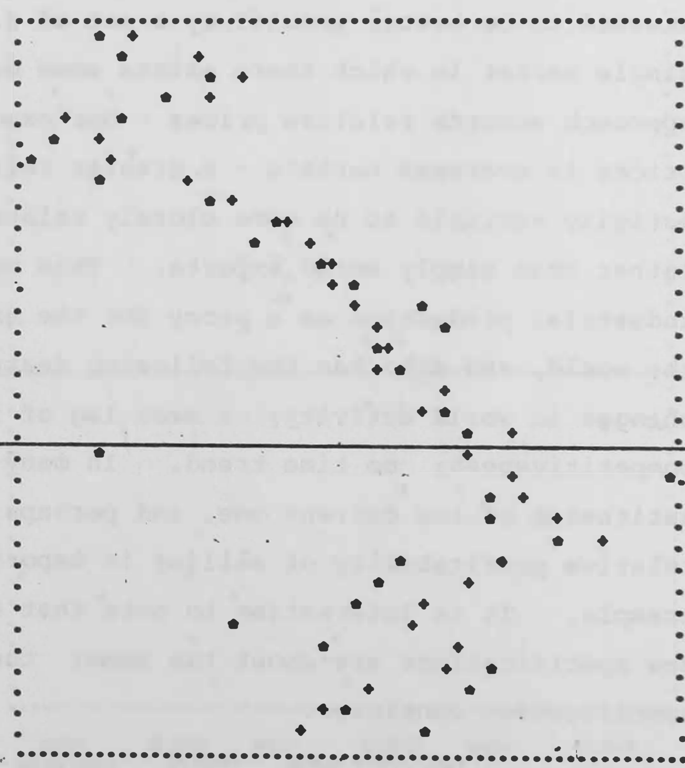
$$\Sigma A_i = -0.5070$$
(2.3)

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 3680.88 TO 4770.12

34

	ACTUAL XGMA *	SOLUTION XGMA +	RESIDUALS	NORMALIZED	
1974 1	3793.560	3846.262	-52.702	-0.014	77
1974 2	3831.120	3964.414	-133.294	-0.034	78
1974 3	3981.360	4045.880	-64.520	-0.016	79
1974 4	3906.240	3986.065	-79.825	-0.020	80
1975 1	3831.120	3736.239	94.881	0.025	81
1975 2	3718.440	3792.504	-74.064	-0.020	82
1975 3	3680.880	3805.707	-124.827	-0.033	83
1975 4	3793.560	3946.654	-153.094	-0.040	84
1976 1	3981.360	4021.019	-39.659	-0.010	85
1976 2	4094.040	4115.293	-21.253	-0.005	86
1976 3	4056.480	4156.355	-99.875	-0.024	87
1976 4	4169.156	4199.207	-30.051	-0.007	88
1977 1	4244.277	4198.785	45.492	0.011	89
1977 2	4356.957	4239.977	116.980	0.027	90
1977 3	4394.520	4278.832	115.687	0.027	91
1977 4	4281.840	4292.352	-10.512	-0.002	92
1978 1	4319.398	4266.855	52.543	0.012	93
1978 2	4394.520	4384.203	10.316	0.002	94
1978 3	4394.520	4344.906	49.613	0.011	95
1978 4	4432.078	4496.523	-64.445	-0.014	96
1979 1	3793.560	4426.687	-633.128	-0.154	97
1979 2	4770.117	4501.141	268.977	0.058	98
1979 3	4469.637	4520.734	-51.098	-0.011	99
1979 4	4469.637	4570.363	-100.727	-0.022	100
1980 1	4582.316	4661.793	-79.477	-0.017	101
1980 2	4319.398	4491.719	-172.320	-0.039	102
1980 3	4281.840	4418.637	-136.797	-0.031	103
1980 4	4244.277	4342.266	-97.988	-0.023	104
1981 1	4018.920	4330.406	-311.486	-0.075	105
1981 2	4169.156	4410.187	-241.031	-0.056	106
1981 3	4469.637	4383.129	86.508	0.020	107
1981 4	4432.078	4263.352	168.727	0.039	108
1982 1	4206.719	4185.324	21.395	0.005	109
1982 2	4356.957	4147.508	209.449	0.049	110



RSE= 0.002 RMS= 0.039 RHO= 0.021
MEAN ERR= -0.0113 MEAN= 4183.5039
UNNORMALISED ERRORS, MEAN = -45.0472 RMSE = 164.6654

Exports of manufactures

The current specification for exports of manufactures was discussed in Enoch (1978). Exports (XGMA) are related to UK weighted world trade in manufactures (WTX) - a demand factor - and to normalised relative unit labour costs (NULC), which has been interpreted as embracing both demand and supply influences. Up to sixteen lags of cost competitiveness are included; the average lag is six though. However, no lags of world trade could be included. The equation also requires an attenuated time trend.

As with some of the more key equations in the model, this equation has been subject to a substantial degree of testing. Not surprisingly, the long run coefficient on competitiveness is particularly sensitive to minor changes to the specification such as the imposition or not of the end point constraint on the Almon polynomial and to the estimation period. Whilst such parameter instability is of concern, alternative specifications (see Brooks 1984) appear to have related problems.

Current Developments

This equation for manufactured exports is currently (Hotson and Gardiner 1983) being re-examined as part of a wider research project into the manufacturing sector involving domestic prices, trade prices, export volumes and output. In this work, the world market for manufactured goods is assumed to be better proxied by a set of discriminated markets rather than a single market in which there exists some market clearing price. This approach accords relative prices - our export prices relative to wholesale prices in overseas markets - a greater role, and also requires the world activity variable to be more closely related to demand within countries rather than simply world exports. This most recent work uses OECD industrial production as a proxy for the ex post demand for manufactures in the world, and also has the following features: lagged adjustment to changes in world activity; a mean lag of five quarters to changes in price competitiveness; no time trend. In many ways, this approach is the antithesis of the current one, and perhaps lacks some supply influence - relative profitability of selling in export rather than domestic markets for example. It is interesting to note that the standard error of the old and new specifications are about the same; the search for a more general specification continues.

Derivation of output of finished manufactures

Proxy for demand

$$\frac{MND}{EFC} = \underset{(16.8)}{1.59946}\left[\frac{0.13\ CND + 0.5\ CD + 0.139G}{EFC}\right] + 2.0\ \underline{/}(0.4\ INP$$

$$+ 0.2\ IHP \quad + 0.32\ ING + 0.2\ IHG + 0.3\ IIB + 0.4\ IIW$$

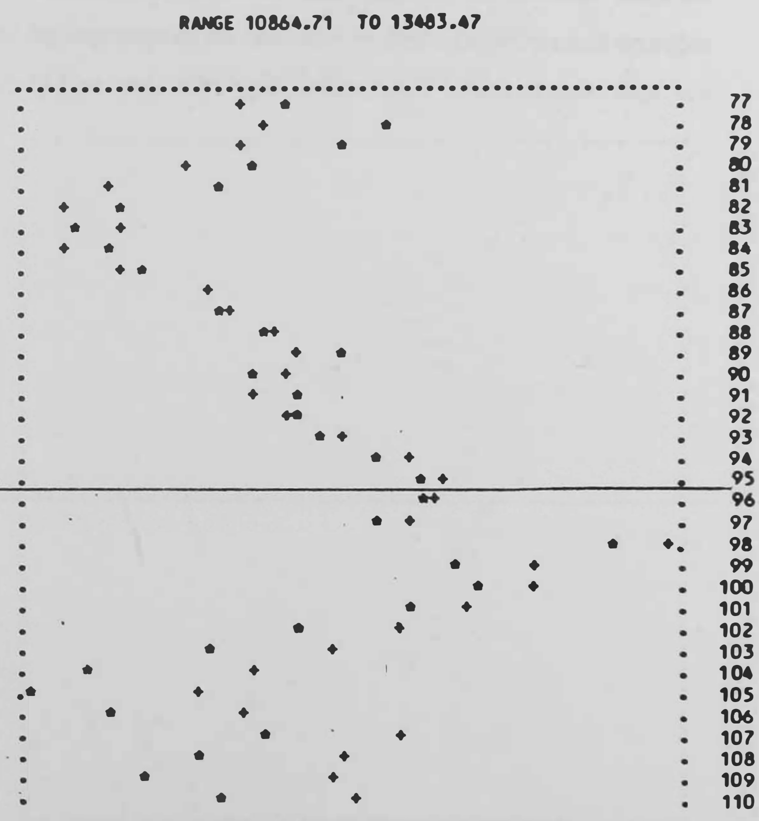
$$+ 0.4\ IIR + 0.25\ IIO - 0.5(GDPE-GDPO))/EFC\underline{\overline{/}}$$

$$+ \underset{(6.6)}{0.59043}\ \frac{XGMA}{EFC} + \underset{(6.4)}{0.68270}\ u_{-1}$$

$\bar{R}^2 = 0.999 \quad SE = 0.004 \quad 1965\ II-1978\ III$

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

455	ACTUAL MND *	SOLUTION MND +	RESIDUALS	NORMALIZED
74 1	11923.199	11718.195	205.004	0.006
74 2	1233?.574	11821.812	511.762	0.015
74 3	1214?.441	11744.496	401.945	0.012
74 4	11769.844	11514.297	255.547	0.007
75 1	11655.246	11167.609	487.637	0.014
75 2	11221.145	11014.695	206.449	0.006
75 3	11068.863	11241.168	-172.305	-0.005
75 4	11197.770	10996.230	201.539	0.006
76 1	11309.691	11244.945	64.746	0.002
76 2	11590.484	11596.953	-6.469	-0.000
76 3	11667.934	11705.840	-37.906	-0.001
76 4	11833.930	11888.945	-55.016	-0.002
77 1	12145.344	11984.395	160.949	0.005
77 2	11774.477	11899.164	-124.687	-0.004
77 3	11951.312	11771.148	180.164	0.005
77 4	11988.215	11942.156	46.059	0.001
78 1	12063.840	12150.965	-87.125	-0.002
78 2	12302.937	12409.719	-106.781	-0.003
78 3	12453.906	12567.160	-113.254	-0.003
978 4	12453.488	12507.266	-53.777	-0.001
979 1	12278.906	12439.172	-160.266	-0.004
979 2	13235.398	13483.469	-248.070	-0.007
979 3	12607.387	12918.852	-311.465	-0.009
979 4	12715.336	12954.375	-239.039	-0.006
980 1	12418.094	12668.426	-250.332	-0.007
980 2	11955.266	12386.984	-431.719	-0.012
980 3	11611.941	12084.266	-472.324	-0.013
980 4	11097.746	11781.984	-684.238	-0.018
981 1	10864.715	11566.945	-702.230	-0.019
981 2	11183.543	11746.875	-563.332	-0.015
981 3	11827.090	12385.719	-558.629	-0.015
981 4	11576.477	12129.738	-553.262	-0.015
982 1	11318.336	12126.355	-808.020	-0.022
982 2	11647.832	12174.723	-526.891	-0.014



MSE= 0.000 RMS= 0.010 RHO= 0.847

MEAN ERR= -0.0035 MEAN= 11858.4961

UNNORMALISED ERRORS, MEAN = -133.6863 RMSE = 365.4885

Manufacturing Output and Imports of finished manufactures

The current framework for modelling the manufacturing sector output and imports of finished manufactures relies on two equations; one proxying the UK demand for finished manufactures (MND), and the second apportioning that demand between the sources from which it is met, domestic production (MPRM) and imports (MGFM). The data for the demand series (MND) is constructed from the ex post identity between the supply of and demand for finished manufactures; demand (MND) is equal to gross output (1.67 x net output MPRM) plus imports (MGFM) less stockbuilding (IIFM). This constructed demand series is then the dependent variable in an equation which relates the demand for finished manufactures to the expenditure components of GDP. The coefficients on the expenditure terms are largely derived from input - output weights but with some estimation.

The MND equation has tended to overpredict quite substantially in recent years. The gross to net output ratio has risen through time which raises the estimates of MND which assume this factor is constant. Another reason for the poor tracking may be the divergence between the output and expenditure measures of GDP; actual data for MND are derived in part from output measures while the predicted values of MND are based solely on expenditure measures. Some attempt to allow for GDP discrepancies is made in the equation, but this may not be sufficient.

Allocation to domestic output

$$\frac{1.67\ MPRM - IIFM - 0.68321\ XGMA}{MND - 0.68321\ XGMA} = \underset{(6.0)}{1.21048} - \underset{(8.5)}{0.00504}\ TIME$$

$$+ \underset{(3.2)}{0.31149}\left[\frac{\tfrac{1}{2}\sum_{i=o}^{7}(MND - 0.68321\ XGMA)_{-i}}{MND - 0.68321\ XGMA}\right]$$

$$- \underset{(2.4)}{0.29599}\ \tfrac{1}{2}\left[\tfrac{1}{2}\left[\sum_{i=o}^{1}\left(\frac{PIMO}{UMM}\right)_{-i} + \sum_{i=o}^{2} A_i\left(\frac{NULC}{100}\right)_{-i}\right]\right]$$

$$+ \underset{(3.9)}{0.47429}\ u_{-1} - D821^{*}(TIME-108)^{*}0.00125$$

$$A_{0-2} = 0.25;\ 0.50;\ 0.25$$

$$\bar{R}^2 = 0.917 \quad SE = 0.0170 \quad 1965\ I - 1978\ I$$

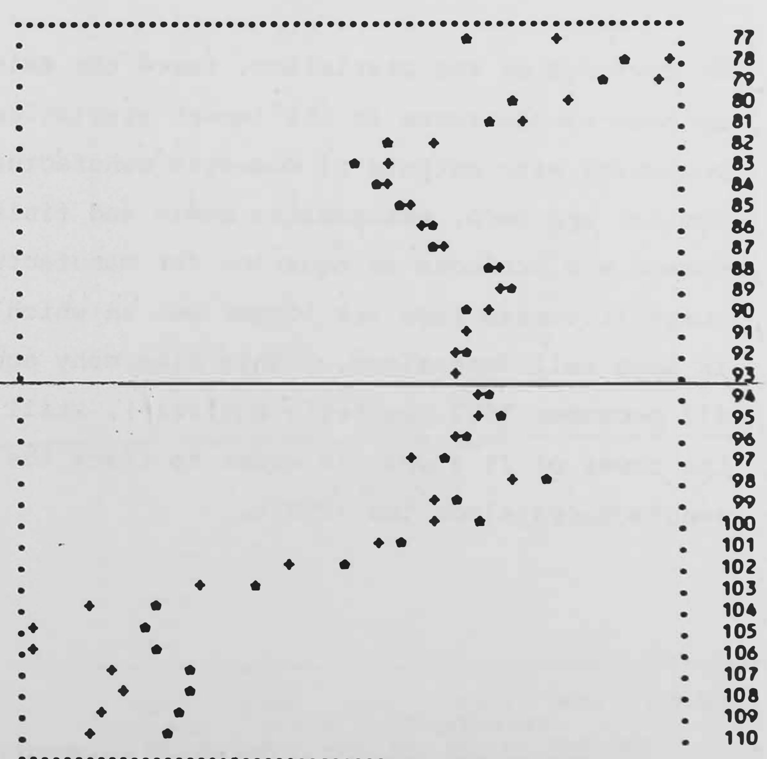
Finished manufactures

$$MGFM = MND + IIFM - 1.67\ MPRM$$

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

457	ACTUAL MPRM *	SOLUTION MPRM +	RESIDUALS	NORMALIZED
74 1	6056.070	6335.309	-279.238	-0.050
74 2	6525.402	6680.934	-155.531	-0.027
74 3	6480.941	6634.098	-153.156	-0.027
74 4	6191.117	6364.098	-172.980	-0.032
75 1	6113.270	6222.152	-108.883	-0.020
75 2	5801.586	5932.496	-130.910	-0.025
75 3	5714.348	5806.937	-92.590	-0.018
75 4	5758.848	5811.816	-52.969	-0.010
76 1	5854.609	5870.238	-15.629	-0.003
76 2	5931.691	5923.125	8.566	0.002
76 3	5940.480	5962.230	-21.750	-0.004
76 4	6108.211	6145.012	-36.801	-0.007
77 1	6172.848	6168.922	3.926	0.001
77 2	6062.922	6133.086	-70.164	-0.013
77 3	6033.199	6066.461	-33.262	-0.006
77 4	6033.141	6005.082	28.059	0.005
78 1	6025.160	6027.652	-2.492	-0.000
78 2	6135.469	6074.426	61.043	0.011
73 3	6156 547	6098.762	57.785	0.010
78 4	6063.727	6016.027	47.699	0.008
79 1	5995.074	5879.137	115.937	0.020
79 2	6295.430	6184.879	110.551	0.019
79 3	6021.172	5932.949	88.223	0.015
79 4	6074.816	5937.516	137.301	0.024
80 1	5841.070	5759.207	81.863	0.015
80 2	5647.801	5505.379	142.422	0.026
80 3	5388.008	5199.579	188.430	0.036
80 4	5058.344	4865.449	192.895	0.039
81 1	5018.488	4682.199	336.289	0.069
81 2	5067.656	4692.496	375.160	0.075
81 3	5179.168	4944.738	234.430	0.045
81 4	5162.004	4953.766	203.238	0.040
82 1	5121.062	4888.465	232.598	0.046
82 2	5086.020	4871.238	214.781	0.041

RANGE 4682.20 TO 6680.93



RSE= 0.001 RMS= 0.030 RHO= 0.926
MEAN ERR= 0.0089 MEAN= 5826.9102
UNNORMALISED ERRORS, MEAN = 85.1423 RMSE = 156.9730

Demand for finished manufactures can be satisfied either from domestic production, stocks or imports. In the model, the share met from domestic production is determined by competitiveness, and the change in demand and a time trend. Partial adjustment of output to changes in demand is provided for, implying that imports act as a buffer in the short run. The short run (one year) elasticity of imports to demand is 1.7, whereas in the long run it falls to 1.2. Both price - wholesale output prices relative to import prices - and cost - IMF normalised unit labour costs - competitiveness terms are included. Imports of finished manufactures (MGFM) are then obtained by inverting the data construction identity for ex post demand.

The equation has shown a tendency to underpredict the share of demand met by domestic production. Over the current recession the problem of underprediction has increased, possibly because the equation fails to capture the effects on competitiveness of productivity gains made over this period.

Future developments

There are a number of problems with this approach. These include different coverage of "finished" goods in the import and output statistics, the reliance on input output analysis based on 1973, and the assumed constancy of the gross to net output ratio.

On coverage of the statistics, there the main problem is that goods classed as semi-manufactures in the import statistics can be both inputs to and competing with outputs of domestic manufacturing. An alternative, but similar approach, amalgamates semi- and finished goods in both imports and demand and produces an equation for manufacturing output in which competitiveness lags are longer but in which the partial adjustment mechanism is less well determined. This like many equations in this area, (see page 472 December 1982 Quarterly Bulletin), still requires implied time trends of the order of 7% a year in order to track the growth of imports of manufactures since the 1960's.

$$\Delta \ln HMFT = \underset{(10.4)}{1.4376} + \underset{(10.3)}{0.30678} \ln(MPRO/HMFT_{-1}) + \underset{(7.9)}{0.00221} D73T_{-2}$$

$$- \underset{(10.5)}{0.00332} TIME - \underset{(2.1)}{0.01131} D721 + \underset{(3.6)}{0.01912} D721_{-1}$$

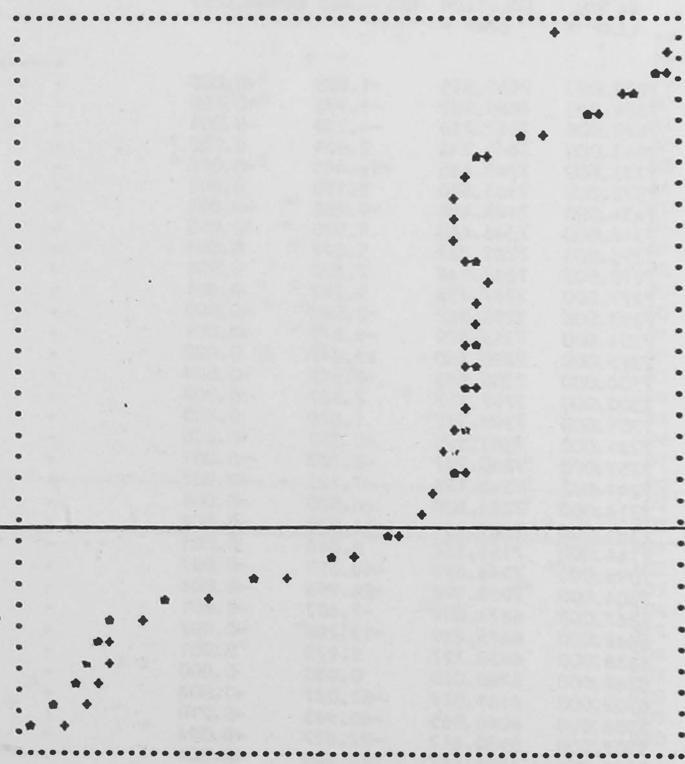
$$- \underset{(9.1)}{0.04997} D741 + \underset{(6.2)}{0.03706} D741_{-1} - D821*(TIME-108)*0.000383$$

$$\bar{R}^2 = 0.9 \quad SE = 0.005 \quad DW = 1.6 \quad 1968\ I\text{-}1979\ IV$$

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE230322.37 TO332504.37

300	ACTUAL HMFT *	SOLUTION HMFT +	RESIDUALS	NORMALIZED	
1974 1	313784.625	313892.750	-108.125	-0.000	77
1974 2	332389.437	332504.375	-114.937	-0.000	78
1974 3	330140.062	332257.437	-2117.375	-0.006	79
1974 4	326974.687	326025.875	948.812	0.003	80
1975 1	320146.125	322360.937	-2214.812	-0.007	81
1975 2	308407.500	312570.625	-4163.125	-0.013	82
1975 3	302[illegible]2.437	303202.437	-490.000	-0.002	83
1975 4	299504.437	299724.625	-220.187	-0.001	84
1976 1	297627.250	298291.812	-664.562	-0.002	85
1976 2	297633.812	298203.125	-569.312	-0.002	86
1976 3	299230.187	298146.125	1084.062	0.004	87
1976 4	301711.312	301062.250	649.062	0.002	88
1977 1	303627.312	303428.500	198.812	0.001	89
1977 2	302914.125	302732.562	181.562	0.001	90
1977 3	302624.250	301546.062	1078.187	0.004	91
1977 4	302000.937	301100.937	900.000	0.003	92
1978 1	302334.375	300337.562	1996.812	0.007	93
1978 2	300778.062	301829.250	-1051.187	-0.003	94
1978 3	299568.937	300680.500	-1111.562	-0.004	95
1978 4	299342.875	298195.312	1147.562	0.004	96
1979 1	298031.125	296738.187	1292.937	0.004	97
1979 2	297657.062	299759.437	-2102.375	-0.007	98
1979 3	294153.812	295712.750	-1558.937	-0.005	99
1979 4	293644.187	293575.687	68.500	0.000	100
1980 1	288074.500	289761.625	-1687.125	-0.006	101
1980 2	278388.125	282810.312	-4422.187	-0.016	102
1980 3	265414.000	272358.312	-6944.312	-0.026	103
1980 4	251661.375	258986.062	-7324.687	-0.029	104
1981 1	243740.625	248639.437	-4898.812	-0.020	105
1981 2	241305.500	243256.375	-1950.875	-0.008	106
1981 3	240038.625	242797.812	-2759.187	-0.011	107
1981 4	237678.812	241562.937	-3884.125	-0.016	108
1982 1	234577.000	239065.750	-4488.750	-0.019	109
1982 2	230322.375	236220.312	-5897.937	-0.025	110



MSE= 0.000 RMS= 0.011 RHO= 0.768

MEAN ERR= -0.0058 MEAN=289356.625

UNNORMALISED ERRORS, MEAN = -1505.8289 RMSE = 2860.6208

Manufacturing industry

$$\Delta(\ln LEMF + 0.05 \ln HN + 0.06 \ln HN_{-1}) = \underset{(8.0)}{-0.2453} + \underset{(21.3)}{0.4664}\Delta \ln HMFT$$

$$+ \underset{(11.2)}{0.1840}\Delta \ln HMFT_{-1} + \underset{(8.0)}{0.12399}(\ln HMF_{-2} - 0.5 \ln HN_{-2})$$

$$+ \underset{(5.1)}{0.00013}\ TIME + \underset{(7.9)}{0.00949}\ D721 - \underset{(4.2)}{0.00641}\ D721_{-1}$$

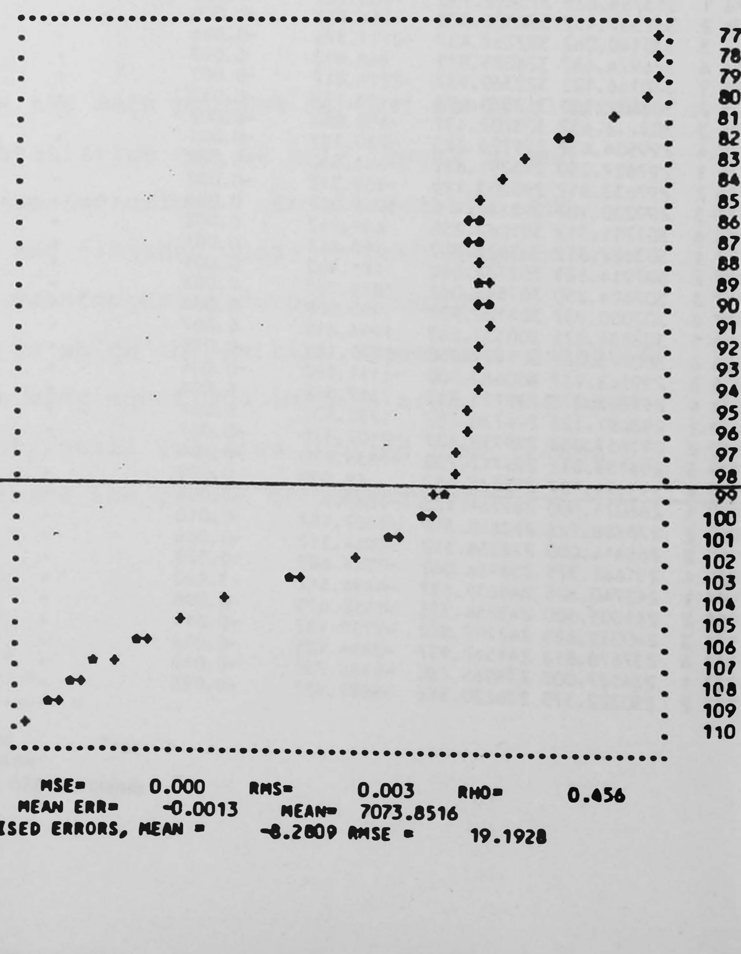
$$+ \underset{(15.4)}{0.02912}\ D741 - \underset{(6.7)}{0.01563}\ D741_{-1}$$

$\bar{R}^2 = 0.97$ SE = 0.0 DW = 1.9 1970 I-1979-II

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 5748.00 TO 7889.89

428	ACTUAL LEMF *	SOLUTION LEMF +	RESIDUALS	NORMALIZED
1974 1	7888.000	7889.895	-1.895	-0.000
1974 2	7884.000	7885.922	-1.922	-0.000
1974 3	7883.000	7887.238	-4.238	-0.001
1974 4	7843.000	7840.316	2.684	0.000
1975 1	7733.000	7749.465	-16.465	-0.002
1975 2	7572.000	7563.820	8.180	0.001
1975 3	7434.000	7443.488	-9.488	-0.001
1975 4	7348.000	7346.480	1.520	0.000
1976 1	7293.000	7287.723	5.277	0.001
1976 2	7270.000	7262.148	7.852	0.001
1976 3	7277.000	7267.738	9.262	0.001
1976 4	7293.000	7295.562	-2.563	-0.000
1977 1	7304.000	7313.879	-9.879	-0.001
1977 2	7315.000	7299.160	15.840	0.002
1977 3	7308.000	7308.555	-0.555	-0.000
1977 4	7300.000	7297.113	2.887	0.000
1978 1	7301.000	7299.371	1.629	0.000
1978 2	7281.000	7283.391	-2.391	-0.000
1978 3	7257.000	7260.707	-3.707	-0.001
1978 4	7241.000	7248.125	-7.125	-0.001
1979 1	7218.000	7224.520	-6.520	-0.001
1979 2	7195.000	7209.531	-14.531	-0.002
1979 3	7164.000	7155.152	8.848	0.001
1979 4	7098.000	7146.699	-48.699	-0.007
1980 1	7004.000	7030.996	-26.996	-0.004
1980 2	6867.000	6874.602	-7.602	-0.001
1980 3	6662.000	6675.289	-13.289	-0.002
1980 4	6438.000	6432.727	5.273	0.001
1981 1	6261.000	6260.020	0.980	0.000
1981 2	6109.000	6161.027	-52.027	-0.008
1981 3	5986.000	6046.965	-60.965	-0.010
1981 4	5908.000	5930.617	-22.617	-0.004
1982 1	5828.000	5853.687	-25.688	-0.004
1982 2	5748.000	5760.621	-12.621	-0.002



MSE= 0.000 RMS= 0.003 RHO= 0.456
MEAN ERR= -0.0013 MEAN= 7073.8516
UNNORMALISED ERRORS, MEAN = -8.2809 RMSE = 19.1928

"Other" (excluding North Sea oil and) HM forces) and self-employed

$$\ln LOTH = \underset{(3.2)}{0.25094} + \underset{(7.7)}{1.05301} \ln LOTH_{-1} - \underset{(2.1)}{0.24111} \ln LOTH_{-2}$$

$$+ \underset{(2.1)}{0.09398} \ln OOTH + \underset{(1.9)}{0.09412} \ln OOTH_{-1}$$

$$-\underset{(3.2)}{0.04050} \ln \left(\left[-\frac{(YWS+YEC+YECS)}{YWS} * WOO + \frac{TSET}{LOTH}-\right]\right.$$

$$/((GDP£ - 3ADJ.PGDP + RESE - MPRO.PIMO - 0.6G£$$

$$\left. - 40.5\ NSO*PX2B)/OOTH)\right)$$

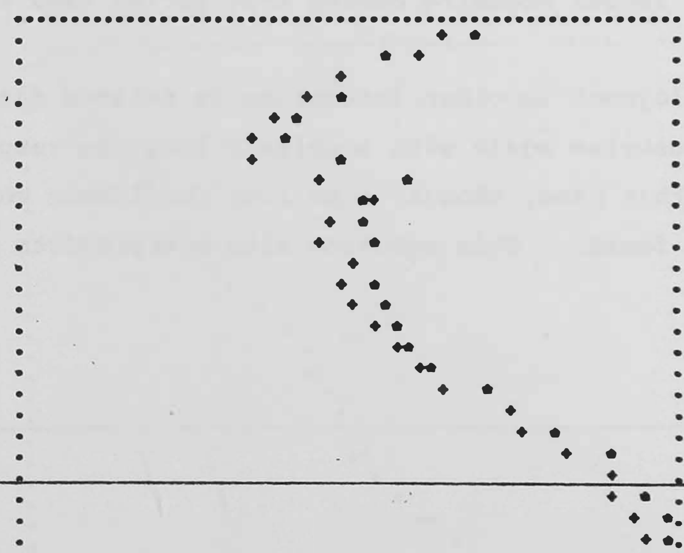
$$- \underset{(3.8)}{0.0113}\ DNAT_{-1} - \underset{(2.8)}{0.01547}\ DNAT_{-2} - \underset{(2.1)}{0.00609}\ DNAT_{-3}$$

$\bar{R}^2 = 0.98$ SE = 0.004 DW = 1.9 1965 I-1979 II

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 10154.00 TO 11016.00

426	ACTUAL LOTH *	SOLUTION LOTH +	RESIDUALS	NORMALIZED	
74 1	10762.500	10720.070	42.430	0.004	77
74 2	10639.199	10684.457	-45.258	-0.004	78
74 3	10575.301	10582.988	-7.688	-0.001	79
74 4	10572.602	10533.598	39.004	0.004	80
75 1	10514.500	10490.660	23.840	0.002	81
75 2	10508.000	10459.711	48.289	0.005	82
75 3	10583.500	10458.656	124.844	0.012	83
75 4	10667.500	10542.453	125.047	0.012	84
76 1	10614.402	10624.785	-10.383	-0.001	85
76 2	10600.301	10561.230	39.070	0.004	86
76 3	10623.203	10554.133	69.070	0.007	87
76 4	10599.703	10596.855	2.848	0.000	88
77 1	10622.203	10583.734	38.469	0.004	89
77 2	10639.402	10597.430	41.973	0.004	90
77 3	10659.203	10619.910	39.293	0.004	91
77 4	10668.500	10655.703	12.797	0.001	92
78 1	10696.801	10678.020	18.781	0.002	93
78 2	10766.602	10713.211	53.391	0.005	94
78 3	10798.000	10809.785	-11.785	-0.001	95
78 4	10871.500	10824.074	47.426	0.004	96
79 1	10933.000	10877.977	55.023	0.005	97
79 2	10940.500	10943.457	-2.957	-0.000	98
79 3	10986.500	10932.840	53.660	0.005	99
79 4	11016.000	10972.738	43.262	0.004	100
80 1	11011.000	10984.551	26.449	0.002	101
80 2	10987.000	10966.379	20.621	0.002	102
80 3	10933.500	10928.844	4.656	0.000	103
80 4	10798.000	10853.656	-55.656	-0.005	104
81 1	10641.000	10703.449	-62.449	-0.006	105
81 2	10501.000	10557.141	-56.141	-0.005	106
81 3	10394.500	10430.785	-36.285	-0.003	107
81 4	10276.500	10339.883	-63.383	-0.006	108
82 1	10210.000	10241.293	-31.293	-0.003	109
82 2	10154.000	10198.555	-44.555	-0.004	110



MSE= 0.000 RMS= 0.005 RHU= 0.542

MEAN ERR= 0.0015 MEAN= 10669.5625

UNNORMALISED ERRORS, MEAN = 15.9532 RMSE = 49.6715

Employment

The categorisation of employment in the model is manufacturing; non-trading public sector; and the remainder, so called 'other' employment. The behavioural equations relate to manufacturing, and to 'other'.

Employment in manufacturing is determined by a two stage approach. First total man hours worked (HMFT) are determined through an equation which relates hours to output (MPRO) with unit long-run response and time trends implying 4.4% a year trend productivity growth up to 1974 and 1.5% a year afterwards. No relative price effects could be identified within this structure. Second, employment (LEMF) is related to man-hours. In this equation the long-run elasticity of employment to total man hours is unity; employment is also assumed (long-run elasticity - 1/2) to rise as the size of the standard working week (basic hours HN) falls.

The man hours equation increasingly overpredicts from mid-1979 onwards. The interpretation of this breakdown of the equation is unclear - whether it reflects a step change or a trend change in productivity growth for example or what the omitted variables in the estimation period are: equally trend productivity growth post 1974 might be too low but then the reasons for labour hoarding during that period need explanation.

Employment in other industries is related directly to output in these industries again with a unitary long run response of employment to output. In this case, though, some role for labour costs relative to output prices was found. This equation also overpredicts over the recent past.

DOMESTIC PRICES

Wholesale prices of manufacturing output

$$
\begin{aligned}
\Delta \ln \text{PIMO} = {} & 0.47752 + \underset{(2.1)}{0.0035}\ \text{Q1} - \underset{(1.9)}{0.00147}\ \text{TIME} + 0.000348\ \text{D73T}_{-2} \\
& - \underset{(1.5)}{0.00018}\ \text{TIME.D73A}_{-2} - \underset{(3.4)}{0.02065}\ \text{D73C} \\
& + \underset{(3.2)}{0.37652}\ \Delta \ln \left[1 + \frac{\text{FCA£} - \text{ACAR}_{-1} - \text{AVAT}_{-1} - \text{TGAS} - \text{YECS} - \text{TSET}}{\text{GDP£}} \right] \\
& + \underset{(2.8)}{0.13968} \ln \left(\frac{\text{ECMM}_{-1}}{\text{PIMO}_{-1}} \right) + \underset{(3.2)}{0.1104} \ln \left(\frac{\text{PMAM}_{-1}}{\text{PIMO}_{-1}} \right) \\
& + \underset{(1.6)}{0.06703}\ \Delta \ln \text{PMAM}_{-1} + \underset{(1.5)}{0.05289}\ \Delta \ln \text{PMAM} + \underset{(1.2)}{0.09464}\ \Delta \ln \text{ECMM} \\
& + \underset{(1.3)}{0.02822} \ln \text{PIMO}_{-1} - \underset{(.5)}{0.02289}\ \Delta \ln \left(\frac{\text{MPRO}}{\text{LEMF}} \right) + \underset{(2.4)}{0.37608}\ u_{-1} \\
& - \text{D821}*(\text{TIME}-108)*0.000696
\end{aligned}
$$

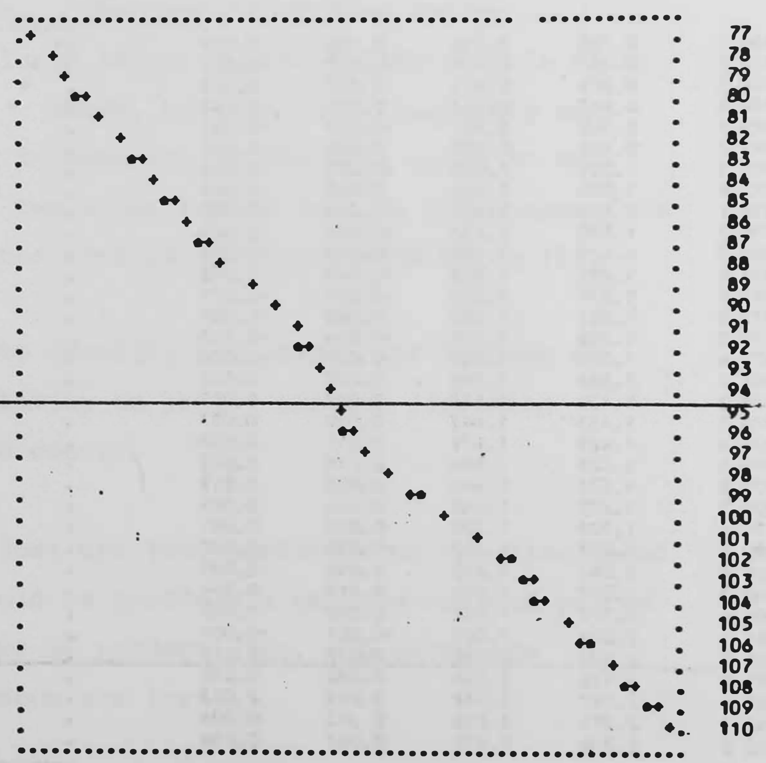
$\bar{R}^2 = 0.889$ SE = 0.006 1963 IV-1978 II

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MCD

RANGE 0.75 TO 2.4

276

	ACTUAL PIMO *	SOLUTION PIMO +	RESIDUALS	NORMALIZED
974 1	0.752	0.753	-0.001	-0.001
974 2	0.805	0.800	0.005	0.006
974 3	0.837	0.844	-0.007	-0.008
974 4	0.880	0.883	-0.003	-0.004
975 1	0.937	0.930	0.007	0.008
975 2	0.985	0.983	0.002	0.002
975 3	1.021	1.030	-0.009	-0.008
975 4	1.057	1.066	-0.009	-0.009
976 1	1.103	1.115	-0.012	-0.011
976 2	1.145	1.154	-0.009	-0.008
976 3	1.192	1.211	-0.019	-0.016
976 4	1.252	1.256	-0.004	-0.003
977 1	1.330	1.316	0.014	0.010
977 2	1.396	1.386	0.010	0.007
977 3	1.438	1.440	-0.002	-0.001
977 4	1.458	1.475	-0.017	-0.012
978 1	1.492	1.495	-0.003	-0.002
978 2	1.518	1.530	-0.012	-0.008
978 3	1.548	1.559	-0.011	-0.007
978 4	1.573	1.588	-0.015	-0.010
979 1	1.616	1.622	-0.006	-0.004
979 2	1.680	1.670	0.010	0.006
979 3	1.764	1.742	0.022	0.012
979 4	1.818	1.806	0.012	0.007
980 1	1.914	1.903	0.011	0.006
980 2	1.990	1.973	0.017	0.009
980 3	2.036	2.049	-0.013	-0.006
980 4	2.061	2.092	-0.031	-0.015
981 1	2.123	2.134	-0.011	-0.005
981 2	2.194	2.173	0.021	0.010
981 3	2.241	2.258	-0.017	-0.008
981 4	2.292	2.321	-0.029	-0.013
982 1	2.343	2.374	-0.031	-0.013
982 2	2.384	2.397	-0.013	-0.005



MSE= 0.000 RMS= 0.008 RHO= 0.429
MEAN ERR= -0.0027 MEAN= 1.5346
UNNORMALISED ERRORS, MEAN = -0.0045 RMSE = 0.0145

Consumer price deflators

Non-durables, total

$$\ln PCND = \underset{(1.5)}{0.29950} + \ln(TAXT) + \underset{(4.0)}{0.39938} \ln PIMN + \underset{(8.5)}{0.35666} \ln ULC$$
$$+ \underset{(2.6)}{0.09633} \ln PONI + \underset{(4.4)}{0.14767} \ln PM - \underset{(1.5)}{0.00355}\, TIME$$

$$\text{where } TAXT = \left(1 + \left[\frac{TB+TWS+TT+THCO+TADJ+TPRM+TMVD-0.8\,ESAB+AVT^*}{CND£-(TB+TWS+TT+THCO+TADJ+TPRM+TMVD-0.08\,ESAB+AVT^*}\right] + \left[\frac{TRAT - 0.2\,ESAB}{EF£ - FCA£}\right]\right)$$

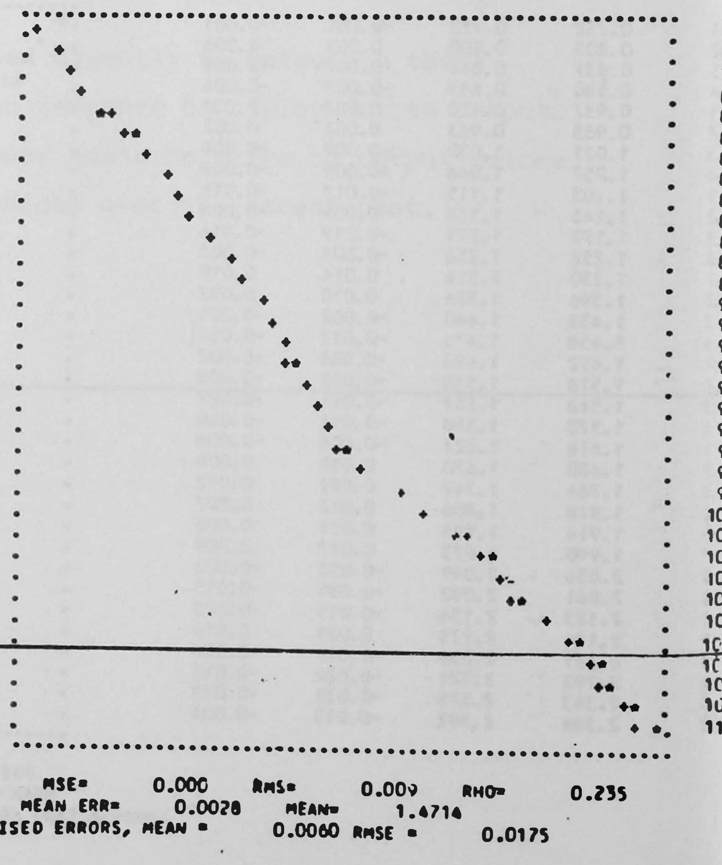
$$\text{and} \quad AVT^* = AVAT - 0.2(VATS/(VATS+100))G£ - 0.324(((TRCD/(TRCD+100)) - (VATS/(VATS+100)))\,CD£ - (VATS/(VATS+100))\,CD£$$

$$\bar{R}^2 = 0.999 \qquad SE = 0.009 \qquad DW = 2.1 \qquad 1973\ II - 1981\ II$$

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 0.75 TO 2.29

80	ACTUAL PCND *	SOLUTION PCND +	RESIDUALS	NORMALIZED
1974 1	0.753	0.750	0.004	0.005
1974 2	0.791	0.798	-0.007	-0.009
1974 3	0.825	0.823	0.002	0.003
1974 4	0.867	0.867	0.001	0.001
1975 1	0.920	0.927	-0.007	-0.007
1975 2	0.982	0.977	0.005	0.005
1975 3	1.029	1.033	-0.003	-0.003
1975 4	1.070	1.064	0.007	0.007
1976 1	1.104	1.105	-0.000	-0.000
1976 2	1.135	1.138	-0.004	-0.003
1976 3	1.171	1.180	-0.008	-0.007
1976 4	1.225	1.235	-0.009	-0.008
1977 1	1.277	1.278	-0.001	-0.001
1977 2	1.321	1.323	-0.002	-0.001
1977 3	1.350	1.354	-0.004	-0.003
1977 4	1.371	1.380	-0.009	-0.006
1978 1	1.398	1.385	0.013	0.010
1978 2	1.430	1.423	0.007	0.005
1978 3	1.453	1.443	0.010	0.007
1978 4	1.483	1.471	0.011	0.008
1979 1	1.528	1.516	0.011	0.007
1979 2	1.570	1.549	0.020	0.013
1979 3	1.670	1.663	0.008	0.005
1979 4	1.728	1.726	0.002	0.001
1980 1	1.802	1.842	-0.040	-0.022
1980 2	1.882	1.872	0.010	0.005
1980 3	1.927	1.915	0.012	0.006
1980 4	1.972	1.952	0.020	0.010
1981 1	2.024	2.025	-0.001	-0.001
1981 2	2.098	2.072	0.027	0.013
1981 3	2.148	2.126	0.022	0.010
1981 4	2.197	2.169	0.028	0.013
1982 1	2.231	2.218	0.013	0.006
1982 2	2.294	2.226	0.067	0.030



MSE= 0.000 RMS= 0.009 RHO= 0.235
MEAN ERR= 0.0028 MEAN= 1.4714
UNNORMALISED ERRORS, MEAN = 0.0060 RMSE = 0.0175

Domestic Prices

Wholesale prices (PIMO and net of tax PIMN) play a central role in the prices sector. They are related to earnings costs per man in manufacturing (ECMM) and import costs (PMAM). The equation assumes fixed mark up on costs in the long run; the time trends are intended to represent trend productivity growth. In the short run there is some allowance for the effect of changes in actual productivity $\frac{(MPRO)}{LEMF}$ on price setting, though the effect is small. Changes in taxes, largely specific duties and rates, have no long run effect on wholesale prices according to the equation; a feature that casts some doubt on the equation.

The deflator for non-durable consumption (PCND) is a similar fixed mark up on costs equation. It is related to net of tax wholesale prices (PIMN), nationalised industry output prices (PONI), whole economy unit labour costs (ULC) and import prices (PM). A unit elasticity with respect to taxes (TAXT) bearing on consumption is imposed.

There are a number of unsatisfactory features of these equations which further research has thus far failed to remove, and a number of desirable features that are excluded:

(i) the incidence of taxes; the equations perhaps show the two extremes of possibilities. The results of some policy simulations depend to a large extent on the coefficient in taxes in the prices equations. These, however, are frequently not well-determined, and the information in the data tends to be dominated by only one or two major events such as the change from purchase tax to VAT and the rise in VAT rates from 8% to 15%.

(ii) It has proved difficult to identify any effects of volumes on prices, in particular activity on profit margins (defining margins relative to trend costs).

(iii) Productivity trends are just one interpretation of the time trend in the equations; it would be preferable to have related prices more explicitly to changes in productivity, and allow the equation dynamics to produce the trend.

Unit value index

$$\Delta\ln UXGM = \underset{(3.9)}{0.7644} + \underset{(2.7)}{0.4202}\,\Delta\ln PIMO + \underset{(5.2)}{0.2358}\,\Delta\ln(PCOM.ERUK)$$

$$- \underset{(3.8)}{0.3469}\,\ln UXGM_{-1} + \underset{(2.5)}{0.1849}\,\ln PIMO_{-1}$$

$$+ \underset{(3.9)}{0.184}\,\ln(PCOM.ERUK)_{-1}$$

$\bar{R}^2 = 0.795$ SE = 0.00936 DW = 1.9 1964 I-1978 II

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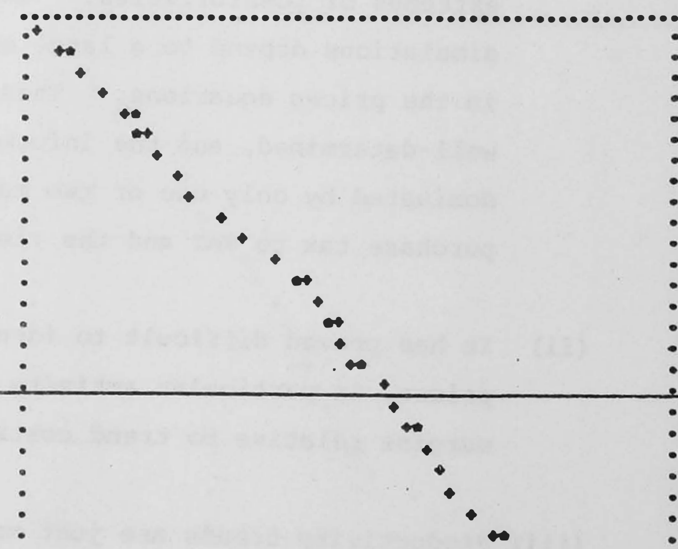
RANGE 72.28 TO 221.54

282	ACTUAL UXGM *	SOLUTION UXGM +	RESIDUALS	NORMALIZED	
1974 1	73.181	72.281	0.900	0.012	77
1974 2	79.181	78.073	1.108	0.014	78
1974 3	83.136	83.054	0.082	0.001	79
1974 4	88.136	87.563	0.573	0.007	80
1975 1	95.045	92.963	2.082	0.022	81
1975 2	97.045	98.795	-1.750	-0.018	82
1975 3	102.000	101.271	0.729	0.007	83
1975 4	105.909	106.031	-0.121	-0.001	84
1976 1	109.819	109.924	-0.105	-0.001	85
1976 2	115.909	116.440	-0.531	-0.005	86
1976 3	122.864	122.038	0.827	0.007	87
1976 4	129.819	131.103	-1.284	-0.010	88
1977 1	134.864	136.588	-1.724	-0.013	89
1977 2	139.774	140.987	-1.213	-0.009	90
1977 3	143.774	144.906	-1.133	-0.008	91
1977 4	146.728	146.755	-0.026	-0.000	92
1978 1	150.683	149.125	1.558	0.010	93
1978 2	154.774	155.154	-0.380	-0.002	94
1978 3	158.819	157.753	1.066	0.007	95
1978 4	163.819	161.261	2.558	0.016	96
1979 1	166.864	166.325	0.539	0.003	97
1979 2	168.000	168.524	-0.524	-0.003	98
1979 3	172.045	170.679	1.366	0.008	99
1979 4	177.271	176.293	0.979	0.006	100
1980 1	186.041	181.085	4.956	0.027	101
1980 2	190.860	187.800	3.060	0.016	102
1980 3	195.403	190.366	5.037	0.026	103
1980 4	196.403	192.740	3.663	0.019	104
1981 1	198.860	195.420	3.440	0.017	105
1981 2	202.905	201.450	1.455	0.007	106
1981 3	207.814	208.606	-0.792	-0.004	107
1981 4	213.769	213.297	0.473	0.002	108
1982 1	217.362	218.413	-1.051	-0.005	109
1982 2	218.226	221.536	-3.310	-0.015	110



MSE= 0.000 RMS= 0.012 RHO= 0.373

MEAN ERR= 0.C042 MEAN= 150.2084

UNNORMALISED ERRORS, MEAN = 0.6619 RMSE = 1.9695

Imports of finished manufactures

\$ unit value index

$$\Delta \ln UMM\$ = 0.03016 + \underset{(5.2)}{0.55168}\ \Delta \ln PXWM - 0.35\ \Delta \ln ERUK$$

$$- \underset{(3.5)}{0.39794} \ln UMM\$_{-1} + \underset{(3.3)}{0.25147} \ln PXWM_{-1}$$

$$+ \underset{(2.6)}{0.15615} \ln (PIMN/ERUK)_{-1}$$

$\bar{R}^2 = 0.872$ SE = 0.013 DW = 1.7 1972 III - 1980 I

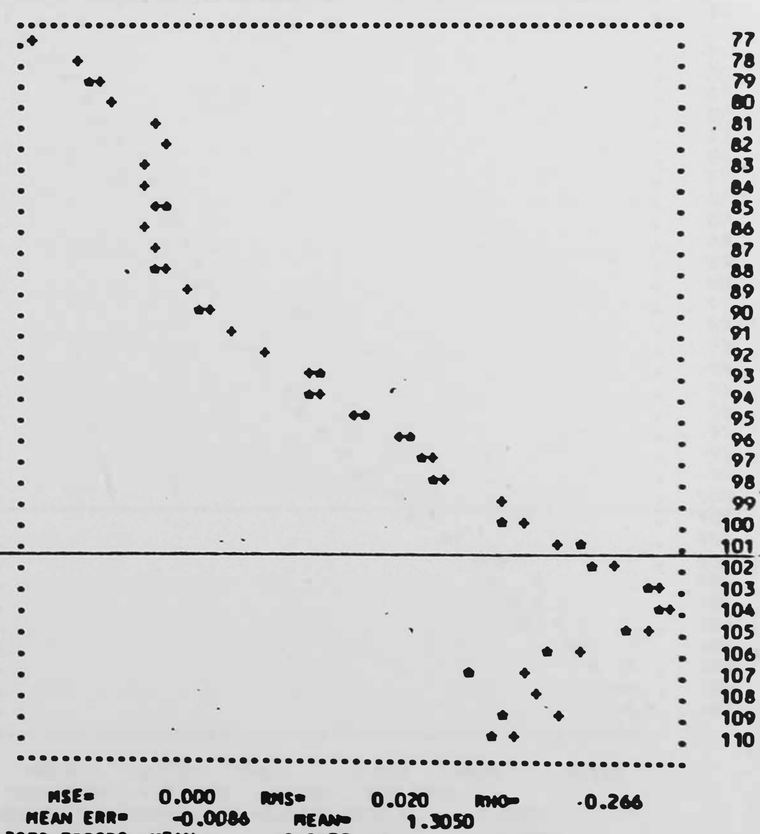
£ unit value index

UMM = ERUK.UMM\$

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 0.79 TO 1.87

111	ACTUAL UMMS *	SOLUTION UMMS +	RESIDUALS	NORMALIZED
1974 1	0.793	0.800	-0.006	-0.008
1974 2	0.868	0.871	-0.003	-0.004
1974 3	0.890	0.900	-0.010	-0.012
1974 4	0.917	0.934	-0.017	-0.018
1975 1	1.003	0.999	0.004	0.004
1975 2	1.015	1.027	-0.013	-0.012
1975 3	0.987	0.985	0.002	0.002
1975 4	0.991	0.986	0.005	0.005
1976 1	1.012	1.004	0.008	0.008
1976 2	0.979	0.992	-0.013	-0.013
1976 3	1.011	1.006	0.006	0.006
1976 4	1.011	1.020	-0.009	-0.009
1977 1	1.065	1.051	0.014	0.013
1977 2	1.085	1.090	-0.005	-0.005
1977 3	1.127	1.127	-0.001	-0.001
1977 4	1.194	1.182	0.012	0.010
1978 1	1.277	1.269	0.008	0.007
1978 2	1.266	1.286	-0.021	-0.016
1978 3	1.368	1.343	0.024	0.018
1978 4	1.440	1.420	0.019	0.014
1979 1	1.459	1.476	-0.017	-0.012
1979 2	1.482	1.500	-0.018	-0.012
1979 3	1.581	1.597	-0.015	-0.010
1979 4	1.587	1.621	-0.033	-0.021
1980 1	1.723	1.690	0.033	0.019
1980 2	1.742	1.784	-0.041	-0.023
1980 3	1.846	1.857	-0.011	-0.006
1980 4	1.855	1.874	-0.019	-0.010
1981 1	1.794	1.839	-0.045	-0.025
1981 2	1.658	1.727	-0.069	-0.041
1981 3	1.532	1.624	-0.092	-0.059
1981 4	1.645	1.656	-0.011	-0.007
1982 1	1.596	1.678	-0.082	-0.050
1982 2	1.573	1.616	-0.043	-0.027



MSE= 0.000 RMS= 0.020 RHO= -0.266
MEAN ERR= -0.0086 MEAN= 1.3050
UNNORMALISED ERRORS, MEAN = -0.0135 RMSE = 0.0307

Trade Prices

The division of trade prices in the model is between raw materials, oil and manufactures. For imported raw materials and oil, the UK is assumed to be a price taker, with import prices dependent upon world commodity prices and EEC agricultural prices expressed in sterling terms. For manufactures, both export and import prices are assumed to depend upon competitors export prices and domestic output prices expressed in a common currency.

For manufactures export prices (UXGM), the equation accords 50% weight to competitors export prices (PXWM) and 50% to domestic net of tax wholesale prices (PIMN).

For import prices of finished manufactures (UMM), the equation gives 60% weight to competing prices (PXWM) and 40% to domestic net of tax wholesale prices (PIMN) in the long run. Some of the issues relating to the equations in this version of the model have been discussed elsewhere (Bond 1981).

Most recent research work on this area of the Bank model is discussed in a Bank technical paper (Hotson and Gardiner 1983).

Average earning per employee in manufacturing

$$\Delta \ln(((WAEM +(D741*3.01))*7.09259 = - \underset{(2.8)}{0.31134} \ln ((WAEM+(D741*3.01))*7.09259)_{-1}$$

$$- \underset{(3.5)}{0.37213} \ln ((WAEM + (D741*3.01)) * 7.09259)_{-2} + \underset{(6.5)}{0.00594} TIME$$

$$+ \underset{(5.2)}{1.98237} - \underset{(5.4)}{0.06047} \ln LU + \underset{(4.4)}{0.48011} \ln PC_{-1} - \underset{(3.0)}{0.2269} \ln PC_{-2}$$

$$- \underset{(3.6)}{0.36770} IP + \underset{(3.1)}{0.35775} \ln WAPS_{-1} - \underset{(3.1)}{0.17512} \ln (1 - (\frac{TRY + GRJ}{100}) - \frac{1}{WS}$$

$$(((\frac{100.TARR}{TRY} + MSCR)/(4.0 (1.45 NTAM + NTAS))) \frac{TRY}{100} - 13 (RFJ + GIJ)))_{-1}$$

$$+ \underset{(1.7)}{0.09988} \ln (1 - (\frac{TRY + GRJ}{100}) - \frac{1}{WS} (((\frac{100.TARR}{TRY})$$

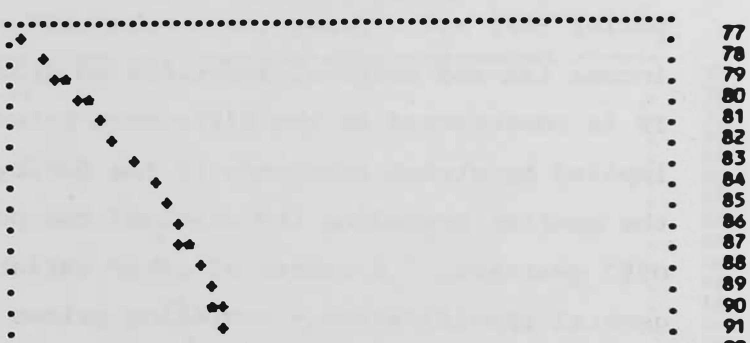
$$+ MSCR/(4.0 (1.45 NTAM + NTAS) \frac{TRY}{100} - 13 (RFJ + GIJ)))_{-2}$$

$\bar{R}^2 = 0.785$ SE = 0.007 DW = 1.8 1965 III - 1979 IV

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 64.10 TO 231.50

607	ACTUAL WAEM *	SOLUTION WAEM +	RESIDUALS	NORMALIZED
1974 1	64.100	64.177	-0.077	-0.001
1974 2	69.700	70.218	-0.518	-0.007
1974 3	74.900	74.184	0.716	0.010
1974 4	80.400	79.401	0.999	0.013
1975 1	84.400	84.979	-0.579	-0.007
1975 2	88.200	89.025	-0.825	-0.009
1975 3	93.900	93.198	0.702	0.008
1975 4	97.900	98.383	-0.483	-0.005
1976 1	101.300	101.165	0.135	0.001
1976 2	104.500	103.868	0.632	0.006
1976 3	108.400	106.417	1.983	0.018
1976 4	110.700	110.546	0.154	0.001
1977 1	113.400	113.515	-0.115	-0.001
1977 2	114.800	116.980	-2.180	-0.019
1977 3	117.700	118.205	-0.505	-0.004
1977 4	122.500	123.303	-0.803	-0.007
1978 1	126.800	127.961	-1.161	-0.009
1978 2	132.400	132.243	0.157	0.001
1978 3	136.200	137.270	-1.070	-0.008
1978 4	140.700	141.043	-0.343	-0.002
1979 1	145.400	145.896	-0.496	-0.003
1979 2	152.700	151.543	1.157	0.008
1979 3	155.000	157.262	-2.262	-0.014
1979 4	166.200	164.590	1.610	0.010
1980 1	170.600	175.863	-5.263	-0.030
1980 2	179.900	182.104	-2.204	-0.012
1980 3	188.300	193.773	-5.473	-0.029
1980 4	191.300	201.376	-10.076	-0.051
1981 1	196.900	202.820	-5.920	-0.030
1981 2	200.500	208.068	-7.568	-0.037
1981 3	212.000	215.139	-3.139	-0.015
1981 4	216.900	224.200	-7.300	-0.033
1982 1	222.200	226.137	-3.937	-0.018
1982 2	226.500	231.503	-5.003	-0.022



MSE= 0.000 RMS= 0.018 RHO= 0.506
MEAN ERR= -0.0088 MEAN= 138.4498
UNNORMALISED ERRORS, MEAN = -1.7370 RMSE = 3.3675

Domestic wages

The wages sector of the Bank model is split into three bargaining groups: manufacturing (WAEM); non-trading public sector (WAPS) and other (WOO) which includes nationalised industries. Reasons for adopting the disaggregated approach include: the more exposed position of the manufacturing sector of the economy to competitive pressures (particularly foreign competition); the greater cyclical volatility of manufacturing output and employment; the special position of the public sector as an employer. The approach also allowed the specific issue of wage-wage interactions eg comparability in the inflationary process to be examined. It is a convenience too in forecasting as different assumptions on public and private pay for example can easily be made and integrated into the rest of the model.

Manufacturing wages (WAEM)

The dependent variable is average earnings in manufacturing expressed as £ per quarter per employee with adjustment to the raw data for three day week working in the first quarter of 1974. The main explanatory variables are the consumer price deflator (PC), the level of unemployment (LU), public sector wages per head (WAPS), a measure of the effectiveness of incomes policy (IP) and a proxy for a retention ratio (ie the ratio of pay net of income tax and national insurance to gross pay). The incomes policy variable IP is constructed as the difference between the rate of earnings increase implied by strict adherence to the policy and the actual rate of increase in the quarter preceding the onset of the policy; its value is zero in "policy off" quarters. A number of other variables were included in an initial general specification - competing prices represented by import prices; manufacturer's output prices; the ratio of unemployment benefits to net employment incomes - but were subsequently eliminated.

The long run properties of the final equation may be summarised as:-

(i) elasticity with respect to consumer prices 0.37

(ii) elasticity with respect to public sector wages 0.52

(iii) long run coefficient on retentions ratio term 0.11

Average earnings in Public Sector

$$(160)\ \Delta \ln WAPS = \underset{(5.1)}{0.143} + \underset{(4.2)}{0.25990} \ln (((WAEM + (D741 * 3.01))_{-1} * 7.09259)/WAPS_{-2}$$

$$+ \underset{(3.3)}{0.53519} \ln (PC/PC_{-4}) - \underset{(2.7)}{0.80893} \ln (PC_{-1}/PC_{-4})$$

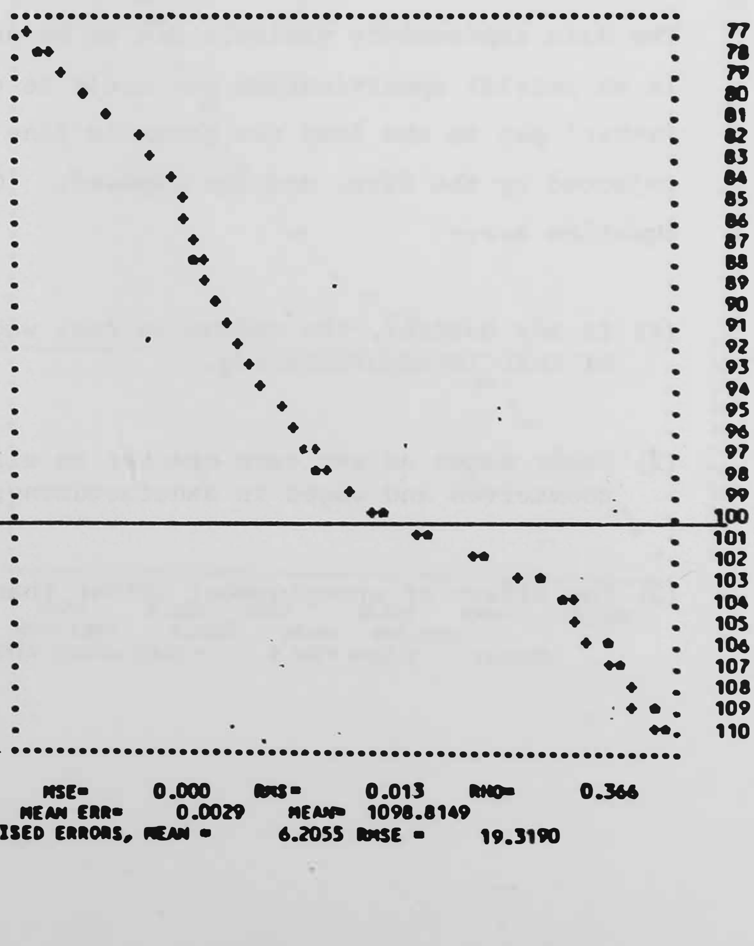
$$+ \underset{(2.5)}{0.62726} \ln (PC_{-2}/PC_{-4}) - \underset{(3.5)}{0.56213} IP_{-1} - \underset{(4.3)}{0.01699} \ln LU_{-4}$$

$R^2 = 0.747$ SE = 0.010 DW = 1.98 1965 III 1979 IV

TIME=09:59:25 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 508.64 TO 1823.00

160	ACTUAL WAPS *	SOLUTION WAPS +	RESIDUALS	NORMALIZED
1974 1	508.640	513.168	-4.528	-0.009
1974 2	534.970	545.423	-10.453	-0.019
1974 3	574.150	570.201	3.948	0.007
1974 4	624.270	626.903	-2.633	-0.004
1975 1	679.760	678.443	1.317	0.002
1975 2	731.400	733.682	-2.282	-0.003
1975 3	773.440	767.255	6.185	0.008
1975 4	803.640	806.320	-2.680	-0.003
1976 1	823.250	827.880	-4.630	-0.006
1976 2	837.010	837.136	-0.126	-0.000
1976 3	848.660	848.353	0.307	0.000
1976 4	860.970	867.100	-6.130	-0.007
1977 1	875.750	879.323	-3.573	-0.004
1977 2	893.800	899.598	-5.798	-0.006
1977 3	915.450	916.957	-1.507	-0.002
1977 4	940.540	936.300	4.240	0.005
1978 1	968.440	974.583	-6.144	-0.006
1978 2	998.020	996.898	1.122	0.001
1978 3	1028.440	1027.608	0.832	0.001
1978 4	1059.140	1061.789	-2.649	-0.002
1979 1	1087.000	1098.156	-11.156	-0.010
1979 2	1113.000	1123.783	-10.783	-0.010
1979 3	1176.000	1184.618	-8.618	-0.007
1979 4	1236.000	1224.037	11.963	0.010
1980 1	1350.000	1317.939	32.061	0.024
1980 2	1464.000	1433.892	30.108	0.021
1980 3	1580.000	1515.284	64.716	0.042
1980 4	1617.000	1631.011	-14.011	-0.009
1981 1	1642.000	1629.121	12.879	0.008
1981 2	1716.000	1658.004	57.996	0.034
1981 3	1734.000	1712.614	21.386	0.012
1981 4	1751.000	1742.811	8.189	0.005
1982 1	1791.000	1756.372	34.628	0.020
1982 2	1823.000	1806.191	16.809	0.009



MSE= 0.000 RMS= 0.013 RHO= 0.366
MEAN ERR= 0.0029 MEAN= 1098.8149
UNNORMALISED ERRORS, MEAN = 6.2055 RMSE = 19.3190

(iv) an increase of 100,000 in unemployment from an initial level of 2.5 million reduces the level of wages by over 0.3%, at 1 million unemployed the same increase in unemployment would reduce the wage level by nearly 0.9%.

(v) the time trend adds 3 1/2% per annum to wages growth.

(vi) incomes policy is a significant restraining effect on wage inflation.

Non-trading public sector (WAPS)

The main explanatory variables are earnings in manufacturing (WAEM), consumer prices (PC), unemployment (LU) and the incomes policy variable (IP) discussed above. An initial specification included the retentions ratio, wages in the other sector and a time trend but these were eliminated in subsequent testing. The restriction that public sector pay in the long run grows in line with that in manufacturing was not rejected by the data. The final equation suggests that incomes policy has a strong effect on public sector pay. Other properties of the single equation are:-

(1) the long run elasticity with respect to consumer prices is zero.

(2) an additional 100,000 unemployed at an initial level of 2.5 million reduces public sector pay by 1/4%; at 1 million, the same increase would reduce public sector pay by 2/3%.

Other wages (WOO)

The main explanatory variable are as before. Public sector pay was included in an initial specification but could be eliminated. The restriction that 'other' pay in the long run grows in line with that in manufacturing was not rejected by the data, and was imposed. Other properties of the final equation are:-

(1) In any quarter, the change in real wages in 'other' is about two-thirds of that in manufacturing.

(2) Other wages adjust each quarter to eliminate half the divergence between themselves and wages in manufacturing; a rapid response.

(3) The effect of unemployment (other than through WAEM) is small.

Average earnings in 'other sectors'

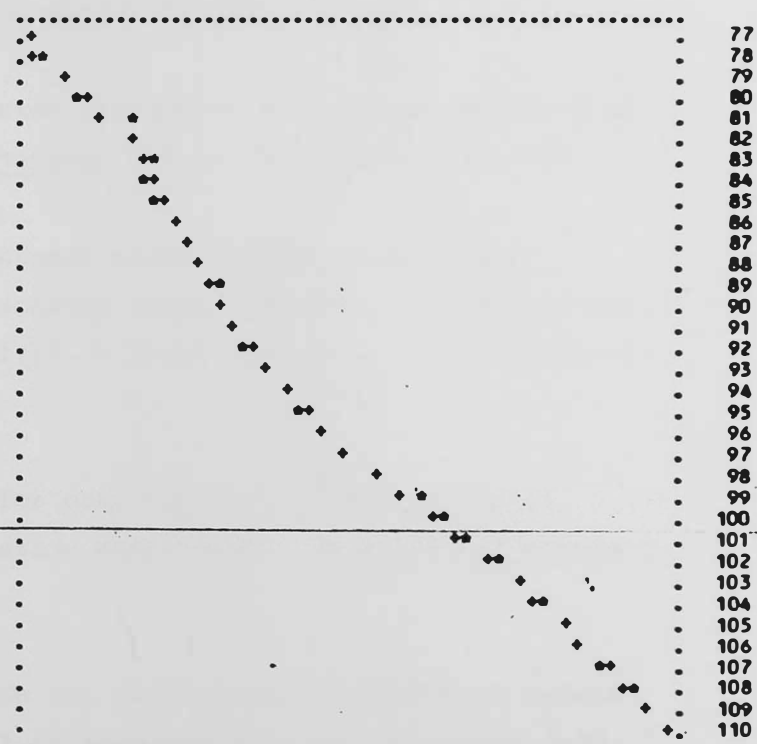
$$\begin{aligned}\Delta \ln WOO - \Delta \ln PC = {} & \underset{(3.0)}{0.672467}\ ((\Delta \ln ((WAEM + (D741 * 3.01)) * 7.09259) \\ & - \Delta \ln PC) - \underset{(4.5)}{0.498813} \ln (WOO_{-1}/(((WAEM + (D741 * 3.01))_{-1} \\ & * 7.09259)) - \underset{(2.1)}{0.633877}\ IP - \underset{(1.1)}{0.077179} \ln (LU/LU_{-2}) \\ & + \underset{(1.4)}{0.180662} \ln (LU_{-1}/LU_{-2}) - \underset{(3.6)}{0.005983} \ln LU_{-2}\end{aligned}$$

$R^2 = 0.378$ SE = 0.0237 DW = 2.02 1965 III 1979 IV

TIME=09:59:23 DAY=TUESDAY DATE= 8 MAR 83 RESIDUAL CHECK OF PAST DATA ON REVISED MODEL

RANGE 428.06 TO 1466.54

204	ACTUAL WOO *	SOLUTION WOO +	RESIDUALS	NORMALIZED
1974 1	429.469	436.319	-6.850	-0.016
1974 2	441.824	428.062	13.762	0.032
1974 3	476.407	480.588	-4.181	-0.009
1974 4	505.167	515.238	-10.072	-0.020
1975 1	598.646	545.594	53.052	0.093
1975 2	588.630	598.146	-9.516	-0.016
1975 3	622.932	606.924	16.008	0.026
1975 4	618.416	635.100	-16.684	-0.027
1976 1	635.053	640.565	-5.512	-0.009
1976 2	659.825	656.607	3.219	0.005
1976 3	675.480	682.917	-7.438	-0.011
1976 4	703.479	702.608	0.871	0.001
1977 1	730.637	724.342	6.295	0.009
1977 2	742.306	739.875	2.432	0.003
1977 3	753.728	752.542	1.186	0.002
1977 4	774.126	788.182	-14.056	-0.018
1978 1	811.631	811.029	0.602	0.001
1978 2	854.866	848.403	6.463	0.008
1978 3	870.754	879.225	-8.471	-0.010
1978 4	893.345	903.225	-9.880	-0.011
1979 1	946.065	930.711	15.355	0.016
1979 2	989.932	989.634	0.297	0.000
1979 3	1057.732	1020.632	37.101	0.036
1979 4	1095.718	1092.848	2.870	0.003
1980 1	1139.651	1117.776	21.875	0.019
1980 2	1185.365	1179.425	5.941	0.005
1980 3	1227.532	1221.741	5.791	0.005
1980 4	1272.555	1251.382	21.174	0.017
1981 1	1295.593	1299.264	-3.671	-0.003
1981 2	1322.219	1324.213	-1.995	-0.002
1981 3	1363.054	1374.677	-11.623	-0.008
1981 4	1409.753	1401.862	7.891	0.006
1982 1	1435.480	1438.513	-3.033	-0.002
1982 2	1458.927	1466.539	-7.612	-0.005



MSE= 0.000 RMS= 0.021 RHO= -0.360
MEAN ERR= 0.0035 MEAN= 899.5952
UNNORMALISED ERRORS, MEAN = 2.9879 RMSE = 14.5985

Future Work

The equations are not stable with respect to either the estimation period or minor perturbations of the data. The construction of the data is not satisfactory and any future work will start with improving the data.

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Listing of variables

Code	Definition	Data unit [a]
BAL	Current balance of payments	£mn
C	Total consumers' expenditure	75 £mn
CD	Consumers' expenditure on durable goods	75 £mn
CND	Consumers' expenditure on non-durable items	75 £mn
EER	Effective UK exchange rate index	
EF	Total final expenditure	75 £mn
EFUS	US final expenditure	US$ bn
EF£	Total final expenditure	£mn
ENIH	National insurance payments	£mn
FCA	Factor cost adjustment	75 £mn
G	Public authorities' current expenditure on goods and services	75 £mn
GDP	Gross domestic product (average estimate)	75 £mn
GDPE	Gross domestic product (expenditure estimate)	75 £mn
HMF	Actual average hours worked in manufacturing industry	hrs/wk
HMFT	Total hours worked in manufacturing industry	hrs/wk
HN	Normal hours worked in manufacturing industry	hrs/wk
IF	Gross fixed investment	75 £mn
IHP	Private sector residential fixed investment: dwellings	75 £mn
II	Total stockbuilding	75 £mn
IIB	Stockbuilding: basic materials, fuels and work in progress	75 £mn
IIF	Total finished goods stocks	75 £mn
IIFM	Stockbuilding: finished goods held by manufacturers	75 £mn
IIO	'Other' stockbuilding	75 £mn
IND	Total industrial investment	75 £mn
KHBB	Stock of bank loans for house purchase	£mn
KHPG	Stock of public sector loans for home purchase	£mn
KIIB	Stock level: basic materials, fuels and work in progress	75 £mn
KM£S	Stock of sterling M3	£mn
KND	Capital stock (industrial investment)	75 £mn
KZNA	Stock of LZNA	£mn
LEMF	Employment in manufacturing industry	000's
LHBB	Loans for house purchase by banks	£mn
LOTH	Employment in 'other' sector (mainly nationalised industries and private services)	000's
LU	Number unemployed excluding school-leavers and adult students (UK)	000's
LZNA	Net advances on mortgages by building societies: OFIs	£mn
M	Imports of goods and services	75 £mn
MGBM	Imports of basic materials (OTS)	75 £mn
MGFM	Imports of finished manufactures (OTS), excluding North Sea equipment, aircraft and ships	75 £mn

[a] Unless otherwise stated, seasonally-adjusted series are used in all cases provided appropriate statistics are available or can be derived.

Code	Definition	Data unit [a]
MGSM	Imports of semi-manufactures, excluding precious stones (OTS)	75 £mn
MND	Proxy for the demand for finished manufactured goods	75 £mn
MPRM	Proxy for production of finished manufactured goods	75 £mn
MPRO	Manufacturing production	75 £mn
MS	Imports of services	75 £mn
NETG	Net rate of tax on General Government final consumpion	Per cent
NETX	Net rate of tax on final expenditure	Per cent
NLAJ	Persons' holdings of net liquid assets (end-quarter)	£mn
NULC	Normalised relative unit labour costs	1975=100
OOTH	Output of 'other' sector (mainly nationalised industries and private services)	75 £mn
ORNT	Owner-occupier imputed rent	£mn
PAHM	House price index (mix adjusted)	1975=1
PC	Price deflator for total consumption	1975=1
PCD	Price deflator for consumption of durable goods	1975=1
PCND	Price deflator for consumption of non-durable items	1975=1
PEXP	Proxy for expected rate of inflation (prices based)	Per cent
PIHP	Price deflator for private residential fixed investment	1975=1
PIND	Price deflator for industrial investment	1975=1
PIMN	Imputed wholesale price index of manufacturing output (net of tax)	1975=1
PIMO	Wholesale price index of manufacturing output	1975=1
PM	Price deflator for imports of goods and services	1975=1
PMAM	Adjusted price deflator for imports of goods and services, excluding finished manufactures	1975=1
PMS	Price deflator for imports of services	1975=1
PONI	Proxy for the price of pubic corporations' net output	1975=1
PS	Price deflator for stock levels	1975=1
PSBR	Public sector borrowing requirement	£mn
PXS	Price deflator for exports of services	1975=1
PXWM	Price of world exports of manufactures	1975=1 US$
RCBR	Clearing banks' base rate	Per cent
RLAE	Local authority three-month rate (end-quarter)	Per cent
TWIP	OECD trade-weighted industrial production	1975=100
UMBM	£UVI for imports of basic materials	1975=1
UMSM	£UVI for imports of semi-manufactures	1975=1
UMM	UVI for imports of finished manufactures	1975=1
UMM$	$ UVI for imports of finished manufactures	1975=1
UXGM	Unit value index of exports of manufactures	1975=100
WAEM	Index of average earnings in manufacturing	Jan.1970=100
WAPS	Average earnings in public sector	£ per qtr/man
WIP	OECD naturally-weighted industrial production	1975=100
WOO	Average earnings in "other" sectors	£ per qtr/man
WTM	UK weighted world import volumes (all goods)	1975=100
WTX	World trade in exports: volume index	1975=100
XGMA	Exports of finished and semi manufactures excluding ships, aircraft, North Sea installations and precious stones (OTS)	75 £mn
XSOT	Services credits (excluding shipping)	75 £mn

Bank of England Discussion Papers

	Title	Author
1-5, 8 11-14, 16 & 17	*A list of these papers can be found in the December 1981* Bulletin, *or can be obtained from the Bank. These papers are now out of print, but photocopies can be obtained from University Microfilms International (see below).*	
6	'Real' national saving and its sectoral composition	C T Taylor A R Threadgold
7	The direction of causality between the exchange rate, prices and money	C A Enoch
9	The sterling/dollar rate in the floating rate period: the role of money, prices and intervention	I D Saville
10	Bank lending and the money supply	B J Moore A R Threadgold
15	Influences on the profitability of twenty-two industrial sectors	N P Williams
18	Two studies of commodity price behaviour: Interrelationships between commodity prices Short-run pricing behaviour in commodity markets	 Mrs J L Hedges C A Enoch
19	Unobserved components, signal extraction and relationships between macroeconomic time series	T C Mills
20	A portfolio model of domestic and external financial markets	C B Briault Dr S K Howson
21	Deriving and testing rate of growth and higher order growth effects in dynamic economic models	K D Patterson J Ryding

Papers presented to the Panel of Academic Consultants[a]

	Title	Author
8	International monetary arrangements the limits to planning*	P M Oppenheimer
9	Institutions in the financial markets: questions, and some tentative answers*	M V Posner
10	The arguments for and against protectionism*	M Fg Scott The Hon W A H Godley
14	The usefulness of macroeconomic models*	Prof W H Buiter T F Cripps Prof Angus Deaton Prof A P L Minford M V Posner
15	Factors underlying the recent recession*	G D N Worswick Dr A Budd
17	Why do forecasts differ?*	Prof M J Artis
19	Bank lending, monetary control and funding policy*	Prof A D Bain
20	The economics of pension arrangements*	Prof Harold Rose J A Kay
22	Monetary trends in the United Kingdom	Prof A J Brown Prof D F Hendry and N R Ericsson

Technical Series

	Title	Author
1	The consumption function in macroeconomic models: a comparative study*	E P Davis
2	Growth coefficients in error correction and autoregressive distributed lag models	K D Patterson
3	Composite monetary indicators for the United Kingdom; construction and empirical analysis	T C Mills
4	The impact of exchange rate variability on international trade flows	G Justice
5	Trade in manufactures	A C Hotson K L Gardiner
6	A recursive model of personal sector expenditure and accumulation	E P Davis
7	A dynamic 'translog' model of substitution technologies in UK manufacturing industry	D J Asteraki
8	Financial asset portfolio allocation by industrial and commercial companies	Mrs P D Jackson
9	Some properties of the Bank model	G P Dunn N H Jenkinson I M Michael G Midgley

* These papers are no longer available from the Bank, but photocopies can be obtained from University Microfilms International: enquiries regarding the service provided should be made to the company at one of the addresses shown on the reverse of the contents page.

(a) Other papers in this series were not distributed.