JOURNAL OF APPLIED ECONOMETRICS, VOL. 2, 259–307 (1987)

# A STOCK-FLOW CONSISTENT MACRO-ECONOMETRIC MODEL OF THE UK ECONOMY—PART II

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SUMMARY

This paper is the second of a series of two which describe the estimation and simulation of a stock-flow consistent macro-economic model of the UK economy. The first part (Davis, 1987) surveyed the theoretical literature on stock-adjustment dynamics, criticized existing UK forecasting models for omitting many potential stock-flow interactions and gave an outline of the model which is constructed here. The estimation and simulation results suggest that variables encapsulating such stock-flow effects are frequently significant in the estimation of key equations, and that their inclusion may make a sizeable difference to the simulation properties of a model.

## 1. INTRODUCTION

This paper is the second of a series of two which construct a small macro-econometric model of the British economy featuring a consistent treatment of macro-economic stocks and flows. In the first part, Davis (1987) suggested important stock-flow effects that macro-economic theory implies may be crucial to an understanding of the dynamics of an economy, pointed out various lacunae in the modelling of stocks and flows in most maco-economic models of the British economy and outlined a model which would fill in some of these gaps in modelling practice. This section describes estimation and simulation of such a small annual macro-model of the British economy in which the theoretical effects described in Davis (1987) are allowed for. These are effects arising from the capital stock, the production function, the equity market, financial portfolio adjustment, inflation adjustment of sectoral income, wealth effects on expenditure, effects of the government budget deficit and effects of external deficits. The significance of these effects in estimation give a reflection of their importance. Their operational relevance is also shown by the difference they make to the models' simulation properties, discussed in Section 4b below.

The model is aggregated to four sectors—public, overseas, company and personal sectors—with the overseas sector only very incompletely modelled. It should be emphasized that the model, as presented, has some shortcomings. Use of annual data means a shortage of degrees of freedom in estimation, and hence restricts equations to having simple dynamics, and presents problems in the interpretation of asymptotic diagnostic statistics such as the Lagrange multiplier test. Quarterly data were not used owing to resource, time and data constraints. Ordinary least squares (OLS) estimation was generally employed despite the presence of endogenous regressors. In such cases instrumental variables (IV) estimation was attempted, but in most cases made little difference to the coefficients. However, it is suggested that future work in this area should employ IV estimation from the beginning.

A further shortcoming is that the model uses several rather crude statistical series—particularly those for the capital stock and estimates of capacity utilisation—is

0883–7252/87/040259–49$24.50

*Received June 1986*
*Revised March 1987*

'eclectic' between neo-classical and Keynesian paradigms in key equations and markets, and has many equations which could perhaps be improved upon statistically. The basic model does not feature 'monetarist' effects from the money stock to consumers' expenditure and the labour supply: effects here are confined to total wealth. However, a variant was presented in Davis (1986a) showing the effects on simulation properties of different wealth definitions in the consumption function.

## 2. THE MODEL IN MORE DETAIL

It should be noted at the outset that several features of the model are derived from existing modelling practice. In particular the wage, price and exchange rate equations are developed from those currently used in the Bank of England medium-term model, and the factor demand equations are derived from a capital, labour, energy, raw materials (KLEM) production function in a similar way to those used in the City University Business School (CUBS) model. Such claims as there are to novelty relate to changes made to these specifications, the rest of the model and the way in which the whole is assembled.

The following section describes the main equations, their position in the structure and the relationships between them. References are to the list of equations in Appendix 1.

### (a) Components of Aggregate Demand (equations A1–A23)

(i) *Consumption and Personal Income (equations A1–A8)*

The consumption function is an annualized version of the equation proposed by Hendry and von Ungern Sternberg (HUS) (1980), using variables appropriate to the aims and level of aggregation of the model. The equation is thus used to determine aggregate consumption, while 'wealth effects' enter via the real net wealth of the personal sector, netting off building society deposits against mortgages. Hence this aggregate includes money, bonds, foreign assets, equity and the net residential capital stock, less bank advances. Assets held via life assurance and pension funds are included in this aggregate. The lagged asset stock is deflated by the lagged price level. As pointed out by Pesaran and Evans (PE) (1984), this may cause 'dynamic misspecifications when prices are changing and can cause overprediction of consumption when prices are rising rapidly'. However, deflation by the current price level may also cause problems. If all assets are indexed and inflation approaches infinity, the wealth term approaches zero, with negative effects on consumption. The adopted solution to this problem has been to redefine the income term as suggested by Patterson (1984), and as shown in equation (A7).

Income in this model comprises the level of real personal disposable income less the losses due to inflation on the stock of real net liquid assets and plus (minus) the net capital gains or losses on illiquid financial assets such as gilts and equities. A wider range of inflation adjustments are thus made than in HUS (1980). However, unlike the results of PE (1984), strong effects from illiquid asset revaluations on consumption were not found. This is economically plausible, as most of these assets are held by the rich (who would have a low marginal propensity to consume) or indirectly via life assurance and pension funds.* Grid search (to minimize the residual sum of squares) suggested that a coefficient of only 0·06 was appropriate for these gains and losses. Inflation losses are entered in two terms. The first term is the net

*PE did not include such indirectly-held assets in their definitions.

proportionate loss due to inflation ($\dot{P}$) times the lagged nominal asset stock, ($A$), deflated by the current price level ($P$). However, as:

$$\dot{P} \cdot \frac{A_{-1}}{P} = \left[\frac{\dot{P}}{1+\dot{P}}\right] \cdot \frac{A_{-1}}{P_{-1}}$$

then entering the latter definition ensures that the problems posed by very high rates of inflation no longer occur, while still taking into account the change in the price level over the current period. The second term gives the approximate losses due to inflation on the nominal assets appropriated during the period—an effect omitted from the definition above. This is done using the formula:

$$\left(1 - \left(1 - \frac{\dot{P}}{1-\dot{P}}\right)^{1/2}\right) \cdot ((A - A_{-1})/(P \cdot P_{-1})^{1/2})$$

in each case.

The preferred version of the consumption function (A8) has the expected signs for derivative, proportional and integral control terms. It has a short-run marginal propensity to consume (MPC) out of income of 0·6, and a long-run MPC from the real asset stock of around 0·2 *ceteris paribus*. The statistical properties are fairly satisfactory. The choice of variables can of course be criticized in various ways. Aggregation of durables with non-durables ignores evidence that their behaviour and determinants are rather different (see Mizon and Hendry, 1980) and eliminates the possibility of using stocks of durables as a component of wealth, determinant of expenditure, and influence (via depreciation) on income (see Patterson, 1984). Secondly, other variables such as hire purchase controls and real interest rates (to show intertemporal substitute and/or cost of credit effects) might be felt to be important. However, results to date have suggested that these do not have strong effects in this formulation. Thirdly, the breadth of the wealth definition might be questioned—other studies have generally used the narrower 'net liquid assets' definition. Results presented in Davis (1986a) suggest that, although narrower definitions are accepted by the data, the broader definition is superior in terms of goodness of fit.

(ii) *Stockbuilding (equations A9–A12)*

The behavioural equation determines the total level of stockholding, with the flow of stockbuilding determined as the first difference of this stock. The specification postulates a long-run homogeneous relationship between the stock level, demand as given by the expenditure measure of gross domestic product (GDP(E) and the real interest rate, modified in the short run by the rate of growth of demand, the rate of growth of capacity utilization and a larger real interest rate effect. Stocks thus build up when the economy grows, when the interest rate falls or when capacity utilization falls, all of which seem reasonable. Capacity utilization and the lagged real interest rate have '$t$' values below two, while the LM statistic indicates some autocorrelation, but, in general, the diagnostics suggest that the equation fits fairly well

In the simulation presented below it is seen that stockbuilding is the main cause of cyclical fluctuations in this model. This is in line with actual experience. The interest rate effect also ensures that it is an important transmission mechanism for financial effects. The term in the growth rate of capacity utilization ensures that stocks fulfil a 'buffer' function when the economy cycles about its trend path.

The rest of the stockbuilding sector determines nominal stockbuilding and stock appreciation in a fairly conventional way. There are no sectoral stockbuilding equations in the model: for simplicity, inventories are assumed to be held and built up 80 : 15 : 5 per cent, by the company, personal and public sectors.

(iii) *'Q' and Fixed Investment (equations A13–A16)*

The function for non-residential investment is a factor demand equation derived from a capital, labour, energy, raw materials (KLEM) production function as suggested in Nickell and Andrews (1982) and Beenstock *et al.* (1983), substituting out the demand equations for energy and materials into the production function algebra. However, the cost of capital is replaced by the valuation ratio or '*q*'. In theory, '*q*' should encompass all the necessary information on factor prices and quantities, leaving only itself and the lagged capital stock in the equation. However, experimentation showed that while real factor prices of fuel and raw materials did not influence the share price, they did have an important independent influence on investment when '*q*' is in the equation, so they remain. On the other hand, real wages inclusive of employers' contributions, which proxy the price of labour, were found to be insignificant in the investment function.

'*q*' is defined broadly as suggested in Jenkinson (1981), as the nominal stock of equity* outstanding divided by the replacement cost of the net non-residential capital stock, taking into account investment allowances. As described below, the share price brings into this variable the influence of company liquidity,† interest rates and capacity utilization, while '*q*' is obviously also influenced by lagged investment, investment allowances, stockbuilding and inflation (which raises the replacement cost of the capital stock).‡ '*q*' is thus a pivotal variable in the model. It enters the equation in log form—thus as it varies about its equilibrium value of one, the log changes about zero. This was felt to give a more plausible response path than entering the linear version in a log equation, as it gives a stronger effect of falls in '*q*' on investment and weaker effects of rises than the linear case. This asymmetry is in line with the likely pressures on management to act in each case—it is probably easier to postpone investment decisions when business is good than to resist the pressure to cut investment under adverse conditions.

The equation also features the lagged gross capital stock (thus giving it a 'capital stock adjustment' basis), a time trend (giving trend growth) and a constant. All variables are entered with lags, which can be justified by reference to costs of adjustment, delivery lags, planning periods, etc. The price elasticities suggest that capital is a complement to energy but a substitute for raw materials, as appears borne out by the fact that fuel crises have been accompanied by declining investment, while increases in general raw material prices have led to greater investment to increase efficiency in use of materials. These material prices are influenced directly by the exchange rate (equations E14 and E15) on the assumption that fuel and raw materials are generally either imported or priced in dollars, or both. The exchange rate is thus an important influence on investment, with depreciation leading on balance to higher investment. The coefficient of $-0{\cdot}5$ on the lagged capital stock suggests that adjustment occurs fairly rapidly towards the desired level of the stock. The diagnostics suggest

*It has been suggested that the use of stock market data for '*q*' may be unreliable, as the variance of share prices does not conform with the underlying volatility of dividends. Hence share prices may be a biased proxy for firms' underlying profitability. However, they were the best proxies available.

†See also Chappell, Cheng and Richards (1984).

‡See Abel (1982) for a discussion of '*q*' and the interaction of tax policy and accelerated depreciation due to inflation.

that the equation gives a reasonable description of the data, though the Lagrange multiplier test exceeds the critical level of 6. The size of the time trend also seems a little implausible.

The equation for housing investment (A15) has a fairly conventional 'supply-side' specification, whereby the real short rate (representing builders' borrowing costs), the labour cost/price ratio (showing other costs in relation to a proxy for selling prices) and the lagged capital stock influence investment, in a partial adjustment framework. All signs are as might be anticipated, and all coefficients are significant. The powerful real interest rate effect makes this equation an important conduit for monetary policy. Such an effect has been widely observed elsewhere (see Easton, 1985).

Total fixed investment is completed by public investment, which is exogenous.

(iv) *Capital Stock (equations A17–A21)*

The capital stock data used in the model are consistent with those published in the 1983 'Blue Book' (CSO, 1983). As described on page 114 (*ibid.*), the imputed asset lives were shortened for that set of data, so as to be a great deal more in line with the perceptions of the undertakings owning the capital. While retaining their well-known imperfections (see for example, Maurice, 1968), the data should thus be more realistic than hitherto.

In order to simplify the model, the real stocks have been defined by deflating the current price stocks by the appropriate (flow) investment deflators. Use of constant price numbers would mean a proliferation of deflators, and perhaps little gain in precision, since the current price numbers are understood by the author to be the basic calculations from which the constant price data are merely derived by estimation. Current price stocks are designated by the letter 'C' in the equation listing, constant price by 'K'.

Turning from the data to the specifications, real gross and net private (residential and non-residential) and gross public (non-residential) capital stocks are determined endogenously, all at replacement cost. Gross stocks are used throughout in activity equations (investment, production function), as in principle, assuming no deterioration in the physical productivity of the capital good, they measure more closely the productive capacity of the capital.* Net stocks are used where a wealth measure is required, since they measure the part of capital which is likely to be realizable. (To clarify concepts, 'gross capital' measures the size of the extant capital stock net of scrapped assets, while the net capital stock deducts from this an allowance for depreciation due to the age of assets in relation to their expected lives.) In the model, the gross stocks are estimated using simple equations whereby gross investment is added to the lagged capital stock less an estimate of scrapping, as captured by a coefficient on lagged capital of below one. Estimates for the non-residential capital stock suggest average asset lives of around 50 years, which is long compared with other countries, though not in comparison with assumptions made by government statisticians. The private residential stock lasts longer, as might be expected, though the lagged dependent variable of 0·999 is perhaps too high.

This methodology for gross stocks is valid in a steady state, where investment occurs continuously and smoothly, and assets are correspondingly scrapped smoothly after asset lives expire. Obviously the history of investment has not been a steady state; cycles, wars, etc., having intervened. This methodology will thus be subject to error. However, it was felt that the

*This is a strong assumption, and is incorrect to the extent that capital equipment deteriorates in physical productivity over its service life. However, the view was taken that any *marked* deterioration would be met by scrapping, and that the alternative assumption of a continuous falling-off of productivity towards zero at life's end was considerably more unrealistic. To the extent that the assumption is false, the equations will overstate the economy's productive potential and understate the incentive to invest, at least in so far as these depend on *levels* rather than *trends* in gross capital.

alternative of determining scrapping explicitly by tracing the history of different types of capital good, using historic investment series and various asset lives, would be excessively complex. Hence smooth implied rates of scrapping were used as an approximation and residuals added to aid tracking over historic periods.

The real net stocks are estimated as simple proportions of the gross stock in each case, though a time trend is included in the residential stock. The nominal net stocks are these real stocks times the appropriate price deflators. Thus important valuation effects on these variables during inflationary periods are captured.

(v) *Trade Equations (equations, A22, A23)*

The export and import functions embody both 'price' and 'activity' effects, together with capacity utilization. Oil is omitted from the equations and left as exogenous.

In the case of exports (A22), there is a long-run unit elasticity with world trade (OECD trade weighted industrial production), modified by the ratio of sterling export prices to the sterling equivalent of UK trade weighted competitors' prices, in 'effective' units* rather than dollars. This construct allows exchange rate modelling to concentrate on the effective and not the dollar rate, and should, in any case, give a more sensitive picture of the United Kingdom's competitive position, *vis-à-vis* the world and not just the United States. Short-run price and activity effects are also entered into the equation. The lower coefficients than those in the long run allow the equation to exhibit 'J curve' effects. The lagged level of capacity utilization has a positive coefficient, showing that, as utilization grows, exports are choked off, being sucked back into the home market. It might be felt to be implausible that such an effect should occur independently of price changes, though one might argue that it would occur in the case of 'satisficing' firms, who, with growing capacity utilization, would take the easier option of serving home market buyers, rather than seeking export markets. Conversely, when demand is slack there would be more incentive to try to sell abroad, while prices might not be cut so as to protect margins. The export function selected appears to have reasonable statistical properties.

The import function (A23) again features a long-run unit elasticity between imports and activity—in this case domestic activity as indicated by total final expenditure.† As in the export function, the restriction of unit elasticity was tested and found to be accepted by the data. This effect is modified by the ratio of sterling import prices to domestic prices, and a time trend, indicating a long-run growth in import penetration.‡ In the short run there is a large response of imports to growth in domestic demand—a short-run elasticity of 1·8. This 'overshooting' is in line with other studies of imports and past experience. The capacity utilization term indicates that imports are sucked into the UK economy as full capacity is neared—again a common feature of the trade cycle. Similar arguments about the plausibility of pure volume responses to shortages and excess demand must be accepted. The import function fits badly compared with the export function, and the LM statistic shows that some autocorrelation remains.

(vi) *Other Elements of Demand (equations A24–A27)*

The factor cost adjustment (FCA) is the difference between GDP at market prices and factor cost, and comprises the net value of indirect tax and subsidy payments. It was estimated using

*That is, using an index for foreign prices based on the sterling trade-weighted exchange rate index.

†This aggregate was used instead of GDP as the latter excludes the effect of demand for imports.

‡A trend could also have been introduced to the export function: however our aim was to avoid time trends as much as possible (i.e. except where a trendless equation was totally unacceptable) to avoid problems in the long-run properties of the model.

weights based on the level of such taxes and subsidies on government current expenditure, fixed investment and exports, taken from the Bank of England short-term model. The coefficient on consumption was left to be estimated, and gave a coefficient of 0·15. The FCA deflator is defined to follow the path of the GDP deflator, modified by changes in the indirect tax rate.

Aggregated demand is given by the summation of the components described above, in a normal Keynesian manner.

### (b) **Labour Market (equations B1–B6)**

#### (i) *Labour Supply (equations B1, B2)*

Modelling of the labour supply proved a particularly difficult exercise. Data availability enforced the use of the definition 'employment plus unemployment', which may diverge from those actually in the 'labour force', for example, by a lack of benefit entitlement preventing those seeking work from signing on as unemployed. The formulation hypothesises that changes within sample in the labour force participation ratio are composed of two factors. Firstly, there is a demographic shift influenced by social factors, i.e. the increasing labour force participation of married women, for evidence on which see Greenhalgh (1980) and Joshi (1983). This change is proxied by a constant and a time trend, as it is assumed not to be influenced by economic variables identified in the model. Secondly, deviations about the trend are influenced by lagged economic variables—personal sector real net wealth (as in the consumption function), post-tax real wages and the rate of unemployment (the discouraged worker effect). The reason for this two-stage process, besides its economic plausibility, is that if economic variables are entered at the first stage, then trends in wealth and wages capture the 'social' trend, giving implausibly large elasticities. Wages and wealth were chosen as variables as they indicate respectively income available after entering the labour force, and the assets which could be drawn down if an individual chooses not to join the labour force.

The equation (B2) could be criticized for omission of non-labour income and also because certain other transfers are not included in wages. Benefits are omitted as their effect is ambiguous—many individuals not in the labour supply are entitled to supplementary benefit, which is at broadly the same level as unemployment benefit, and many who are seeking work are not entitled to unemployment benefit. The lagged rate of unemployment emerges as an important determinant of the labour supply, but causes problems in simulations as it induces cycling of the labour supply and unemployment rate. The imposition of the 4-year averaging constraint reduces this problem, and may give a plausible planning period for labour supply decisions. The other determinants are also still significant after several lags were taken. The behaviour of this equation in simulations is discussed further below.

#### (ii) *Labour Demand (equations B3–B5)*

Private sector demand for labour is defined to include the self-employed as well as employees in employment. Although objectionable in some ways, as self-employment might be seen as a substitute for employment, it may be argued in favour of this aggregation that demand for self-employment is likely to depend on similar factors to those determining employment, i.e. output, costs, the level of the capital stock, etc. Labour demand is determined by a factor demand equation derived similarly to the investment function,* with the addition of a term in

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*In theory, the approach adopted implies cross-equation constraints between the labour and capital demand and production functions. These were not tested or imposed in this exercise.

aggregate demand as a proxy for expected output. As well as being standard in most UK models of labour demand, this term was added to give a more plausible response of the equation to increased demand in simulations. Although it makes the equation more of a 'hybrid', it does not significantly change the size or significance of the other terms. Demand was entered both directly and by using instrumental variables which were, however, found not to improve the equation. The equation shows labour to be a complement for fuel and raw materials. Capacity utilization again enters, suggesting that more labour is demanded when capacity utilization is high, though inclusion of this variable may cause problems of interaction between labour supply and demand. As with the investment function, all the determinants except demand are lagged; this can be rationalized by reference to contract periods and adjustment costs in hiring and firing labour. Because of the lags, OLS is an appropriate method of estimation.

A significant negative time trend showing productivity changes might have been anticipated in this equation, with a size of $-0{\cdot}01$ similar to that in the production function, but it proved to be insignificant. Many of the included variables are insignificant at the 95 per cent level. In general, the equation is somewhat unsatisfactory and theoretically inconsistent, but improvement did not prove possible in the time available.

Public sector demand for labour is determined by government expenditure. The equal weights on current and investment expenditure may be objectionable, as in practice non-residential public investment has a lower labour content than the others. However, attempts to estimate different coefficients proved unsuccessful.

(iii) *Unemployment (equation B6)*

As noted above, unemployment is left as the difference between the labour supply and total demand for labour. It is a crucial determinant of wages, as discussed in section (d) below.

## (c) **Output (equations C1–C3)**

(i) *Production Function (Capacity Output) (equations C1–C3)*

This equation is particularly important to the structure of the model, as using the level of factor availability it determines the potential level of output and hence the pressure of demand in the activity equations, given the existing level of activity. It also uses the weakest data and is itself imposed, and should thus be viewed as exploratory and highly provisional.

The approach to the problem of capacity has been to use data for whole economy capacity utilization estimated independently by Knoester and Van Sinderen (1984); then to estimate a production function using the implied data for capacity GDP. In short, their method derives an equation for changes in productive capacity, with investment and extra hours worked adding to potential, while depreciation and scrapping reduce it. The KVS data have been extensively criticized by Jenkinson (1984), in particular for low asset lives and a zero elasticity of capacity output with respect to hours worked.*

However, for current purposes the data are convenient in that they are based in OECD estimates, for which a longer time series is not available, and, except for the late 1970s they have a broadly plausible path (see Table I). For dynamic simulations the model will, in any case, follow the path defined by the equation. Experiments were also conducted with

*A further problem with the index is that it is derived from a clay–clay model. So to be fully consistent such a model should be estimated here.

data proposed by Artus and Turner (1978), which may be more plausible. However, these data only relate to manufacturing, and only go up to 1977, so they were not adopted.

Initial attempts were made to estimate freely various production functions, but difficulties were encountered—in particular, labour and capital would not both emerge with a positive sign, perhaps owing to identification or collinearity problems. Beenstock *et al.* (1983) managed to estimate freely without this problem, but included demand variables such as the real money supply in their equation, whereas here the intention was to have a pure supply side specification. Artus and Turner (1978) obtained production function estimates, but only for manufacturing, and their approach largely ignored effects of raw materials and energy prices, only using a dummy variable to test for oil price shock effects, and did not enable direct derivation of the separate coefficients on capital and labour, as is essential here. The intermediate solution chosen for the current equation was to *impose* coefficients for the labour force and the capital stock equal to their approximate factor shares in the income measure of gross domestic product (GDP(I)) as is implied by profit maximization in the case of constant returns to scale—a procedure suggested by Klein (1953), though criticized by Wallis (1979) and others for assuming and not testing constant returns to scale of a Cobb Douglas variety.* The imposition of an elasticity of substitution equal to one may also not be warranted.† The rest of the KLEM equation was estimated—energy and raw material prices having the correct sign, though the former was insignificant, and the time trend suggesting disembodied technical progress proceeds at a rate of 1·0 per cent per annum.‡

The dependent variable in the equation is, as noted, capacity GDP as defined by GDP(E) divided by capacity utilization.§ Owner-occupied rents, i.e. returns on the residential capital stock, are excluded. The labour force variable is labour supply, the rationale for this being that capacity GDP should imply full employment, whereas use of labour demand in a production function defining capacity would imply that the unemployed are not a potential resource. Capacity utilization thus is defined to be below unity when there is spare labour capacity as well as unused capital. Of course, this may lead to some counter-intuitive results—if sufficient 'discouraged workers' re-enter the labour force when employment rises during a recovery, then capacity utilization may fall—but it may be more tenable than the alternative. Capital is defined in the production function as the mid-year stock of real gross non-residential capital. Omission of owner-occupied rent means that the return from the private-residential capital stock is already allowed for, while the return from public residential capital—council house rents—is felt to be sufficiently small to be ignored. The inclusion of the private and public non-residential stocks with equal weights as parts of economic capacity implies that they are equally productive—a view that might be challenged by certain economists.

The equation implies the path shown in Table I for capacity utilization, i.e. actual GDP(E) divided by the estimate of capacity GDP.

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*In support of our approach, we note that Artus and Turner (1978 found the sum of labour and capital coefficients for manufacturing to be insignificantly different from one, implying constant returns to scale. More recent studies of the production function (Artus (1984), Helliwell et al. (1985)) found it reasonable to assume constant returns to scale from the outset.

†Available evidence does not strongly oppose this assumption. For example, Helliwell *et al.* (1985), who estimated elasticities of substitution using a CES production function, commented: 'the derived equations for production and factor demands revealed very little power to choose a value for the newly freed elasticity of substitution. The evidence suggested that in most countries it could easily be as low as 0·65 or as high as 1·0, and that the choice has virtually no effect on the fit or parameter values of the estimated production and factor demand equations' (Helliwell *et al.* (1985), p. 48)).

‡Artus (1984) estimated a similar rate for UK manufacturing over 1974–1982.

§Though gross output rather than value added should in principle be the dependent variable in a KLEM function.

Table I. Estimated (actual) capacity utilization (%)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1965 | 89·0 (89·3) | 1970 | 86·6 (85·4) | 1975 | 79·9 (83·6) | 1979 | 78·0 (79·5) |
| 1966 | 87·6 (88·0) | 1971 | 85·5 (84·7) | 1976 | 83·1 (83·9) | 1980 | 72·9 (72·7) |
| 1967 | 87·1 (87·3) | 1972 | 82·4 (84·1) | 1977 | 83·1 (80·0) | 1981 | 71·3 (—) |
| 1968 | 89·4 (87·9) | 1973 | 86·8 (88·7) | 1978 | 80·1 (79·5) | 1982 | 72·1 (—) |
| 1969 | 87·8 (86·1) | 1974 | 85·6 (85·8) | | | | |

The KVS numbers which were used as a basis for the estimation are shown in parentheses. It can be seen that the equation picks out the trough of the current recession as 1981, and features higher and perhaps more realistic numbers for 1977–1978, though the estimate for 1973 is perhaps rather low.

## (d) Wages and Income from Employment (equations D1–D6)

### (i) *Phillips Curve (equation D1)*

The Phillips curve in the model is similar to that used in the Bank of England medium-term model, except that it incorporates a post-tax target real wage.* In the long run, post-tax real wages approach a level such that labour cost is a constant proportion of GDP at factor cost, subject to the rate of unemployment (i.e. labour supply less labour demand), and a positive time trend. In the short run, nominal wages closely follow market prices, productivity and rates of direct tax, though wages are homogeneous in prices only in the long run; *ceteris paribus*, inflation initially causes real wages to fall. We attribute this result to the inclusion of a wider range of independent variables than most studies of UK wage behaviour. This equation implies that wage bargaining is influenced by, *inter alia*, direct and indirect taxes and employers' contributions. However, the effect of taxes, which enter the long-run solution via the long-run target post-tax real wage, is relatively small compared with that of employers' contributions, which enter via the labour cost share term. In fact (assessing the effect of 1 per cent increase in tax and contribution rates at 1982 levels) the ratio is 1 : 29, so, in the long run, wages are mainly demand-determined. Taxes are, however, more important to wage bargaining in the short run. The restriction on the components of the long-run target real wage was tested and found to be accepted by the data ($F = 2{\cdot}9$ compared with $F(10,2) = 4{\cdot}1$).

The Phillips curve, together with the production function and labour supply and demand functions, ensures that the labour market has at least a tendency towards equilibrium, as unemployment reduces wages, which increases labour demand and contracts labour supply. The process is likely to be extremely slow, however. The implied natural rate of unemployment, at a labour cost share of 0·6 and a post-tax real wage of 80£ 5000, is $8\frac{1}{2}$ per cent. Other natural rates arise from other levels of real wages and cost share. The dynamic multiplier on prices (see Patterson and Ryding, 1982; Currie, 1982) is (−16), assuming the labour cost share is constant in a constant growth equilibrium.

The dependent variable in the Phillips curve is the average wage of those in employment. This gives some imprecision to the measure of labour income (including self-employment and forces), and a residual is used to give more comprehensive measures of personal and company income.† The alternative of using 'average labour income' in the Phillips curve was attempted, but the estimate was inferior to that reported here.

*See Henry *et al.* (1976).
†Since profits are basically GDP less income from employment.

(ii) *Labour Income (equation D2)*

This identity derives labour income from labour demand and the average wage of those in employment.

(iii) *Employer's Contributions (equations D3, D4)*

Employers' contributions must be determined in order that costs of hiring labour may be accurately estimated. National insurance rates are exogenous.* while 'other' contributions grow at the same rate as the aggregate wage bill, subject to a positive influence of the rate of unemployment.

(e) **Prices (equations E1–E15)**

(i) *Domestic Prices—Rates of Growth (equations E1–E6)*

The level of disaggregation of the model still necessitates determination of a set of price deflators, in order to determine nominal expenditures and hence allow derivation of sectoral net acquisitions of financial assets. All the equations are based on a similar specification, of which the equation for consumer prices may be used as an example.

The formulation is 'cost plus', where prices are determined in the short and long run by unit labour costs (ULC), import prices (PM) and (in the case of consumer prices) 'unit indirect tax costs' (UITC), and the equations are in an 'error correction' format. There are no 'pressure of demand' effects on consumer prices. The rather sharp contrast in formulation between the price and wage equations may be rationalized by appealing to the greater importance of 'stocks' of unemployed workers in the labour market, and the importance of countervailing pressure from trades unions for target wage increases. The dominant effect in the price equations comes from unit labour costs, defined as labour income plus employers' contributions divided by real gross domestic product, though import prices also have a strong influence. The long-run solution of the equation is:

$$\ln PC = 0{\cdot}39 \ln PM + 0{\cdot}46 \ln ULC + 0{\cdot}15\, UITC + 0{\cdot}54$$

The equation fits the data particularly well.

The other equations are in a similar format, though indirect taxes do not influence the level of the deflators. In the equation for the stockbuilding deflator, capacity utilization was found to be correctly signed and fairly significant: this was not the case in the other equations. Long-run effects of import prices could not be found in the housing investment or government investment deflator equations, and in the government current expenditure equation the long-run effects were not well determined. Although all the equations pass the LM test, the level of explanation for the private housing investment deflator was rather low.

Besides assessing direct effects of capacity utilization, the equations were also re-estimated using 'capacity unit labour costs', i.e. labour costs divided by capacity GDP, a variant of 'normal cost pricing' (Godley, Nordhaus and Coutts, 1978). However, although theoretically desirable as it allows for the relationship between wages and trend productivity, and as it removes the occasionally spurious changes of prices predicted when actual GDP changes sharply, the result was a far less good 'fit' for all the equations.

*In fact, it is likely that the government increases these at the same time as unemployment rises to balance the fund.

(ii) *Domestic Price Levels (equations E7–E9)*

Current price GDP and the deflators for current and market price GDP are easily derived from these deflators, as shown in equations E7–E9.

(iii) *Trade Prices (equations E10, E11)*

The export and import price deflators are constructed as simple weighted averages of sterling competitors' wholesale prices and the factor cost GDP deflator. In the case of export prices the weights are 30 : 70 between foreign and domestic prices, while, for import prices the weights are 70 : 30. These figures are broadly in line with those found by more systematic research elsewhere (see Bond, 1981). Although not constrained to sum exactly to one, the coefficients could easily be made to do so with little violence to the data. These trade prices and volumes allow derivation of the trade balance and current account, as described below.

(iv) *Exchange Rate (equation E12)*

The exchange rate equation, which determines the trade-weighted index rather than the dollar/sterling rate, is basically a purchasing power parity (PPP) formulation adapted from the Bank of England medium-term model. The equation suggests that the exchange rate is determined by the short interest rate in the short run, while in the long term it depends on competitiveness, portfolio balance in the market for net foreign assets, and sterling's status as a petro-currency. The difference of short rates was used rather than an interest rate differential because it gave a better result. In any case, foreign interest rates enter in the reduced form as they are the main determinant of the short rate (equation H10). The equation was estimated by instrumental variables (IV), using lags of the short rate to determine the instrument, in order to allow for simultaneity between exchange rates and interest rates. The resulting estimate was a considerable improvement over the non-IV estimate, with all coefficients significant and the LM tests indicating no residual autocorrelation. The equation can, however, be criticized in various ways. For example, it is estimated over a period including regimes of fixed and floating exchange rates—a necessity due to degrees of freedom problems*—(though the low LM statisitc suggests that the equation is not misspecified), it has a rather large time trend, with $2\frac{1}{2}$ per cent annual depreciation, and oil exports are used as a crude proxy for the state of the oil market and Britain's known reserves. Imposition of PPP in a single equation might be felt less desirable than PPP being a system property, and many would argue that relative unit labour costs are, in any case, a better determinant of competitiveness (for a discussion, see Hotson and Gardiner, 1983).

### (f) **Public Sector (equations F1–F9)**

The public sector of the model is fairly simple and conventional, and, as such, requires little comment. A balance has been attempted between size and a realistic number of government 'levels' that can be used in simulations, while maintaining the accounting identities. Debt interest, current grants and the tax 'take' are endogenous, while other elements of income and expenditure are exogenous. Debt interest is simply defined as a proportion of the long interest rate times non-monetary debt outstanding to the non-bank private sector. Surprisingly, the coefficient exceeds one—perhaps due to measurement error and interest paid by the public sector to other sectors. The equation for current grants assumes that the unemployment benefit rate is an adequate proxy for all benefits. Hence there is the benefit rate times

*However, re-estimation over the floating rate period resulted in no significant changes in the coefficients.

unemployment to show the amount of benefit paid to the workless, while there is the benefit rate times 55,000 (the total population) less the population of working age not in full-time education, to show grants paid to pensioners, students and child benefit. A significant coefficient of 1·6 suggests that this is a reasonable regressor, though obviously some persons in this aggregate receive more than the unemployment benefit rate. A time trend and constant help the tracking of this quantity. An equation was also estimated for the rate of unemployment benefit, but homogeneity with prices was not accepted—an elasticity of 0·8 being implied instead. While it is quite plausible that governments have systematically reduced real benefit rates in the past decade, this did not seem an appropriate assumption in simulations, so an equation with unit elasticity was programmed for use in simulations.

Public sector receipts include endogenous tax receipts, insofar as personal and company incomes are multiplied by the actual average tax rate in each year, imposed as an exogenous variable, with company sector taxable income lagged to allow for the lag between accrual and payment of tax by companies. Given progressive rates, thresholds, etc., use of an average tax rate would not be an adequate assumption for large changes in income, but should be adequate for marginal changes.* The nominal factor cost adjustment is also included in 'receipts'. Since this is actually indirect taxes less subsidies, 'receipts' here differ slightly from the more conventional definition. Payments are amended correspondingly, so that saving is in line with normal usage. Public sector investment is completely exogenous, as are capital transfers. These items plus saving allow derivation of the public sector NAFA (changes in net financial assets of the public sector). The difference (POTH) between this and the net addition to public borrowing (PSBR) has also been left exogenous.

## (g) Balance of Payments (equations G1, G2)

Net property income from abroad is determined endogenously by the stock of net foreign assets times the US bond rate. A dummy which takes the value '1' after the abolition of exchange controls has a significant negative coefficient, suggesting that investors have since then invested in lower-yielding assets. Together with trade volumes and prices and the exogenous residual (net transfers from abroad), property income allows derivation of the current account.

## (h) Non-bank Private Sector (NBPS) Financial Model (equations H1–H13)

### (i) *Inflows (equations H5)*

The set of 'real' equations and identities described above determines the public sector borrowing requirement and the current-account surplus, which are sources of 'outside' financial wealth for the non-bank private sector. Following the usage of the Bank of England small monetary model (see, for example, Coghlan, 1979; Johnston 1982), these flows are used to define the increase in net financial wealth of the non-bank private sector, along with revaluations and an exogenous residual (increase in non-deposit liabilities, counterparts identity residual, foreign currency counterparts residual). The algebra proving this correspondence is well known—see the references for a derivation. A further portfolio system for the personal sector, described below, divides these assets between the company and personal sectors, and determines personal sector demand for equity.

*The alternative is a complex derivation of all the tax 'takes' based on actual tax rates such as is found in the Inland Revenue's tax models.

(ii) *Revaluations (equations H1–H4)*

The revaluations are calculated in a fairly standard manner for gilts as the stock times the proportionate change in the price. The coefficient of 0·7 was imposed, as the mean proportion of non-monetary public sector debt subject to revaluation. Estimation of the equation then suggested that the proxy for revaluations based on this stock times its price warrants a coefficient of 0·78. Net foreign assets are more complex, as the value of assets defined in foreign currency depends in part on the exchange rate and the foreign interest rate, but some of the assets and liabilities are denominated in sterling. The perhaps unsatisfactory solution chosen was to allow net assets to be affected by both the exchange rate and the US bond rate, while a proportion of net assets (proxying the excess of foreign currency gross assets over foreign currency gross liabilities, once net assets were removed) were indexed by the exchange rate alone. Losses due to revaluations of UK and foreign equities within gross quantities were assumed to cancel. The revaluations of foreign assets were tracked much worse than revaluations of gilts—a coefficient on the proxy of 0·33 being warranted. The residual 'REVR' on revaluations is the difference between the increase in the value of financial wealth and the flows to its components plus revaluations of gilts and net foreign assets.

Revaluations of equity are also determined in this section, though as explained above they are not a net asset of the NBPS. They are defined as the increase in share prices times the stock of equity.

(iii) *Portfolio System—Introduction*

Given the 'inflows' from the PSBR, current account and revaluations, the non-bank private sector (NBPS) is assumed to exercise choice over its proportionate holdings of the various assets, via a portfolio system of asset demand equations. The system is not a very sophisticated one—no allowance is made for rationing of certain assets/liabilities such as bank lending, nor are symmetry, adding up, etc., restrictions imposed or tested. Not all the *a priori* interest rate effects could be established as either significant or with the right sign in all the equations. Moreover, the portfolio system is not used directly to determine interest rates and exchange rates, as in Keating (1984), though portfolio balance terms are significant determinants of exchange rates and long interest rates. Finally, expectations in this system are purely adaptive, whereas arguments could be made for a forward-looking approach.

(iv) *Demand for Money (equation H6)*

The portfolio system used is hierarchical to the extent that the demand for money (£$M_3$) depends on income, wealth and interest rates, while demand for other assets depends only on wealth and interest rates. Also, the demand for money is determined in real terms, while the others are nominal. One can justify this structure by reference to the role of money as means of payment, as a result of which demand for money is closely related to real expenditure, and hence the real size of money balances is a key decision variable (though it could be argued that $M_1$ is a more appropriate definition of transactions balances). By contrast, other public sector debt, foreign assets and bank loans are only relevant in terms of optimal allocation of the net wealth portfolio. A similar argument is deployed in Johnston (1982). The money demand equation in the current model is in 'error correction' form. In the short run, it relates the real demand for £$M_3$ to real disposable GDP and inflows to real net wealth, while in the long run interest rates are also important (a separate short-run effect could not be estimated). There is a long-run unit elasticity between the money and wealth stocks, which was tested and accepted. Similar unit elasticities feature in the other equations. The underlying assumption is that, if relative returns on assets are constant, agents will desire constant equilibrium shares of each asset in the portfolio, as long as relative riskiness (assumed here constant) does not change. The long-run real income elasticity is just over 2, which might be felt to be rather high, while the short-run elasticity is 1·5. The short rate has a positive influence on demand for money, while the long rate has a negative effect. One can argue that this is a plausible result, since £$M_3$ includes time deposits, which yield the short rate. An increase in short rates thus leads the non-bank private sector to shift financial assets from other assets (and sight deposits) to time deposits which are within $M_3$. The effect of a general increase in interest rates on the demand for money is negligible. Indeed, the coefficients on interest rates are so close that they could easily be constrained to be equal, giving homogeneity. Such a low interest elasticity, especially in comparison with the income or wealth elasticities, has often been found in studies of the UK demand for money, and is consistent with a portfolio balance approach to asset demands (see Davis, 1986b). The equation features a 'competition and credit control' (CCC) dummy covering 1972–1974, as the conventional variables were unable to explain the behaviour of money over this period.

The diagnostic statistics for this equation suggest that it fits well—all '*t*' statistics exceed 2 and there appears to be no autocorrelation.

### (v) *Demand for Gilts and Other National Debt (equation H7)*

The other financial asset demand equations feature a common 'error correction' structure, with a short-run non-homogeneous relationship with the 'inflow' to net wealth (including revaluations) and an imposed long-run proportionality with net wealth, modified by the level of interest rates. In the case of other public sector debt the coefficient on the increase in wealth is 1·16, perhaps indicating short-run inertia over the dispersion of gains/losses from revaluations of gilts through the rest of the portfolio. The interest rates have the correct sign, but are not significant at the 95 per cent level. The diagnostics suggest that the equation picks up the track of the data reasonably, particularly given the heterogeneity of other national debt which, although mainly gilts, includes national saving, Treasury bills, etc.

### (vi *Demand for Net Foreign Assets (equation H8)*

Net foreign assets, like 'other public sector debt', is a very heterogeneous item, comprising residents' demand for gross foreign assets less foreigners' demand for residents' liabilities, grouping together very different kinds of asset, including direct and portfolio investments. In the light of this, the performance of the specification seems adequate, as all the coefficients except for that on the increase of wealth are significant, and interest rates have the correct sign.

### (vii) *Demand for Bank Loans (equation H9)*

In normal portfolio manner, an equation is omitted from the system to satisfy the identity, and in this case banking lending is left as a residual. The level of NBPS financial wealth then determines the level of company sector wealth, given that of persons, as described below. The implicit equation for bank lending has not been explicitly checked for implausibility (as suggested by Brainard and Tobin, 1968), though the imposition of unit elasticity with respect to wealth in the other equations means it obtains here too, and the correctly signed interest rates elsewhere should suggest similar signs here. In fact, a bank lending equation has been estimated, based on the specification in Davis (1984) and criticized by Green (1984).* The signs are generally reasonable (the coefficient on the change in wealth should be negative, since loans are a liability, hence entering negatively in wealth), though that on base rates/bank rate is positive. This can be rationalized as an income gearing effect—if rates rise, companies may need to borrow more to pay interest—but is more likely due to misspecification. The credit control dummy is an annual version of the series detailed in Davis (*ibid.*).

(viii) *Interest Rates (equations H10, H11)*

The specification for the short nominal rate is mainly a reaction function rather than a behavioural equation. It hypothesizes that the authorities adjust the short rate so as to retain broad parity with the Euro-dollar rate. The reaction is not instantaneous; 70 per cent occurs in the first year, but parity is maintained in the long run. Such a reaction function is in line with a policy of attempting to prevent excessive changes in the exchange rate resulting from capital outflows when profits can be made by arbitrage. The portfolio adjustment effect which makes the equation consistent with the asset demand equations is thus implicit—an explicit term could not be obtained in this structure. In the short run, the short rate is positively influenced by the inflation rate, thus giving some tendency towards maintenance of real rates during periods of inflation, and negatively influenced by an instrument for the exchange rate. The latter effect is weak, however,

The long rate basically follows the short rate in a term structure style equation. The imposed long-run real rate is 3 per cent, while the long-run inflation rate has an imposed weight of 0·2 in the equation. Inflation also, in any case, enters the reduced form via the short rate equation and via the PSBR and hence the bond/wealth ratio. The other term in the equation is the difference of the bonds/financial assets ratio. This term ensures that a rising level of bond sales in relation to the level of welath is penalized by a rising long rate, as new marginal holders require a higher coupon to be induced to hold gilts, as shown in equation H7. The level of the bond/wealth ratio was not found to be a significant determinant of the long rate, however.

The price of gilts is determined by the long rate. The coefficient below one reflects the fact that most gilts are not consols, hence the redemption date affects the price.

## (i) Personal Sector Income and Expenditure (equations I1–I5)

Determination of income from employment, current grants and employers' contributions has been described above in sections (d) and (f).† However, to obtain total personal income an estimate of 'other income', from rent, net interest, profit and dividends, is required. These are returns on stocks of assets; the fully consistent stock data derived elsewhere in the model are thus also essential to deriving consistent measure of income and wealth.

Persons' imputed rent is derived as a proportion of the net residential private capital stock. Dividends, debt interest and net property income from abroad can be derived as the total flow of returns from the relevant assets times the share of the personal sector in the stock. The cost

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*The equation was:

$$\Delta \ln KBLP = \underset{(3\cdot 7)}{-\,1\cdot 16\,\Delta \ln NFA} \; \underset{(1\cdot 0)}{-\,0\cdot 09 \ln (KBLP/NFA)_{-1}} \; \underset{(0\cdot 1)}{-\,0\cdot 014} \; \underset{(2\cdot 8)}{+\,0\cdot 024\,RLB} \; \underset{(3\cdot 4)}{-\,0\cdot 082\,CCD}$$

$\bar{R}^2 = 0\cdot 57$; SE $= 0\cdot 07$; DW $= 2\cdot 0$; LM(2) $= 5\cdot 9$; 1964–1980

†PYRS in equation (13) is the residual for mismeasurement of labour income, see Appendix 3.

of bank borrowing is given by the short rate times the stock, while the residual (other rent, net returns on unidentified financial assets) is given by 10 per cent of the short rate times the total stock of personal sector wealth. It should be borne in mind that, here as elsewhere in the model, life assurance and pension funds' assets and income are aggregated with those of the household sector.

Disposable personal income is derived from total income by use of an 'average' tax rate (including national insurance contributions). The net acquisition of financial assets (NAFA) may then be derived by deducting nominal expenditure from disposable income. Derivation of such nominal expenditure is a principal reason for estimation of a set of price deflators rather than a single 'catch all' deflator. The estimate of NAFA is still inaccurate, as nominal private housing investment is not exactly equal to persons' fixed investment, and the 15 per cent share of stockholding is unlikely to be held constant, so a residual has been imposed to proxy these inaccuracies and unidentified items.

### (j) **Company Sector Income and Expenditure (equations J1–J5)**

'Companies' in this model include industrial, commercial and financial companies. Company profits are the residual in nominal GDP after labour income, income from rent, public corporations' trading surplus and the residual adjustment is deducted. This may be appropriate in that capital is the factor of production whose return is not determined explicitly; instead it must take what is left of the national income after other factor incomes are deducted. Other company income is determined similarly to other personal income, using the relevant returns and wealth stocks, except for dividends.

Dividends are determined in an equation reminiscent of Lintner (1956), the specification incorporating the findings of his study. These were that managers have a target payment ratio for dividends in relation to corporate income, that they desire stability in the path of dividends, and they only adjust dividend payments partially to changes in profits. This policy can be rationalized by a managerial theory of the firm (see King, 1977) wherein managers use dividend policy as a signalling mechanism for the consequences of company policy which is well-defined and measurable, which is not too costly to adjust and which management are under pressure to relate to long-term expectations. Thus they adjust slowly to a new desired level rather than abuse the signal by increasing its value temporarily. A detailed discussion of this specification, and many other aspects of company behaviour, can be found in Ryding (1984). Although an autoregressive distributed lag model is superior to partial adjustment (see Hendry, Pagan and Sargan, 1982), the lag of income was not significant, and was omitted. The restriction of homogeneity was accepted, however. A dummy for 1973 was introduced into the equation to allow for the change in the data series when advanced corporation tax began to be deducted from 1973 onwards. This is a crude alternative to the measure of the opportunity cost of retained earnings in terms of gross dividends foregone, used in King (1977) and Ryding (1984). The diagnostics suggest that the dividends equation is an adequate representation of the data.

Companies' NAFA is defined similarly to that of persons as gross income less taxes, investment, stockbuilding and stock appreciation. A proxy for taxable income is given by gross income less the nominal value of investment allowances and stock appreciation.

### (k) **Persons' Financial Model (equations K1–K7)**

Personal sector demands for financial assets are determined similarly to those in the non-bank private sector. The supply of new financial assets in each period is equal to the net acquisition of financial assets, determined as described above, plus the share of persons in asset revaluations (revaluations times the share of persons in the stock). A residual is deducted to allow for net acquisition of unidentified financial assets (mainly building society deposits less mortgages).

The portfolio system has the same basis as the system for the NBPS described above. Money is both a medium of exhcange and a store of value, while the other assets are seen principally as alternative stores of value. In each case the demands include those of life assurance and pension funds (LAPFs). Persons have a less interest-elastic demand for money than the NBPS, suggesting plausibly that companies have a high elasticity. The long-run income elasticity is 1·5, again lower than the NBPS. The gilt and foreign asset equations indicate a slower response of holdings to changes in portfolio size and to stock imbalances than for the whole NBPS. This perhaps illustrates a tendency to adjust portfolios only at the margin, and then only slowly. The long-run unit elasticities are less easily accepted than for the NBPS. Interest rates are correctly signed, but many are insignificant.

The model uses a behavioural equation for bank lending and leaves demand for equity as a residual.* The bank lending equation has a long-run income elasticity of 0·6, and a very weak interest rate effect.

### (l) Companies' Financial Model (equations L1–L5)

As NBPS and personal sector demands for financial assets are already determined, companies' holdings of 'outside' financial assets (except equity) drop out by identity. The remaining equations determine the total stock of, and return from, equity.

New issues are modelled as depending on the nominal gross investment which they will help to finance, the state of the share price and the lagged level of issues. Given the gestation lag on investment in equation (A14), this specification does not have problems of simultaneity. The coefficient on the lagged dependent variable is negative, showing the market to be unwilling to accept continuing high levels of issues. The share price has a large short-run effect and a smaller, but nonetheless positive, long-run effect. Thus a buoyant stock market is implied to be an important factor for successful new issues.

The share price equation is a key equation in this model, but, as is well known, it is an extremely difficult variable to model; indeed, its short-run behaviour is often claimed to be best described by a random walk. Here one is obviously interested in economic determinants. Hence capacity utilization and company sector liquidity are used as indicators of companies' expected future profitability,† and the long rate is used to proxy the return on a competing asset. The framework is of partial adjustment, with fairly slow adjustment to changes in the independent variables. The long rate only has an effect in the short run. This result was found

*An alternative equation for the demand for equity is as follows:

$$\begin{aligned}\Delta\ln \text{KEQJ} = {} & \underset{(10\cdot0)}{1\cdot56294}\,\Delta\ln \text{NFWP} - \underset{(1\cdot0)}{0\cdot16664}\ln(\text{KEQJ}/\text{NFWP})_{t-1} - \underset{(0\cdot5)}{0\cdot04796} - \underset{(2\cdot7)}{0\cdot012}\,\text{RUKG} \\ & + \underset{(1\cdot2)}{0\cdot0012}\,\text{RREQ}\end{aligned}$$

$\bar{R}^2 = 0\cdot963$; SE $= 0\cdot046$; DW $= 2\cdot1$; LM(2) $= 2\cdot6$; 1964–1982

A particularly high short-run wealth elasticity is apparent, probably because the value of equity itself is the most volatile component of wealth, and because portfolios are rarely rearranged completely on a stock basis. An alternative model can be generated using this equation, with bank lending as a residual.

†There is no simultaneous feedback in the model from share prices to capacity utilization, given lags in the investment and consumption functions. However, we note that liquidity is partly endogenous and should, in principle, be instrumented.

also when the level and lag were entered separately, the coefficients being equal and opposite. As noted above, real prices of labour and other factors were also assessed in this equation, but they were not significant. Use of portfolio balance terms also proved unsuccessful.

Information generated by the share price, capital issue and dividend equations, and by the lagged stock of equity, allows derivation of the current stock of equity and its pre-tax rate of return.

## 3. THE SCHEMA MODEL—PERFORMANCE

### Introduction

As has been emphasized earlier, the model as it stands suffers from many weaknesses, not least excessive aggregation, theoretical inconsistency (though with general Keynesian tendencies) and a lack of direct influence on demand of the components rather than the total of financial wealth, apart from equity. However, it remains the core of a small, flexible test-bed for different paradigms, which features all of the stock-flow effects identified in Davis (1987), viz. the capital stock, equity, production function, portfolio adjustment, Hicksian sectoral income, wealth effects on expenditure, stock effects of budget deficits and external assets.

Its capabilities are explored briefly in the section below, which describes:* (a) two dynamic simulations; (b) out-of-sample performance.

### (a) Simulations

The following simulations were all run over a 1971–1980 base. There may be problems of base dependence from this approach, but a suitable 10-year future base was not available for a subsequent period. The simulation for government expenditure is the standard test for the properties of macro-economic models (see Wallis, 1985, and any macro-economic model manual). The simulation featuring a change in interest rates allows one to gauge the differences between Schema and conventional models and the contibutions of the stock-flow effect, by reference to simulations quoted in Easton (1985).

(i) *Increase government expenditure by 80 £2,000 million per annum with balanced financing (Table II).* This simulation increases government expenditure while leaving the private sector on its demand curves for money and bonds, i.e. the financing of the deficit is allowed to be determined by the model. There is thus no 'stock disequilibrium' effect on asset prices and interest rates. £2000 million represents roughly 5 per cent of government expenditure over the simulation period. An increase in government expenditure, maintained through the simulation, boosts GDP throughout, but only in the first and second year does the multiplier exceed one. By the fourth year of the simulation the multiplier has fallen to 0·6, a level near which it remains for most of the decade. The endogenous components of this change are as shown in Table III.

'Crowding-out' can be seen to occur for some of these aggregates. Consumption is initially boosted by increased personal incomes and higher wealth due to a higher PSBR, but income is eroded by declining employment in the private sector as real wages rise, and by inflation reducing the real value of wealth.

Investment initially rises as the share price is boosted by rising capacity utilization, hence raising '$q$'. However, this effect is soon offset by the increasing replacement cost of the capital stock as inflation occurs, which reduces '$q$'. This is not entirely plausible and suggests that the

*Details of historic dynamic tracking and a simulation of the effects of increasing investment allowances are presented in Davis (1986a).

Table II.Dynamic simulation; raise government expenditure by 80 £2000 million (percentage changes (absolute changes*) from base)

| Variable | Year 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Real gross capital stock | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | −0·1 | −0·1 |
| Net private financial assets stock (nominal) | +0·5 | +0·2 | +0·3 | +1·4 | +1·9 | +2·0 | +2·0 | +2·4 | +3·2 | +3·9 |
| Persons' real net wealth | +1·5 | +0·3 | +0·2 | +0·3 | +0·7 | +0·7 | +0·5 | +0·3 | +0·6 | +1·0 |
| GDPE | +1·4 | +1·1 | +0·8 | +0·5 | +0·7 | +0·8 | +0·7 | +0·6 | +0·6 | +0·6 |
| Capacity utilization | +1·1 | +0·9 | +0·3 | +0·1 | +0·3 | +0·3 | +0·3 | +0·1 | 0·0 | +0·1 |
| Consumer prices | −0·4 | 0·4 | 0·8 | 0·8 | 0·9 | 1·2 | 1·7 | 2·2 | 2·3 | 2·5 |
| Wages (nominal) | +0·2 | +1·6 | +1·9 | +1·3 | +1·2 | +1·6 | +2·3 | +2·9 | +3·0 | +2·8 |
| Unemployment* (thousands) | −123 | −100 | −14 | −25 | −66 | −115 | −136 | −89 | −47 | −68 |
| Exchange rate | 0·0 | +0·3 | 0·0 | −0·3 | −0·5 | −0·6 | −0·7 | −1·0 | −1·4 | −1·7 |
| Money supply (nominal, £m) | +2·4 | +2·0 | +2·0 | +2·1 | +2·9 | +3·2 | +3·3 | +3·6 | +4·1 | +4·7 |
| Q (valuation ratio) | +2·7 | +0·1 | −1·9 | −1·1 | +0·4 | +0·3 | −0·4 | −1·1 | −0·4 | +0·6 |
| Real fixed investment | 0·0 | +0·3 | −0·3 | −0·6 | −0·4 | −0·2 | −0·4 | −0·7 | −0·8 | −0·6 |
| PSBR (nominal, £m)* | 307 | 344 | 572 | 725 | 865 | 864 | 963 | 1171 | 1545 | 1922 |
| Short interest rate* (percentage points) | −0·1 | 0·1 | 0·1 | 0·1 | 0·0 | 0·1 | 0·1 | 0·1 | 0·1 | 0·1 |
| Current account* (nominal, £m) | −229 | −269 | −342 | −343 | −442 | −591 | −588 | −625 | −746 | −680 |

Table III. Percentage changes (*absolute changes) from base in the components of GDP

| Year | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Consumption | 0·6 | 0·7 | 0·5 | 0·4 | 0·5 |
| Fixed investment | 0·0 | 0·3 | −0·3 | −0·7 | −0·8 |
| Exports | 0·0 | −0·4 | −0·7 | −0·6 | −0·5 |
| Imports | 1·8 | 1·6 | 1·4 | 0·9 | 1·2 |
| Inventories (real £m) | 574 | 26 | 126 | −180 | −77 |

share price should be more closely tied to other domestic prices. Exports fall and imports increase due to rising capacity utilization, imports also rising due to the high short-run elasticity of imports with respect to GDP. Inventories complete a cycle over this 5-year period.

In the labour market unemployment falls sharply as public employment increases. This increases nominal and, due to lags in the price equations, real wages. Increased real wages reduce the private sector demand for labour and increase the supply; hence the initial reduction in unemployment is not maintained. The private sector demand for labour also declines as a result of the above-mentioned crowding out of the increase in GDP. The path of unemployment is not monotonic; it falls back in the sixth and seventh years, reaching a peak in year seven as the economy enters the second stock cycle and labour supply falls due to the 'discouraged worker' effect. To have such cycles over such a long simulation period seems a reasonable property of the model.

Prices, as noted, rise sluggishly at first with wages as unit labour costs increase. This process is reinforced by a decline in the exchange rate from the fourth year onwards, due to lost competitiveness resulting from the said inflation. A depreciation feeds back into domestic prices via import prices. The depreciation also helps to stem the deterioration of the trade balance (the figures for the current account are in nominal terms).

On the financial side, nominal net private financial wealth is boosted by a higher PSBR, despite a deterioration in the current account position and lower revaluations due to higher interest rates. Contributions to the changes in net (outside) financial wealth over the 10 years are (£ million):

| | |
|---|---|
| PSBR | +9,073 |
| Current account | −4,918 |
| Gilt revaluations | −287 |
| Foreign asset revaluations | +55 |
| (Equity revaluations) | (+2,290) |

The distribution of the increase in financial wealth via the portfolio system is as shown in Table IV.

For the non-bank private sector, money stocks increase for most of the period faster than wealth. This is attributable to increased transactions demand as GDP increases. Stocks of other assets increase broadly in line with wealth, though demand for 'other debt' is boosted by an increase in domestic interest rates and a tilt in the yield curve towards the long end. It should be borne in mind that bank lending is the residual asset accommodating to other asset demands—perhaps a plausible assumption on the demand side but not on the supply side, given the history of controls. The split of these assets between persons and companies reveals that persons hold most of the extra money by the tenth year, and generally have a favourable marginal asset/liability position, while companies borrow heavily and end the period closer to a zero balance. This is a plausible response—persons need financial assets both for

Table IV. Distribution of increases in wealth via portfolio system (£ million)

| | Year 1 | Year 5 | Year 10 |
|---|---|---|---|
| NBPS | | | |
| Money | 401 | 1060 | 2859 |
| Other public debt | 88 | 767 | 2778 |
| Foreign assets | 51 | 128 | 623 |
| Bank lending (−) | 388 | 861 | 2338 |
| Net financial wealth | 152 | 1095 | 3923 |
| Persons | | | |
| Money | 41 | 623 | 2037 |
| Other public debt | 121 | 365 | 1661 |
| Foreign assets | 68 | 31 | 148 |
| Bank lending (−) | 0 | 99 | 726 |
| Equity | 886 | 704 | 2541 |
| Net financial wealth | 1118 | 1625 | 5662 |
| Companies | | | |
| Money | 360 | 437 | 822 |
| Other public debt | −33 | 402 | 1117 |
| Foreign assets | −17 | 97 | 475 |
| Bank lending (−) | 388 | 762 | 1612 |
| Net liquidity | −78 | 174 | 802 |

transactions and as a store of value and also only react slowly (via increased consumption) to changes in the wealth/income ratio. Companies, on the other hand, need financial assets principally as working capital to finance investment and to minimize the risk of bankruptcy, while not needing to hold financial assets specifically as a store of value. Bank lending is also an important source of funds for investment and finance of stocks in advance of expected future profits, so one would expect it to increase sharply during an expansion.

Capacity utilization in this simulation is initially far above base, but the discrepancy returns to zero faster than aggregate demand. The increase in capacity GDP arises via increases in the supply of labour and falling relative prices of raw materials and energy. These effects are offset mainly by inflation but also the decline in the capital stock at the end of the simulation.

The section in Wallis (1985) which discusses comparative model properties allows us to make a comparison between the results of this simulation and the simulation properties of the main UK macro-economic models. (The stock-flow consistency of these models was examined in Davis, 1987.) The relevant comparison is with the simulations in Wallis for 'a change in public expenditure: fixed interest rates'. The GDP multipliers are as shown in Table V.

Table V. GDP multipliers

| | Year 1 | Year 4 |
|---|---|---|
| Schema model | 1·1 | 0·45 |
| HM Treasury model | 0·97 | 0·96 |
| London Business School Model* | 0·88 | 1·41 |
| National Institute Model | 1·0 | 2.51 |
| Liverpool | 0·09 | 0.44 |
| City University Business School | 3·5 | −0·09 |

*Asset prices determined by adaptive expectations.

The Schema model is shown to offer a more pessimistic outlook for fiscal expansion than the Keynesian models, but more optimistic than the neo-classical models. As noted above, the low multiplier is partly attributable to the unrealistic properties of the share price equation during periods of inflation. However, we also have crowding-out via certain stock-flow effects: notably falling total real personal sector wealth during inflation, which reduces consumption, effects of increases in capacity utilization on net trade, and the inventory cycle arising largely from the initial overstocking in relation to output. Given the caveats regarding the behaviour of '$q$' these results may still suggest that omission of certain stock-flow effects may lead to an underestimation of the crowding-out caused by government expenditure. It may be of significance that the predictions of the models which emphasize supply-side effects are lower than for the Schema model, while the traditional demand-side models offer higher multipliers.

The exposition in Wallis (1985) does not show the detailed effects of the fiscal expansion on the components of GDP. However, the following simulation does offer further insights into the potential importance of stock-flow effects on model properties, by using the detailed discussion of the effects of interest rates in UK models given in Easton (1985).

(ii) *Increase the short interest rate by 2 percentage points throughout (Table VI).* The effect of this shock is to deflate the economy. GDP is below base throughout, reaching a trough in the second and third years, after which the effect is rather small. The paths of the endogenous components of GDP are as shown in Table VII.

Investment is hit particularly hard, as residential investment is directly interest elastic and because rising interest rates reduce share prices and hence '$q$' in the non-residential fixed investment function. Consumption rises because persons are net creditors and hence an increase in interest rates increases their non-labour incomes substantially. This boosts consumption, despite initial falls in persons' real net wealth due mainly to devaluations of illiquid financial assets and reduced housing investment. The trade balance improves only marginally as exports fall as well as imports. Imports fall due to lower aggregate demand, while exports are hit by an appreciation of the exchange rate, induced by the increase in interest rates and reinforced by falling prices. These 'price' effects on exports override the beneficial effects of falling capacity utilization. Inventory investment is directly hit by rising interest rates, but cycles back after 3 years of decline to increase in the fourth and fifth years.

Unemployment increases for the first 6 years, as the demand for labour falls in line with aggregate demand and a declining capital stock. Wages have little effect on quantities in the labour market as unemployment and currency appreciation combine to give broadly flat real wages. After the first few years, recovering personal sector wealth begins to reduce the supply of labour, leading to an attenuation in the later years of the initial increase in unemployment.

Capacity GDP falls because the capital stock declines and raw material prices increase with the appreciation of the exchange rate. This is reflected in the greater decline of capacity utilization than in actual GDP.

On the financial side, net financial assets initially fall, due to negative revaluations of gilts when interest rates increase. However, the inflow of assets is positive as a result of the positive PSBR and current account surplus which accompany the recession. By the sixth year these inflows exceed the negative revaluations. This turnaround is reflected in the demand for money, which is also boosted by a tilt in the yield curve (long rates increase less than short rates). As noted, the stock of equity is heavily devalued by the rising interest rates, thus influencing both persons' real net wealth and the valuation ratio. These are thus shown to be important conduits of monetary policy onto the real economy, as suggested in the theory of Davis (1987). Comparison of this simulation with results for other UK macro-economic

Table VI. Dynamic simulation; raise domestic short rates by 2 percentage points (percentage changes (absolute changes*) from base)

| Variable | Year 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Real gross capital stock | 0·0 | 0·0 | −0·1 | −0·2 | −0·2 | −0·2 | −0·3 | −0·3 | −0·4 | −0·4 |
| Net private financial assets stock (nominal) | −4·5 | −6·5 | −4·5 | −2·0 | −0·4 | +0·2 | +0·6 | +1·4 | +3·7 | +5·2 |
| Persons' real net wealth | −5·4 | −7·4 | −5·2 | −2·5 | −1·7 | −1·6 | −1·7 | −2·3 | −1·5 | −0·5 |
| GDPE | −0·2 | −0·5 | −0·5 | −0·1 | −0·1 | −0·2 | 0·0 | 0·0 | −0·1 | 0·0 |
| Capacity utilization | −0·2 | −0·8 | −0·7 | −0·4 | −0·4 | −0·4 | −0·2 | −0·3 | −0·4 | −0·3 |
| Consumer prices | −0·1 | −0·2 | −0·6 | −1·0 | −1·3 | −1·8 | −2·1 | −2·1 | −2·2 | −2·6 |
| Wages (nominal) | −0·1 | −0·4 | −1·1 | −1·1 | −1·3 | −1·9 | −2·0 | −1·6 | −1·7 | −2·2 |
| Unemployment* (thousands) | +6 | +52 | +12 | +30 | +74 | +36 | −32 | −16 | +35 | +62 |
| Exchange rate | +1·2 | +1·6 | +2·0 | +2·6 | +3·1 | +3·5 | +3·9 | +4·3 | +4·5 | +4·7 |
| Money supply (nominal, £m) | −3·1 | −4·2 | −2·4 | +0·5 | +2·4 | +3·3 | +4·8 | +6·3 | +8·1 | +9·7 |
| Q (valuation ratio) | −9·9 | −13·3 | −10·9 | −8·2 | −6·4 | −6·0 | −6·2 | −8·3 | −10·6 | −11·5 |
| Real fixed investment | −0·3 | −1·7 | −2·3 | −2·0 | −1·9 | −1·7 | −1·8 | −2·1 | −2·5 | −2·6 |
| PSBR (nominal, £m)* | +142 | +295 | +327 | +308 | +505 | +600 | +778 | +998 | +1364 | +1939 |
| Short interest rate* (percentage points) | +1·9 | +2·7 | +3·0 | +3·0 | +3·0 | +3·0 | +3·0 | +3·2 | +3·2 | +3·2 |
| Current account* (nominal, £m) | +67 | +79 | +145 | +102 | +45 | +207 | −43 | −87 | −64 | −407 |

Table VII. Percentage changes (absolute changes*) from base in the components of GDP

| | Year | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Consumption | 0·2 | 0·1 | 0·3 | 0·8 | 0·9 |
| Fixed investment | −0·3 | −1·7 | −2·3 | −2·0 | −1·9 |
| Exports | −0·1 | −0·5 | −0·5 | −0·6 | −0·8 |
| Imports | −0·2 | −0·5 | −0·5 | 0·1 | 0·1 |
| Inventory investment* | −420 | −514 | −555 | 6 | 47 |

models can be made by reference to Easton (1985), and give an indication of the importance of the stock-flow effects.

Analysis shows that while changes in GDP are broadly comparable in the Schema model with those of the Bank, National Institute, Treasure and LBS, the composition of GDP differs. Investment falls more in the Schema model, highlighting the importance of stock-flow effects operating via equity prices, $q$, the capital stock and capacity output, largely absent from the other models. The increase in consumption is less than in the comparable Bank and Institute models (with no direct interest rate effect on consumption) as the decline in wealth due to equity and gilt revaluations offsets the changes in personal income due to higher ipd. Using only liquid assets in the consumption function, this effect is missed in the other models. The stock cycle in this model is a feature absent from the other models in the simulation period shown; capacity utilization, again a unique feature of the Schema model, helping to produce this. Finally, the non-monotonic change in unemployment results partly from the response of the labour supply to wealth and wages, an equation absent from most other models. These considerations suggest that the stock-flow effects highlighted in this paper could make an appeciable difference to the simulation properties of macro-economic models of the United Kingdom.

(iv) *Summary*. These simulations reveal that the model gives a plausible picture of the behaviour of the British economy, albeit suggesting rather a large amount of labour market inflexibility. Most other markets appear to work well, though some doubts have been expressed concerning the demand for labour and the response of share prices to inflation. Some of the differences with other UK macro-economic models have been highlighted.

The next section considers the out-of-sample performance of the model.

### (b) Out-of-sample performance over 1980–1983

Although some of the equations were estimated up to 1982, the period 1980–1983 covers some years of out-of-sample performance for most of them, and, at the time of writing, data for 1984 were in any case not available. The model used was the basic model described above. The results are shown in Table IX.

GDP is broadly underpredicted over this period, particularly in 1982–1983, principally due to an underprediction of consumption and a pessimistic projection of the non-oil trade balance. Investment is predicted fairly well, despite underpredictions of the level of the valuation ratio, and the stock cycle (Table VIII) is captured in sign if not level.

The growth of unemployment is tracked reasonably well, though the public sector labour demand function fails to capture the reduced elasticity of employment with respect to government expenditure over this period, and thus accounts for most of the errors. The labour supply and private sector labour demand functions predict developments well over this period, despite the difficulty of tracking the 'labour shake-out', as shown in Table X.

Table VIII. Predicted and actual inventory investment (80 £ million)

| Inventory investment | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|
| Predicted | −4500 | −1467 | −1721 | 1807 |
| Actual | −2899 | −2739 | −1247 | 207 |

Table IX· Dynamic simulation over 1980–1983 (percentage error (*absolute error))

| Variable | Year 1980 | 1981 | 1982 | 1983 | Percentage RMSE[a] |
|---|---|---|---|---|---|
| Real gross capital stock | 0·1 | 0·1 | 0·1 | 0·2 | 0·1 |
| Net private financial assets stock (nominal) | 0·2 | −0·2 | 3·0 | 11·8 | 6·1 |
| Persons' real net wealth | 8·7 | 9·4 | 12·6 | 17·2 | 12·5 |
| GDPE | 1·4 | 0·2 | 3·3 | 4·6 | 2·9 |
| Capacity utilisation | −0·7 | −0·7 | 2·2 | 4·9 | 3·8 |
| Consumer prices | 0·5 | −0·2 | −2·1 | −4·9 | 2·7 |
| [inflation rate] | [15·9] | [12·0] | [10·3] | [8·0] | |
| Wages (nominal) | 0·1 | −2·8 | −1·0 | 0·6 | 1·5 |
| Unemployment* (000s)[b] | 0 | −37 | 24 | 476 | 8·1 |
| Exchange rate | 0·8 | −1·1 | −2·8 | −7·9 | 4·2 |
| Money supply (£m nominal) | 1·0 | 2·9 | 5·9 | 7·5 | 5·0 |
| Q (valuation ratio) | 14 | 19 | 21 | 35 | 24·0 |
| Real fixed investment[c] | 1·6 | −2·3 | 3·4 | 1·4 | 2·3 |
| PSBR* (£m nominal) | −1615 | −2211 | −2107 | 7804 | 41·8 |
| Short interest rate (percentage points) | 1·1 | −4·0 | −2·9 | −1·3 | 20·8 |
| Current account (£m nominal) | 436 | 2705 | 2112 | 1554 | 38·8 |

[a]Root mean square error.
[b]% RMSE labour supply, 0·7; private labour demand, 1·1; public labour demand, 2·9.
[c]% RMSE for non-residential, 3·1; residential, 8.9.

Table X. Employment and unemployment—errors in thousands

| — | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|
| Labour supply | +354 | −39 | −17 | +71 |
| Private labour demand | +350 | +73 | +118 | −63 |
| Public labour demand | +4 | −75 | −160 | −341 |
| Unemployment | 0 | −37 | +24 | +476 |

The growth of wages is followed closely, though prices are somewhat overpredicted in 1983. The exchange rate equation does not capture the rate of decline observed over 1981–1983, perhaps because of the positive influence of North Sea oil exports in the equation, which the market itself had in fact already discounted at this stage. Overprediction of the exchange rate accounts for the pessimistic prediction of the trade balance. In the financial sector, net

Table XI. Shares (percentages) in NBPS gross financial wealth—actual (predicted)

| | Money | Other debt | Net foreign assets | Bank lending |
|---|---|---|---|---|
| 1980 | 40 (40) | 45 (46) | 15 (14) | 31 (32) |
| 1981 | 40 (39) | 43 (45) | 17 (15) | 31 (33) |
| 1982 | 37 (38) | 43 (46) | 20 (16) | 31 (32) |
| 1983 | 37 (40) | 43 (42) | 20 (17) | 33 (34) |

financial assets are underpredicted in 1983, mainly due to a sharp underprediction in that year of the PSBR and the current account surplus. Financial assets are thus at a lower level than actuals, but the shares are predicted well, as shown in Table XI.

Some of the shares are roughly constant, which shows that the specifications, in terms of error correction equations related to long-run desires shares, may be reasonable. The slight relative decumulation of money and bonds and accumulation of net foreign assets and bank loans are captured by the system.

In the equity market, problems arise both due to inaccuracies in the share price equation and a failure of the actual share price index to capture the revaluations which occurred over this period. Problems with the stock of equity account for the large errors in '$q$' over the period.

To sum up, 1980–1983 is tracked imperfectly, problems arising particularly in the exchange rate equation and in the valuation ratio—showing the practical problems of using the latter in a forecasting model. However, the root mean errors generally remain below 10 per cent and such variables as GDP, wages, investment, the labour market variables and wealth are tracked fairly accurately.

## 4. CONCLUSIONS AND SUGGESTED FURTHER WORK

A model has been presented which makes some progress towards integrating stock and flow effects on the UK economy in an economically plausible manner. This paper has outlined the structure of the model, described the equations, and presented results from tracking and simulation exercises, including contrasts with results from other models. From the estimation results we can conclude that the model suggests that stocks of assets, in particular the capital stock and financial assets, should have a central place in an explanation of the behaviour of the British economy, notably of physical investment, inventory investment, consumption, employment and developments in financial markets, and that these magnitudes can be tracked by a fairly simple structure, subject to sizable errors from vintage effects' and revaluations. The paper also indicates some differences between the simulation properties of the Schema model and those of conventional models which can be attributed to the stock-flow effects. Together, the simulation and estimation properties signal some possible improvements to be made to existing modelling practice. Not that the Schema model lacks deficiencies. We now conclude by assessing the problems and the achievements of the project, in relation to the analytical paradigms surveyed in Davis (1987), as well as making suggestions for further research.

Davis (1987) surveyed stock-flow effects which have been highlighted in the theoretical literature, drawing in particular on the work related to 'dynamic IS/LM' models and 'dynamic portfolio' models. Comparison of these effects with the estimated model described in this section gives a measure of the success of the modelling project, and indicates some of the difficulties involved in empirical implementation of such paradigms. (Of course, a lack of success in empirical modelling may also indicate a lack of realism in the features of a theoretical model!)

A principal failing of the Schema model in this respect is the lack of a strong money stock-interest rate relation normally encapsulated in the LM curve. Instead, the demand for money depends on the yield curve—the choice of monetary aggregate in fact implies a positive relation of money demand to the short rate. The short rate is determined by foreign interest rate parity without direct reference to money demand or supply. However, in defence of this feature it can be argued that foreign rates have historically been a crucial determinant of UK short rates, and few macro-economic models have been able to demonstrate a strong causal relation of money to the interest rate in the United Kingdom. A corollary of this result, together with use of total wealth in expenditure functions, is that *strong* differential effects of money- and bond-financed deficits are absent. Weak effects arise via the portfolio balance term in the long rate equation, as described above.

Some unsatisfactory features of the Schema model arise in the financial system. For example, there is generally not an endogenous determination of asset prices by asset demands and supplies. At most, asset prices are determined in reduced form equations, with portfolio imbalance terms feeding in wealth disequilibrium effects. Foreigners' portfolio preferences are not explicitly modelled, while theoretical considerations suggest that they should be an important determinant of the exchange rate. Thirdly, there is no explicit modelling of certain non-cleared markets, such as those for bank advances, as suggested by Backus et al. (1980).

Concerning wealth effects, these are restricted, except in an experiment described in Davis (1986a), to determination of expenditure by total wealth. Desired personal sector wealth (in the consumption function) depends only on income, though it is influenced by interest rates in the reduced form—as, for example, higher real interest rates increase personal incomes via their non-labour component, and hence they increase desired wealth. The sequential decision process in the model could also be criticized. To summarize this process, given income and lagged wealth, the decision to spend is a primary decision, determining also the total accumulation of assets. Investment is then separately determined, leaving financial assets as a residual, which is then split among the financial asset portfolio. Certain of the analytical models quite correctly treat these decisions as simultaneous. The sequential approach would be more appropriate if interest rates affected expenditures directly. However, empirical evidence from estimations suggest that these effects are relatively weak.

Inflation effects on income are identified above as an important conduit of stock effects on real behaviour. Although this is implemented for persons, it is not carried through for the company, overseas and public sectors. In these cases the stock-flow modelling is not consistent.

Finally, one may consider the influence of prices. Explicit modelling of price expectations is avoided except implicitly as backward-looking, adaptive expectations, for example in the wage equation, with only long-run homogeneity of wages and prices. 'Rational' or forward-looking price expectations are an obvious alternative, and might be expected also to feature in the exchange rate equation, the financial system and certain real expenditure equations (in this connection, see Easton and Matthews, 1986). Rational expectations might also be appropriate in other areas of the model.

These problems, of which interest rate determination is perhaps the most serious, mean the model does not entirely encapsulate the properties of the analytical models—in particular, a money-financed expansion does not exert an expansionary influence on the economy via a strong downward pressure on the interest rate. Effects arise instead via wealth effects on consumption and labour supply and liquidity effects on investment. The expansionary result still arises, but it would do so equally through a bond-financed expansion, except to the extent crowding-out occurs via an increase in the long rate.

On the credit side the modelling exercise does incorporate most of the other properties of the paradigms, encapsulated in the discussion of desirable properties of macro-economic models enumerated in our earlier paper, Davis (1987). Certain features of the model could also be highlighted as useful additions to the paradigms. For example, the model has a foreign trade sector, with trade volumes, prices and the exchange rate endogenous There is also a wide disaggregation of investment, labour demands, prices, financial assets and of income and expenditure at a sectoral level. One could point out in particular the disaggregation of equity, which allows substitutability for persons of financial assets with claims to capital. It also allows a more complete determination of Hicksian income. Like other asset prices, however, equity prices are only modelled as a reduced and not a structural form.

A further distinction of the Schema model is endogenous capacity utilization, which is used widely to influence market clearing. The specification of potential output, with a time trend, and labour supply determined by population growth, gives endogenous growth to the model and hence positive capital accumulation and net saving in a steady state, unlike certain analytical models.

The model encapsulates the slow process of market clearing in an economy, and hence might be thought more 'realistic' than certain of the analytical paradigms. This is achieved principally by use of market clearing long-run solutions in key equations, but only partial adjustment in the short run and slow adjustment to the steady state. The accuracy of the model's representation of the market behaviour of the economy is of course subject to the weakness of data, the inaccuracy of the prior choice of independent variables, the estimation methods, the Lucas critique, etc.*

Finally, one might note the use of wealth as a determinant of the labour supply, and company liquidity as a determinant of the equity price.

On balance, it can be claimed that the modelling exercise represents progress in consistent stock-flow modelling, but there remain some problems and deficiencies. The shortcomings of the model in relation to the paradigms thus form an important area of future research. Other areas could also be noted, however, which are important to stock-flow modelling but are not analysed either by the theoretical work instanced in this paper, nor in the modelling exercise. Future stock-flow modelling work would be needed to take them into account.

1. The role of bank credit as a determinant of expenditures and a determinant of interest rates. A complete treatment obviously requires modelling of the banking system.
2. Treatment of the PSBR *vis-à-vis* private sector borrowing—should it have different effects on the economy, as it does implicitly in the work above?
3. Identification of a buffer variable and/or direct effects of disequilibrium assets on real variables apart from via their total levels. In the Schema model, it has been suggested that inventories form a 'buffer' on the real side, and bank lending on the financial side, but the treatment is not explicit.
4. Should the real exchange rate be allowed to change in the long run, as is not permitted by the purchasing power parity formulation adopted here?

*Hendry and von Ungern Sternberg (1980) show, however, that the error correction mechanism, which is widely used in the Schema model, may be represented as optimal behaviour by agents in an uncertain environment.

5. Besides these wider theoretical issues, we finally note the main specification problems that we have encountered in constructing the Schema model. These indicate that for econometric modelling purposes more research is needed into labour supply and demand, the exchange rate, equity market, more accurate modelling of the capital stock and better data for capacity utilization.

## APPENDIX 1: SCHEMA MODEL EQUATION LISTING

*(a) Components of aggregate demand*

Inflation rate of consumer prices (A1)

$$IPC = (PC - PC_{t-1})/PC_{t-1}$$

Average inflation rate of PC over past 2 years (A2)

$$WIPC = (IPC + IPC_{t-1})/2$$

Growth rate of gilt prices (A3)

$$IPG = (GP - GP_{t-1})/GP_{t-1}$$

Average inflation rate of GP over past 2 years (A4)

$$WIPG = (IPG + IPG_{t-1})/2$$

Growth rate of share prices (A5)

$$ISP = (SPUK - SPUK_{t-1})/SPUK_{t-1}$$

Average inflation rate of SPUK over past 2 years (A6)

$$WISP = (ISP + ISP_{t-1})/2$$

Adjusted personal income (A7)

$$\begin{aligned} YA = {} & YD/PC - (WIPC/x) * [(NCWP - 0{\cdot}7\ KNDJ)/PC]_{t-1} \\ & -[1 - (1 - WIPC/x)^{0{\cdot}5}] * [\Delta(NCWP - 0{\cdot}7\ KNDJ)/(PC * PC_{t-1})^{0{\cdot}5}] \\ & + \{y^*(KEQJ/PC)_{t-1} + z^*(0{\cdot}7\ KNDJ/PC)_{t-1} \\ & + (1 - (1 - y)^{0{\cdot}5}) * [\Delta KEQJ/(PC * PC_{t-1})^{0{\cdot}5}] \\ & + (1 - (1 - z)^{0{\cdot}5}) * [\Delta 0.7\ KNDP/(PC * PC_{t-1})^{0{\cdot}5}]\}^* \ 0{\cdot}06 \end{aligned}$$

where

$$x = 1 + WIPC$$
$$y = (WIPS - WIPC)/(1 + WIPC)$$
$$z = (WIPG - WIPC)/(1 + WIPC)$$

Consumption function (A8)

$$\begin{aligned} \Delta\ln C = {} & \underset{(10{\cdot}4)}{0{\cdot}57047}\ \Delta\ln YA - \underset{(1{\cdot}4)}{0{\cdot}14895}\ \ln (C/YA)_{t-1} \\ & + \underset{(2{\cdot}5)}{0{\cdot}02674}\ \ln ((NFWP + CPDN)_{t-1}/PC)/YA_{t-1}) - \underset{(1{\cdot}8)}{0{\cdot}023} \end{aligned}$$

$\bar{R}^2 = 0{\cdot}899$; SE $= 0{\cdot}007414$; DW $= 2{\cdot}7$; LM(2) $= 5{\cdot}2$; 1966–1982

Stockbuilding (A9)

$$\Delta \ln KIIT = \underset{(2\cdot 3)}{-0\cdot 29056}\, \Delta[\ln(1 + RLB/100) - \Delta \ln PS] + \underset{(1\cdot 4)}{0\cdot 2031}\, [\ln(1 + RLB/100) - \Delta \ln PS]_{t-1} + \underset{(3\cdot 3)}{1\cdot 5606}\, \Delta \ln GDPE + \underset{(2\cdot 5)}{0\cdot 64473} \ln(GDPE/KIIT)_{t-1} \underset{(2\cdot 6)}{-0\cdot 7248} + \underset{(1\cdot 8)}{0\cdot 17638}\, \Delta \ln(GDPC/GDPE)$$

$\bar{R}^2 = 0\cdot 814$; SEE $= 0\cdot 014$; DW $= 1\cdot 5$; LM(2) $= 7\cdot 4$; 1964–1980

Inventory stock-flow identity (A10)

$$II = KIIT - KIIT_{t-1}$$

Nominal stockbuilding (A11)

$$II£ = II * (PS + PS_{t-1})/2$$

Stock appreciation (A12)

$$YSA = (KIIT * PS) - (KIIT * PS)_{t-1} - II£$$

Tobin's '$Q$' (average)

$$Q = KEQC/(CPNN * (1 - IALL)) + (KIIT * PS) \qquad (A13)$$

Private non-residential fixed investment (A14)

$$\ln INP = \underset{(1\cdot 6)}{-0\cdot 54635} \ln(KPNG)_{t-1} - \underset{(2\cdot 1)}{0\cdot 11768} \ln(PFL/PGDP)_{t-1} + \underset{(3\cdot 6)}{0\cdot 52891} \ln(PMBM/PGDP)_{t-1} + \underset{(2\cdot 5)}{0\cdot 1429} \ln Q_{t-1} + \underset{(4\cdot 4)}{0\cdot 08191}\, TIME + \underset{(3\cdot 8)}{15\cdot 65668}$$

$\bar{R}^2 = 0\cdot 968$; SE $= 0\cdot 032162$; DW $= 2\cdot 4$; LM(2) $= 6\cdot 6$; 1966–1982

Private sector housing investment (A15)

$$\ln IHP = \underset{(4\cdot 1)}{0\cdot 55981} \ln IHP_{t-1} - \underset{(3\cdot 9)}{1\cdot 82649}\, [\ln(1 + RLB/100) - \Delta \ln PGDP] - \underset{(3\cdot 2)}{0\cdot 34198} \ln KPDG_{t-1} + \underset{(3\cdot 3)}{3\cdot 57662} \ln(PGDP/ULC) + \underset{(3\cdot 6)}{6\cdot 68591}$$

$\bar{R}^2 = 0\cdot 7$; SE $= 0\cdot 6917$; DW $= 2\cdot 1$; LM(2) $= 3\cdot 8$; 1964–1982

Aggregate fixed investment identity (A16)

$$IF = INP + IHP + ING + IHG$$

Real gross capital stock: public non-residential (A17)

$$KUNG = ING + \underset{(114\cdot 6)}{0\cdot 9889}\, KUNG_{t-1}$$

$\bar{R}^2 = 0\cdot 999$; SE $= 9992$; DW $= 1\cdot 4$; LM(2) $= 5\cdot 0$; 1966–1982

Real gross capital stock: private non-residential (A18)

$$KPNG = INP + \underset{(130\cdot 5)}{0\cdot 97756}\, KPNG_{t-1}$$

$\bar{R}^2 = 0\cdot 999$; SE $= 10065$; DW $= 1\cdot 4$; LM(2) $= 1\cdot 7$; 1968–1982

Real gross capital stock: private residential (A19)

$$\text{KPDG} = \text{IHP} + \underset{(121\cdot9)}{0\cdot99906}\ \text{KPDG}_{t-1}$$

$\bar{R}^2 = 0\cdot999$; SE = 6852; DW = 1·6; LM(2) = 5·1; 1964–1982

Real net capital stock: private non-residential (A20)

$$\text{KPNN} = \underset{(280\cdot6)}{0\cdot61471}\ \text{KPNG (Nominal CPNN} = \text{KPNN.PINP)}$$

$\bar{R}^2 = 0\cdot999$; SE = 3089; DW = 0·2; LM(2) = 15·4; 1965–1982

Real net capital stock: Private residential (A21)

$$\text{KPDN} = \underset{(193\cdot4)}{0\cdot59372}\ \text{KPDG} + \underset{(11\cdot9)}{566\cdot256}\ \text{TIME (Nominal CPDN} = \text{KPDN.PIHP)}$$

$\bar{R}^2 = 0\cdot999$; SE = 892; DW = 0·3; LM(2) = 14·3; 1963–1982

Export volume excluding oil (A22)

$$\Delta\ln(\text{X} - \text{XG2}) = \underset{(3\cdot6)}{0\cdot67429}\ \Delta\ln \text{TWIP} - \underset{(0\cdot9)}{0\cdot14391}\ \Delta\ln\left(\frac{\text{PX}}{\text{WPIM/EER}}\right)$$

$$- \underset{(2\cdot7)}{0\cdot5404}\ \ln\left[\frac{\text{X} - \text{XG2}}{\text{TWIP}}\right]_{t-1} - \underset{(3\cdot2)}{0\cdot46204}\ \ln\left[\frac{\text{PX}}{\text{WPIM/EER}}\right]_{t-1}$$

$$- \underset{(2\cdot7)}{3\cdot2819} + \underset{(1\cdot5)}{0\cdot33051}\ \ln\left(\frac{\text{GDPC}}{\text{GDPE}}\right)_{t-1}$$

$\bar{R}^2 = 0\cdot742$; SE = 0·024; DW = 2·6; LM(2) = 4·2; 1964–1981

Import volume excluding oil (A23)

$$\Delta\ln(\text{M} - \text{MG2}) = \underset{(2\cdot9)}{1\cdot7747}\ \Delta\ln(\text{GDPE} + \text{M}) - \underset{(1\cdot5)}{0\cdot33657}\ \ln(\text{M} - \text{MG2})/(\text{GDPE} + \text{M})_{t-1}$$

$$- \underset{(1\cdot0)}{0\cdot14683}\ \ln(\text{PM/PGDP}) - \underset{(1\cdot0)}{0\cdot3718}\ \ln(\text{GDPC/GDPE})_{t-1}$$

$$+ \underset{(2\cdot2)}{0\cdot01496}\ \text{TIME} - \underset{(1\cdot4)}{0\cdot6914}$$

$\bar{R}^2 = 0\cdot441$; SE = 0·04; DW = 2·0; LM(2) = 7·2; 1964–1981

Factor cost adjustment (A24)

$$\text{FCA} = 0\cdot07757\ \text{G} + 0\cdot06989\ \text{I} + 0\cdot04318\ \text{X} + \underset{(155\cdot8)}{0\cdot15266}\ \text{C}$$

$\bar{R}^2 = 0\cdot9988$; SE = 572; DW = 0·6; 1955–1982

Deflator for FCA (A25)

$$\text{TREF} = \text{TREF}_{-1} \cdot \text{PGDP/PGDP}_{t-1} + \underset{(6\cdot4)}{0\cdot15186}\ \Delta\text{RIT/RIT}_{t-1}$$

$\bar{R}^2 = 0\cdot286$; SE = 0·039; DW = 1·6; 1964–1982

Demand (GDP at factor cost) (A26)

$$\text{GDPE} = \text{C} + \text{IF} + \text{II} + \text{G} + \text{X} - \text{M} - \text{FCA}$$

Total final expenditure (A27)

$$\text{TFE} = \text{GDPE} + \text{M}$$

*(b) Labour market*

Labour supply (B1)

$$\ln (LS/POWA) = \underset{(7\cdot5)}{0\cdot00314}\ TIME - \underset{(60\cdot2)}{0\cdot26749} + DLPT$$

$\bar{R}^2 = 0\cdot763$; SE $= 0\cdot00977$; DW $= 0\cdot6$; LM(2) $= 9\cdot9$; 1966–1982

Deviations of log of participation rate from trend (B2)

$$\begin{aligned} DLPT = {} & \underset{(1\cdot1)}{0\cdot07521} \ln [(WS\,(1 - TRYW))/PC]_{t-1} \\ & - \underset{(0\cdot6)}{0\cdot0578} \ln [(WS\,(1 - TRYW))/PC]_{t-2} \\ & + \underset{(2\cdot4)}{0\cdot13603} \ln [(WS\,(1 - TRYW))/PC]_{t-3} \\ & - \underset{(1\cdot7)}{0\cdot04277} \ln (NFWP + CPDN)/PC_{t-1} \\ & + \underset{(0\cdot9)}{0\cdot03018} \ln (NFWP + CPDN)/PC_{t-2} \\ & - \underset{(2\cdot6)}{0\cdot08048} \ln (NFWP + CPDN)/PC_{t-3} \\ & - \underset{(3\cdot4)}{1\cdot266} \sum_{i=1}^{4} [LU/LS]_{t-i} \end{aligned}$$

$\bar{R}^2 = 0\cdot53$; SE $= 0\cdot0068$; DW $= 1\cdot9$; LM(2) $= 3\cdot3$; 1967–1982

Private sector demand for labour (B3)

$$\begin{aligned} \ln LDP = {} & \underset{(1\cdot8)}{0\cdot19054} \ln (KPNG)_{t-1} - \underset{(1\cdot0)}{0\cdot1879} \ln (PFL/PGDP)_{t-1} \\ & - \underset{(0\cdot6)}{0\cdot03399} \ln (PMBM/PGDP)_{t-1} \\ & - \underset{(1\cdot5)}{0\cdot68664} \ln (WS + (YEC/LD)/PGDP)_{t-1} \\ & - \underset{(1\cdot5)}{0\cdot23105} \ln (GDPC/GDPE)_{t-1} \\ & + \underset{(12\cdot7)}{11\cdot12176} + \underset{(1\cdot3)}{0\cdot1812} \ln GDPE \end{aligned}$$

$\bar{R}^2 = 0\cdot895$; SE $= 0\cdot011$; DW $= 1\cdot9$; LM(2) $= 8\cdot3$; 1966–1981

Public employment (B4)

$$\Delta\ln LDU = \underset{(2\cdot7)}{0\cdot43518}\ \Delta\ln (G + IHG + IHG) - \underset{(1\cdot2)}{0\cdot00287} \ln (LDU/(G + IHG + ING))_{t-1}$$

$\bar{R}^2 = 0\cdot38$; SE $= 0\cdot0202$; DW $= 1\cdot6$; 1965–1982

Demand for labour (B5)

$$LD = LDU + LDP$$

Unemployment (B6)

$$LU = LS - LD$$

*(c) Output*

Mid-year non-residential real gross capital stock (C1)

$$K = \sum_{i=0}^{1} (KPNG + KUNG)_{t-1} \div 2$$

Production function (capacity output) (C2)

$$\ln GDPC = \overline{0{\cdot}6} \ln LS + \overline{0{\cdot}4} \ln K + \underset{(215{\cdot}3)}{3{\cdot}52004} - \underset{(4{\cdot}2)}{0{\cdot}21525} \ln (PMBM/PGDP)$$
$$+ \underset{(7{\cdot}3)}{0{\cdot}01022}\ TIME - \underset{(0{\cdot}9)}{0{\cdot}00556} \ln (PFL/PGDP)$$

$\bar{R}^2 = 0.805$; $SE = 0{\cdot}0226$; $DW = 1{\cdot}5$; $LM(2) = 1{\cdot}8$; 1966–1980

Capacity utilization (C3)

$$CAPU = GDPE/GDPC$$

*(d) Wages and income from employment*

Phillips curve (D1)

$$\Delta \ln WS = -\overline{1{\cdot}0} \ln (YWS + YEC)/GDPE + \underset{(1{\cdot}6)}{0{\cdot}46381} \Delta \ln GDPE/LD + \underset{(1{\cdot}6)}{0{\cdot}41622} \Delta \ln PC$$
$$-\underset{(2{\cdot}5)}{2{\cdot}13583} (LU/LS)_{t-1} + \underset{(2{\cdot}8)}{0{\cdot}0113}\ TIME + \underset{(3{\cdot}1)}{0{\cdot}08974}\ D75 + \underset{(1{\cdot}1)}{0{\cdot}1038} \Delta \ln TRYW$$
$$-\underset{(18{\cdot}4)}{0{\cdot}03892} \ln (WS(1 - TRYW)/PC)_{t-1}$$

$\bar{R}^2 = 0{\cdot}991$; $SE = 0{\cdot}019$; $DW = 1{\cdot}6$; $LM(2) = 1{\cdot}1$; 1964–1982

Labour income (D2)

$$YWS = WS * LD * 0{\cdot}001$$

Employers' national insurance contributions (D3)

$$YECN = ANIR.YWS$$

Employer's other contributions (D4)

$$\Delta \ln YECO = \overline{1{\cdot}0} \Delta \ln YWS + \underset{(2{\cdot}2)}{2{\cdot}72571}\ LU/LS + \underset{(1{\cdot}7)}{0{\cdot}02145}$$

$\bar{R} = 0{\cdot}17$; $SE = 0{\cdot}0495$; $DW = 2{\cdot}0$; $LM(2) = 3{\cdot}4$; 1964–1982

Total employers' contributions (D5)

$$YEC = YECO + YECN$$

Unit labour costs (D6)

$$ULC = ((WS * LD) + YEC)/GDPE$$

*(e) Prices*

Consumer price deflator (E1)

$$\Delta \ln PC = 0{\cdot}39201\ \Delta \ln ULC + 0{\cdot}19937\ \Delta \ln PM + 0{\cdot}08707\ \Delta \ln (FCA£/GDPE)$$
(7·1) (5·4) (1·7)

$$+\ 0{\cdot}15393 \ln (PM/ULC)_{t-1} - 0{\cdot}39883\ [\ln (PC/ULC)_{t-1}$$
(2·6) (3·7)

$$-0{\cdot}15 \ln ((FCA£/GDPE)/ULC)_{t-1}] + 0{\cdot}21289$$
(3·7)

$\bar{R}^2 = 0{\cdot}957$; SE $= 0{\cdot}010636$; DW $= 2{\cdot}2$; LM(2) $= 0{\cdot}2$; 1964–1982

Inventory price deflator (E2)

$$\Delta \ln PS = 0{\cdot}23209\ \Delta \ln ULC + 0{\cdot}29718\ \Delta \ln PM + 0{\cdot}21227 \ln (PM/ULC)_{t-1}$$
(4·6) (6·6) (6·2)

$$-\ 0{\cdot}31673 \ln (PS/ULC)_{t-1} + 0{\cdot}10491 - 0{\cdot}11579 \ln (GDPC/GDPE)_{t-1}$$
(5·1) (2·4) (1·5)

$R^2 = 0{\cdot}974$; SE $= 0{\cdot}0095$; DW $= 2{\cdot}4$; LM(2) $= 4{\cdot}5$; 1964–1981

Private non-resential fixed investment price deflator (E3)

$$\Delta \ln PINP = 0{\cdot}56303\ \Delta \ln ULC + 0{\cdot}14223\ \Delta \ln PM + 0{\cdot}1643 \ln (PM/ULC)_{t-1}$$
(4·6) (1·8) (2·1)

$$-\ 0{\cdot}43343 \ln (PINP/ULC)_{t-1} + 0{\cdot}0992$$
(2·3) (1·5)

$\bar{R}^2 = 0{\cdot}845$; SE $= 0{\cdot}022125$; DW $= 1{\cdot}3$; LM(2) $= 3{\cdot}7$; 1966–1982

Private housing investment price deflator (E4)

$$\Delta \ln PIHP = 0{\cdot}78675\ \Delta \ln ULC + 0{\cdot}41918\ \Delta \ln PM - 0{\cdot}17761 \ln (PIHP/ULC)_{t-1}$$
(3·2) (2·1) (1·2)

$$+\ 0{\cdot}01927$$
(0·8)

$\bar{R}^2 = 0{\cdot}576$; SE $= 0{\cdot}05259$; DW $= 1{\cdot}2$; LM(2) $= 5{\cdot}8$; 1964–1982

Government current expenditure price deflator (E5)

$$\Delta \ln PG = 0{\cdot}8379\ \Delta \ln ULC + 0{\cdot}14755\ \Delta \ln PM + 0{\cdot}26548 \ln (PM/ULC)_{t-1}$$
(10·2) (2·1) (0·8)

$$-\ 0{\cdot}20836 \ln (PG/ULC)_{t-1} + 1{\cdot}78333$$
(0·8) (0·76)

$\bar{R}^2 = 0.94$; SE $= 0{\cdot}015012$; DW $= 2{\cdot}0$; LM(2) $= 3{\cdot}1$- 1964–1982

Public sector investment price deflator (E6)

$$\Delta \ln PING = 0{\cdot}74744\ \Delta \ln ULC + 0{\cdot}28269\ \Delta \ln PM - 0{\cdot}15449 \ln (PING/ULC)_{t-1}$$
(6·3) (3·7) (1·0)

$$+\ 0{\cdot}04242$$
(1·2)

$\bar{R}^2 = 0{\cdot}851$; SE $= 0{\cdot}025$; DW $= 1{\cdot}6$; LM(2) $= 1{\cdot}9$; 1966–1982

Current price GDP (E7)

$$GDPE = (C * PC) + (INP * PINP) + (IHP * PIHP) + ((ING + IHG) * PING)$$
$$+\ (G * PG) + (X * PX) - (FCA * TREF)$$

GDP deflator (E8)

$$PGDP = GDP£/GDPE$$

Deflator for market price GDP (E9)

$$PDGM = (GDP£ + (FCA * TREF))/(GDPE + FCA)$$

Distributed lag of inflation rate of PC (E10)

$$PC7 = 0{\cdot}26 * IPC + 0{\cdot}22 * IPC_{t-1} + 0{\cdot}18 * IPC_{t-2} + 0{\cdot}14 * IPC_{t-3} + 0{\cdot}1 * IPC_{t-4} + 0{\cdot}07 * IPC_{t-5} + 0{\cdot}03\ IPC_{t-6}$$

Export prices (E11)

$$\ln PX = \underset{(1{\cdot}7)}{0{\cdot}15197} \ln (WPIM/EER) + \underset{(1{\cdot}8)}{0{\cdot}19379} \ln (WPIM/EER)_{t-1} + \underset{(3{\cdot}0)}{0{\cdot}47435} \ln PDGP + \underset{(1{\cdot}5)}{0{\cdot}20302} \ln PGDP + \underset{(1{\cdot}0)}{0{\cdot}0198}$$

$\bar{R}^2 = 0{\cdot}0998$; SE $= 0{\cdot}0242$; DW $= 1{\cdot}54$; 1964–1982

Import prices (E12)

$$\ln PM = \underset{(5{\cdot}1)}{0{\cdot}74484} \ln (WPIM/EER) + \underset{(0{\cdot}2)}{0{\cdot}03435} \ln (WPIM/EER)_{t-1} + \underset{(2{\cdot}4)}{0{\cdot}30506} \ln PGDP - \underset{(1{\cdot}2)}{0{\cdot}02791}$$

$\bar{R}^2 = 0{\cdot}995$; SE $= 0{\cdot}435$; DW $= 1{\cdot}2$; 1964–1982

Exchange rate (E13)

$$\Delta \ln EER = -\underset{(4{\cdot}3)}{0{\cdot}38074} \ln PGDP/(WPIM/EER)_{t-1} - \underset{(12{\cdot}2)}{2{\cdot}62936} - \underset{(9{\cdot}5)}{0{\cdot}02687}\ TIME - \underset{(2{\cdot}6)}{0{\cdot}07708}\ D68 + \underset{(3{\cdot}2)}{0{\cdot}033886} \ln XG2 - \underset{(3{\cdot}4)}{0{\cdot}09486} \ln (KNFA/NFA)_{t-1} + \underset{(11{\cdot}6)}{0{\cdot}00624}\ \Delta \widehat{RLB}$$

$\bar{R}^2 = 0{\cdot}930$; SE $= 0{\cdot}017$; DW $= 2{\cdot}2$; LM(2) $= 0{\cdot}4$; 1968–1982

Price of raw materials (E14)

$$PMBM = FMBM/EER$$

Price of fuel (E15)

$$PEL = FFL/EER$$

*(f) Public sector* (F1)

Public sector debt interest

$$EDBT = \underset{(75{\cdot}0)}{1{\cdot}11069} [RUKG/100]\ KNDP$$

$\bar{R}^2 = 0{\cdot}9967$; SE $= 291$; DW $= 1{\cdot}1$; 1963–1982

Rate of unemployment benefit (use in simulations) F2)

$$\Delta \ln RUB = \Delta \ln PC$$

Current grants to persons (F3)

$$YJG = \left(\frac{RUB}{1000} * LU\right) + \underset{(7\cdot5)}{1\cdot61382}\left(\frac{RUB}{1000} * (55000 - POWA)\right) - \underset{(6\cdot7)}{6491\cdot6} - \underset{(2\cdot6)}{837\cdot8}\ TIME$$

$\bar{R}^2 = 0\cdot959$; SE = 1885; DW = 1·4; 1964–1982

Current price government current expenditure (F4)

$$G£ = PG * G$$

Current price government investment (F5)

$$IG£ = (ING + IHP) * PING + 0\cdot05 * (II£ + YSA)$$

Public sector receipts (F6)

$$T^* = (YWS * YTAX) + (CTAX * YCT_{t-1}) + FCA.TREF + YGTA + YGRA$$

Public sector payments (F7)

$$G^* = G£ + EDBT + YJG + EGTA$$

Public sector saving (F8)

$$SG = T^* - G^*$$

Public sector borrowing requirement (F9)

$$PSBR = IG£ - FTKG - SG - POTH$$

*(g) Balance of payments*

Net property income from abroad (G1)

$$BYPA = \underset{(5\cdot6)}{0\cdot82352}\ [RUSG/100].KNFA - \underset{(3\cdot8)}{2510\cdot3}\ DEC$$

$\bar{R}^2 = 0\cdot688$; DW = 1·5; SE = 459; 1963–1982

Current account (G2)

$$CA = (PX.X) - (PM.M) + BYPA + CARE$$

*(h) Non-bank private sector financial model*

Revaluations of gilts (H1)

$$GREV = (IPG * (0\cdot7 * KNDP_{t-1})) * 0\cdot78$$

Revaluations of equities (H2)

$$EREV = \underset{(5\cdot1)}{1\cdot16}.ISP.KEQC_{t-1}$$

$\bar{R}^2 = 0\cdot57$; SE = 10025; DW = 2·2; 1964–1982

Revaluations of foreign assets (H3)

$$FREV = (FRE1 + FRE2) * 0\cdot33$$

$$FRE1 = [EER/EER_{t-1} * (KNFA_{t-1} * (0\cdot6))] - [KNFA_{t-1} * (0\cdot6)]$$

$$FRE2 = [EER/EER_{t-1} * (RUSG_{t-1}/RUSG) * KNFA_{t-1}] - KNFA_{t-1}$$

Revaluations accruing to non-bank private sector (H4)

$$REV = GREV + FREV + REVR$$

Supply of financial assets to non-bank private sector (H5)

$$NFA = NFA_{t-1} + CA + PSBR + REV + FRES$$

Money demand (H6)

$$\Delta \ln KM3£/PGDM = \underset{(4\cdot7)}{0\cdot6433} \ln ((GDP£/PGDM * (1 - DTAX)))_{t-1}$$
$$- \underset{(4\cdot8)}{0\cdot3153} \ln (KM3£/NFA)_{t-1}$$
$$+ \underset{(4\cdot5)}{1\cdot54382} \Delta \ln ((GDP£/PGDM * (1 - DTAX)))$$
$$+ \underset{(5\cdot2)}{0\cdot5693} \Delta \ln (NFA/PGDM)_{t-1}$$
$$- \underset{(4\cdot7)}{7\cdot81841} + \underset{(6\cdot1)}{0\cdot14108} CCD$$
$$+ \underset{(2\cdot7)}{2\cdot02085} \ln (1 + RLB/100) - \Delta_1 \ln PGDM)_{t-1}$$
$$- \underset{(2\cdot7)}{1\cdot92974} (\ln (1 + RUKG/100) - \Delta_1 \ln PGDM))_{t-1}$$

$\bar{R}^2 = 0\cdot909$; SE $= 0\cdot0243$; DW $= 2\cdot3$; LM(2) $= 1\cdot2$; 1965–1982

Demand for gilts and other national debt (H7)

$$\Delta \ln KNDP = \underset{(4\cdot7)}{1\cdot16277} \Delta \ln NFA - \underset{(1\cdot5)}{0\cdot36026} \ln (KNDP/NFA)_{t-1} - \underset{(1\cdot5)}{0\cdot26878}$$
$$+ \underset{(1\cdot1)}{0\cdot01036} RUKG - \underset{(3\cdot3)}{0\cdot00387} RLB - \underset{(0\cdot1)}{0\cdot00047} RUSG$$

$\bar{R}^2 = 0\cdot695$; SE $= 0\cdot057$; DW $= 2\cdot5$; LM(2) $= 4\cdot6$; 1964–1980

Demand for net foreign assets (H8)

$$\Delta \ln KNFA = \underset{(1\cdot3)}{0\cdot74427} \Delta \ln NFA - \underset{(3\cdot0)}{0\cdot71685} \ln (KNFA/NFA)_{t-1} - \underset{(2\cdot9)}{1\cdot13785}$$
$$- \underset{(2\cdot3)}{0\cdot04462} RUKG + \underset{(2\cdot7)}{0\cdot06843} RUSG$$

$\bar{R}^2 = 0\cdot508$; SE $= 0\cdot157$; DW $= 2\cdot2$; LM(2) $= 5\cdot0$; 1964–1980

Demand for bank loans (H9)

$$KBLP = KBLP_{-1} + \Delta KM3£ + \Delta KNDP + \Delta KNFA - \Delta NFA$$

Short rate (H10)

$$\Delta \ln (1 + RLB/100) = \underset{(3\cdot2)}{0\cdot70741} \Delta \ln (1 + REU\$/100) + \underset{(1\cdot7)}{0\cdot19812} \Delta \ln PC$$
$$- \underset{(0\cdot6)}{0\cdot3515} \Delta \ln E\hat{E}R - \underset{(1\cdot4)}{0\cdot01756}$$
$$- \underset{(2\cdot2)}{0\cdot60986} \ln \left(\frac{1 + RLB/100}{1 + REU\$/100}\right)$$

$\bar{R}^2 = 0\cdot32$; SE $= 0\cdot017$; DW $= 2\cdot2$; LM(2) $= 7\cdot5$; 1968–1982

Long interest rate (H11)

$$RUKG = \underset{(23\cdot2)}{0\cdot82805} RLB + \overline{3\cdot0} + \overline{0\cdot2}\, PC7 + \underset{(1\cdot6)}{17\cdot01881} \Delta(KNDP/NFA)$$

$\bar{R}^2 = 0\cdot967$; SE $= 1\cdot5$; DW $= 1\cdot4$; LM(2) $= 1\cdot3$; 1964–1982

Gilt price index (H12)

$$\Delta \ln GP = \underset{(7{\cdot}9)}{-0{\cdot}70236}\ \Delta \ln RUKG$$

$\bar{R}^2 = 0{\cdot}76$; SE $= 0{\cdot}04508$; DW $= 1{\cdot}8$; LM(2) $= 2{\cdot}1$; 1964–1982

Net wealth of non-bank private sector (H13)

$$NW = NFA + CPNN + CPDN$$

*(i) Personal sector income and expenditure*

Owner-occupier's imputed rent (I1)

$$ORNT = \underset{(70{\cdot}7)}{0{\cdot}0595}\ KPDN - \underset{(1{\cdot}8)}{113{\cdot}63}$$

$\bar{R}^2 = 0{\cdot}996$; SE $= 18{\cdot}1$; DW $= 1{\cdot}0$; 1963–1982

Other income, excluding income from self-employment (I2)

$$YJO = ECDV.(KEQJ/KEQC) + EDBT.(KNDJ/KNDP) + BYPA.(KNFJ/KNFA) - (RLB/100).KBLJ + ORNT + \underset{(23{\cdot}8)}{0{\cdot}10172}\ (RLB/100).(NCWP + KEQJ + CPDN)$$

$\bar{R}^2 = 0{\cdot}966$; SE $= 428$; DW $= 1{\cdot}7$; 1963–1982

Total personal income (I3)

$$YJ = YWS + YEC + YJO + PYRS$$

Personal disposable income (I4)

$$YD = YJ * (1 - YTAX)$$

Person's net acquisition of financial assets (I5)

$$FJ = YD - (PC.C) - (IHP.PIHP) - 0{\cdot}15\ (YSA + II£) + PNFR$$

*(j) Company sector income and expenditure*

Company profits (J1)

$$YCP = GDP£ - YWS - PYRS - YEC + YSA - YR - YGTA - RESE$$

Company dividends (J2)

$$\ln ECDV = \underset{(5{\cdot}9)}{0{\cdot}62708}\ \ln ECDV_{t-1} + 0{\cdot}37292\ \ln (YCP + YCO - (0{\cdot}8.YSA) + ECDV - (CTAX.YCT_{t-1})) - \underset{(3{\cdot}4)}{0{\cdot}44242} - \underset{(1{\cdot}5)}{0{\cdot}13134}\ D73$$

$\bar{R}^2 = 0{\cdot}961$; SE $= 0{\cdot}0972$; DW $= 1{\cdot}8$; LM(2) $= 1{\cdot}9$; 1967–1982

Other company income less appropriations (J3)

$$YCO = EDBT.((KNDP - KNDJ)/KNDP) + BYPA.((KNFA - KNFJ)/KNFJ) - ECDV + 0{\cdot}075\ (RLB/100).(NCWC - KEQC + CPNN) - (RLB/100) * (KBLP - KBLJ)$$

Companies' net acquisition of financial assets (J4)

$$FC = YCO + YCP - (INP.PINP) + CNFR - 0{\cdot}8\ (YSA + II£) - (CTAX.YCT_{t-1})$$

Companies' taxable income (J5)

$$YCT = YCO + YCP - (IALL.(PINP.INP)) - 0{\cdot}8\ YSA$$

*(k) Persons' financial model*

Supply of financial assets to persons (K1)

$$NFWP = NFWP_{t-1} + FJ - POFA + FREV.(KNFJ/KNFA) + GREV.(KNDJ/KNDP) + EREV.(KEQJ/KEQC)$$

Persons' demand for money (K2)

$$\Delta\ln(KM3J/PC) = \underset{(5\cdot3)}{0\cdot61055}\ln(YD/PC)_{t-1} - \underset{(6\cdot9)}{0\cdot44445}\ln(KM3J/NFWP)_{t-1} + \underset{(4\cdot6)}{0\cdot34726}\Delta\ln(NFWP/PC) - \underset{(5\cdot4)}{7\cdot83759} + \underset{(3\cdot7)}{0\cdot09947}\,CCCD - \underset{(0\cdot9)}{0\cdot29886}[\ln(1 + RUKG/100)_{t-1} - \Delta\ln PC_{t-1}]$$

$\bar{R}^2 = 0\cdot816$; SE = 0·03276; DW = 2·4; LM(2) = 3·0; 1964–1982

Persons' demand for other public sector debt (K3)

$$\Delta\ln KNDJ = \underset{(3\cdot2)}{0\cdot74115}\Delta\ln NFWP - \underset{(0\cdot1)}{0\cdot01541}\ln(KNDJ/NFWP)_{t-1}\ \underset{(0\cdot6)}{0\cdot13781} + \underset{(1\cdot7)}{0\cdot01562}\,RUKG - \underset{(0\cdot2)}{0\cdot0021}\,RUSG - \underset{(0\cdot7)}{0\cdot00114}\,RREQ$$

$\bar{R}^2 = 0\cdot624$; SE = 0·077874; DW = 2·2; LM(2) = 3·0; 1964–1982

Persons' demand for foreign assets (K4)

$$\Delta\ln KNFJ = \underset{(3\cdot6)}{0\cdot79599}\Delta\ln NFWP - \underset{(1\cdot6)}{0\cdot28811}\ln(KNFJ/NFWP)_{t-1} - \underset{(1\cdot5)}{0\cdot77909} - \underset{(3\cdot4)}{0\cdot04571}\,RUKG + \underset{(3\cdot9)}{0\cdot06511}\,RUSG$$

$\bar{R}^2 = 0\cdot705$; SE = 0·11616; DW = 2·4; LM(2) = 7·0; 1964–1982

Persons' demand for bank lending (K5)

$$\Delta\ln KBLJ = \underset{(2\cdot6)}{0\cdot2684}\ln YD_{t-1} - \underset{(2\cdot9)}{0\cdot40285}\ln(KBLJ/NFWP)_{t-1} - \underset{(3\cdot0)}{3\cdot76926} - \underset{(0\cdot1)}{0\cdot00094}\,RLB - \underset{(3\cdot0)}{0\cdot12442}CCD$$

$\bar{R}^2 = 0\cdot578$; SE = 0·121; DW = 1·4; LM(2) = 2·2; 1964–1982

Persons' demand for NFA (K6)

$$NCWP = KM3J + KNDJ + KNFJ - KBLJ$$

Persons' demand for equity (K7)

$$KEQJ = NFWP - NCWP$$

*(l) Companies' financial model*

Companies' demand for NFA (L1)

$$NCWC = NFA - NCWP$$

New issues of equity (L2)

$$\ln CPI = -\underset{(1\cdot1)}{0\cdot18826}\ln CPI_{t-1} + \underset{(3\cdot1)}{0\cdot35243}\ln(INP.PINP) + \underset{(0\cdot9)}{2\cdot62} + \underset{(5\cdot2)}{2\cdot51412}\ln SPUK - \underset{(4\cdot5)}{2\cdot18673}\ln SPUK_{t-1}$$

$\bar{R}^2 = 0\cdot674$; SE = 0·292678; DW = 2·0; LM(2) = 4·5; 1965–1982

Share price (L3)

$$\ln SPUK = \underset{(3\cdot3)}{0\cdot62236} \ln SPUK_{t-1} + \underset{(2\cdot3)}{0\cdot33488} \ln NCWC - \underset{(1\cdot6)}{0\cdot05707}\, \Delta RUKG - \underset{(1\cdot7)}{1\cdot56276} \ln (GDPC/GDPE) - \underset{(0\cdot4)}{0\cdot51842}$$

$\bar{R}^2 = 0\cdot701$; SE $= 0\cdot1033$; DW $= 1\cdot9$; LM(2) $= 6\cdot4$; 1964–1980

Stock of equity outstanding

$$KEQC = KEQC_{t-1} + CPI + EREV$$

Pre-tax rate of return on equity (L5)

$$RREQ = [ISP + (ECDV/KEQC)] * 100$$

*Notes for equation listing*

"*t*" values are in parentheses. A bar indicates an imposed coefficient. LM($x$) is the Lagrange Multiplier Statistic for auto-correlation of degree $x$ (see Breusch and Godfrey, 1981). The critical level for the statistic at the 95 per cent confidence level is 5·99 when $x = 2$; a value exceeding this indicates a significant degree of auto-correlation. SE is the standard error. $\bar{R}^2$ is the coefficient of (multiple) determination corrected for degrees of freedom. The Durbin–Watson statistic is often not appropriate in these equations, given the presence of a lagged dependent variable.

## APPENDIX 2: VARIABLES

(1) Equation number
(2) Sources: S = standard macro-economic variables (source for this exercise: Bank of England short-term econometric model data base); N = non-standard variables (see Appendix 3, below)
(3) Exogeneity in the Schema model (X = exogenous; E = endogenous)

| | | (1) | (2) (3) |
|---|---|---|---|
| ANIR | = Average (of wage bill) rate of employer's national insurance contribution | — | SX |
| BYPA | = Net property income from abroad | (G1) | SE |
| C | = Consumers' expenditure at 1980 prices | (A8) | SE |
| CA | = Current account | (G2) | SE |
| CAPU | = Capacity utilisation | (C3) | NE |
| CARE | = Current account residual | — | SX |
| CCD | = Credit control dummy | — | NX |
| CCCD | = Dummy for 'competition and credit control' period | — | NX |
| CNFR | = Companies' NAFA residual | — | SX |
| CPI | = New issues of equity | (L2) | SE |
| CPNN | = Net non residential capital stock, end year | (A20) | NE |
| CPDN | = Net residential capital stock end year | (A21) | NE |
| CTAX | = Average rate of direct tax on companies | — | SX |
| DEC | = Exchange controls abolition dummy | — | NX |
| $D_{ii}$ | = Dummy for year ii | — | NX |

| | | (1) | (2) (3) |
|---|---|---|---|
| DLPT | = Deviation of log of labour force participation ratio about trend | (B2) | NE |
| DTAX | = Average rate of direct tax on GDP | — | SX |
| ECDV | = Company dividends | (J2) | SE |
| EDBT | = Debt interest paid by public sector | (F1) | SE |
| EER | = Effective exchange rate index | (E13) | SE |
| EGTA | = Net public sector transfers abroad | — | SX |
| EREV | = Revaluations of equity | (H2) | NE |
| FC | = Net acquisition of financial assets: companies | (J4) | SE |
| FCA | = Factor cost adjustment at 1980 prices | (A24) | SE |
| FCA£ | = Factor cost adjustment | — | SE |
| FFL | = World price of fuel (=PFL * EER) | — | SX |
| FJ | = Net acquisition of financial assets: persons | (I5) | SE |
| FMBM | = World price of raw materials (= PMBM * EER) | — | SX |
| FRES | = Residual on private sector wealth identity | — | NX |
| FREV | = Revaluations of net foreign assets | (H3) | NE |
| FTKG | = Net capital transfers by public sector | — | SX |
| G | = Current government expenditure at 1980 prices | — | SX |
| G* | = Public sector current expenditure excluding subsidies | (F7) | SE |
| G£ | = Government current expenditure | (F4) | SE |
| GDPC | = Capacity output (gross domestic product at factor cost, 1980 prices, divided by estimate of capacity utilization) | (C2) | NE |
| GDPE | = Demand (gross domestic product at factor cost, 1980 prices) | (A26) | SE |
| GDP£ | = Gross domestic product at factor cost | (E7) | SE |
| GP | = Gilt price index | (H12) | NE |
| GREV | = Revaluations of gilts | (H1) | NE |
| IF | = Total fixed investment at 1980 prices | (A16) | SE |
| IALL | = Investment allowances—present value per unit of investment | — | NX |
| IG£ | = Public sector investment | (F5) | SE |
| IHG | = Public sector residential fixed investment at 1980 prices | — | SX |
| IHP | = Private sector residential fixed investment at 1980 prices | (A15) | SE |
| II£ | = Investment in stocks | (A11) | |
| II | = Investment in stocks at 1980 prices | (A10) | SE |
| ING | = Public sector non residential fixed investment at 1980 prices | — | SX |
| INP | = Private sector non residential fixed investment at 1980 prices | (A4) | SE |
| IPC | = Consumer price inflation rate | (A1) | SE |
| IPG | = Rate of change of gilt price | (A3) | SE |
| IPS | = Rate of change of share price | (A5) | SE |
| K | = Non residential fixed capital, at 1980 prices, mid year estimate | (C1) | NE |
| KBLJ | = Stock of bank lending to persons, end year | (K5) | NE |
| KBLP | = Stock of bank lending to the non bank private sector, end year | (H9) | NE |
| KEQC | = Stock of equity outstanding, end year | (L4) | NE |
| KEQJ | = Stock of equity held by persons, end year | (K7) | NE |

| | | (1) | (2) (3) |
|---|---|---|---|
| KIIT | = Stock of inventories and work in progress, end year, 1980 prices | (A9) | SE |
| KM3J | = Stock of £M3 held by persons, end year | (K2) | NE |
| KM3£ | = Stock of £M3, end year | (H6) | NE |
| KNDJ | = Stock of gilts and other non monetary public sector debt held by persons, end year | (K3) | NE |
| KNDP | = Stock of gilts and other non monetary public sector debt, end year | (H7) | NE |
| KNFA | = Stock of net foreign assets held by the non bank private sector debt, end year | (H8 | NE |
| KNFJ | = Stock of net foreign assets held by persons | (K4) | NE |
| KPDG | = Private sector residential gross capital stock, end year at 1980 prices | (A19) | NE |
| KPDN | = Private sector non-residential net capital stock, end year at 1980 prices | (A21) | NE |
| KPNG | = Private sector non-residential gross capital stock, end year at 1980 prices | (A18) | NE |
| KPNN | = Private sector non-residential net capital stock, end year at 1980 prices | (A20) | NE |
| KUNG | = Public sector non-residential gross capital stock, end year at 1980 prices | (A17) | NE |
| LD | = Demand for labour (employed labour force) (000) | (B5) | SE |
| LDP | = Private sector demand for labour (000) | (B3) | SE |
| LDU | = Public sector demand for labour (000) | (B4) | SE |
| LS | = Labour supply (employed plus registered unemployed) (000) | (B1) | SE |
| LU | = Number of registered unemployed workers (000) | (B6) | SE |
| M | = Imports at 1980 prices | (A23) | SE |
| MG2 | = Fuel imports at 1980 prices | — | SX |
| NCWP | = Stock of NBPS financial wealth held by persons | (K6) | NE |
| NCWC | = Stock of NBPS financial wealth held by companies | (L1) | NE |
| NFA | = Net financial wealth of the non-bank private sector, end year | (H5) | NE |
| NFWP | = Persons' net financial wealth | (K1) | NE |
| NW | = Net wealth of the non-bank private sector, end year | (H13) | NE |
| ORNT | = Imputed rent of owner occupied houses | (I1) | SE |
| PC | = Consumer price deflator | (E1) | SE |
| PC7 | = 7-year distributed lag of inflation rate of PC | (E10) | SE |
| PFL | = Deflator for imports of fuel (AVI) | (E15) | SE |
| PG | = Deflator for government current expenditure | (E5) | SX |
| PGDM | = Deflator for GDP at market prices | (E9) | SE |
| PGDP | = Deflator for GDP at factor cost | (E8) | SE |
| PIHP | = Deflator for residential fixed investment | (E4) | SE |
| PING | = Deflator for public sector fixed investment | (E6) | SE |
| PINP | = Deflator for non residential fixed investment | (E3) | SE |
| PM | = Deflator for imports | (E12) | SE |
| PMBM | = Deflator for imports of raw materials | (E14) | SE |

| | | (1) | (2) (3) |
|---|---|---|---|
| PNFR | = Persons' NAFA residual | — | SX |
| POFA | = Persons' acquisition of financial assets other than NBPS assets and equity | — | SX |
| POTH | = Public sector NAFA less PSBR | — | SX |
| POWA | = Population of working age excluding those in full-time education | — | SX |
| PS | = Deflator for inventories | (E2) | SE |
| PSBR | = Public sector borrowing requirement | (F9) | SE |
| PX | = Deflator for exports | (E11) | SE |
| PYRS | = Residual for mismeasurement of income from wages and salaries | — | SX |
| *Q* | = Valuation ratio | (A13) | NE |
| RESE | = Unidentified error in national accounts | — | SX |
| REU$ | = Eurodollar short term interest rate | — | SX |
| REV | = Revaluation of financial assets | — | NE |
| REVR | = Residual on revaluations | — | NX |
| RIT | = Rate of indirect tax | — | NX |
| RLB | = Base rate/MLR | (H10) | NE |
| RREQ | = Rate of return on equity | (L5) | NE |
| RUB | = Annual rate of unemployment benefit | (F2) | SE |
| RUKG | = Rate on 20-year gilts | (H11) | SE |
| RUSG | = Rate on 10-year US bonds | — | SX |
| SG | = Public sector saving | (F8) | SE |
| SPUK | = Share price index | (L3) | SE |
| T* | = Public sector current receipts net of subsidies | (F6) | SE |
| TFE | = Total final expenditure | (A27) | SE |
| TIME | = Time trend | — | NX |
| TREF | = Deflator for factor cost adjustment | (A25) | SE |
| TRYC | = Marginal tax rate on non-wage income | — | NX |
| TRYW | = Marginal tax rate on wage income | — | NX |
| TWIP | = OECD trade weighted industrial production | — | SX |
| ULC | = Unit labour costs (including self-employed and forces) | (D6) | SE |
| WIPC | = Average of IPC over past 2 years | (A2) | SE |
| WIPG | = Average of IPG over past 2 years | (A4) | SE |
| WIPS | = Average of IPS over past 2 years | (A6) | SE |
| WPIM | = UK trade weighted competitors wholesale prices (in 'effective' currency) | — | SX |
| WS | = Average wages and salaries per annum | (D1) | SE |
| X | = Exports | (A22) | SE |
| XG2 | = Exports of fuel | — | SX |
| YA | = Real personal disposable income adjusted for capital gains and inflation losses on financial wealth | (A7) | SE |
| YCO | = Company non-profit income less appropriations | (J3) | SE |
| YCP | = Company profits | (J1) | SE |
| YCT | = Companies' taxable income | (J5) | SE |

| | | (1) | (2) (3) |
|---|---|---|---|
| YD | = Personal disposable income | (I4) | SE |
| YEC | = Employers' contributions | (D5) | SE |
| YECN | = Employers' national insurance contributions | (D3) | SE |
| YECO | = Employers' other contributions | (D4) | SE |
| YGRA | = Public sector income from rent, non trading capital, dividends and interest | — | SX |
| YGTA | = Public corporations' gross trading surplus | — | SX |
| YJ | = Total personal income | (I3) | SE |
| YJG | = Current grants to persons by public sector | (F3) | SE |
| YJO | = Other personal income, excluding self-employment income | (H2) | SE |
| YR | = Income from rent | — | SX |
| YSA | = Stock appreciation | (A12) | SE |
| YTAX | = Average direct tax rate on personal income | — | SX |
| YWS | = Income from employment, self-employment and forces | (D2) | SE |

## APPENDIX 3: DATA SOURCES

Most of the data series used in the model were taken from well-known and easily accessible sources, and would be present in the database of most macro-economic models. These variables or those derived from combinations of such variables are denoted 'S' in the variable list above. The other variables, denoted 'N', are not so readily available or are not recognized economic variables. Their data sources or derivation are detailed below

| *Variable* | *Definition* | *Source* |
|---|---|---|
| CAPU | Capacity utilization | See GDPC |
| CCD | Credit control dummy | Subjective |
| CNFR | Companies' NAFA residual | FC − (YCO + YCP − (INP * PINP) − (0·8)* (II£ + YSA)) − (CTAX * $YCT_{-1}$) |
| Dii | Dummies | — |
| GDPC | Capacity GDP | Derived as GDPE/CAPU where CAPU is a measure of capacity utilization. Use Knoester and Van Sinderen (1984) or estimates from production function as described above |
| EREV | Revaluations of equity | ΔKEQC − CPI as obtained elsewhere |
| FREV | Revaluations of net foreign assets | ΔKNFA + DFA as obtained elsewhere |
| GP | Gilt price index | *Financial Times* gilt-edged securities index |
| FRES | Residual on private sector wealth identity, equal to CPRS + FCRS where CPRS = (PSBR + DNDL − DB + DEFC + DBL − DM and FCRS = DEFC − (CA + DFA), and: | |
| DB | Public sector debt sales to non-bank private sector | *Economic Trends*, annual supplement |
| DBL | £ lending to UK private sector | |
| DEFC | External and fc counterparts | *Economic Trends*, annual supplement |
| DLPT | Deviation of log of labour force participation rate from trend | Residuals from equation (B1) |
| DM | Change to £$M_3$ | *Economic Trends*, annual supplement |
| DNDL | Non-deposit liabilities | *Economic Trends*, annual supplement |
| DFA | Non-bank private sector capital account | *Financial Statistics* |
| GREV | Revaluations of gilts | ΔKNDP − DB as obtained elsewhere |
| IALL | Investment allowances | Series CS COPRTQ on Bank of England company sector group's database 'Present value of investment allowances', or similar proxy |
| KBLJ | Stock of bank loans to persons | *Financial Statistics* (stock outstanding for persons plus life and pension funds) |

| | | |
|---|---|---|
| KBLP | Stock of bank loans to NBPS | *Financial Statistics* |
| KEQC | Stock of equity outstanding from all companies | *Financial Statistics* |
| KEQJ | Stock of equity held by persons | See KBLJ |
| KM3J | Stock of $£M_3$ held by persons | See KBLJ |
| KM3J | Stock of $£M_3$ held by NBPS end year | *Financial Statistics* |
| KNDJ | Stock of gilts and other non-monetary national debt held by persons | See KBLJ |
| KNDP | Stock of gilts and other non-monetary national debt held by NBPS | *Financial Statistics* |
| KNFA | Stock of net foreign assets of NBPS | *Financial Statistics*, 'foreign assets' less 'foreign liabilities' |
| KNFJ | Stock of net foreign assets held by persons | See KBLJ |
| KPDG, KPDN, KPNG, KPNN, KUNG | Capital stocks | A consistent back-run is produced after each 'Blue Book' by UK Central Statistical Office |
| PNFR | Persons' NAFA residual | FJ − (YD − (C * PC) − (IHP * PIHP) − (0·15 * (II£ + YSA))) |
| POFA | Persons' net acquisition of unidentified financial assets (mainly building society deposits less mortgages) | $NFWP - NFWP_{-1}$ − FJ − REVP where REVP is revaluation accruing to persons |
| PYRS | Residual for mismeasurement of YWS | YWSX + income from self employment + forces' pay − YWS where YWSX is 'true' income from employment and YWS is defined as in the model |
| REVR | Revaluations residual | NFA − GREV − FREV − (DB + DM − DFA − DBL) as obtained elsewhere |
| RIT | Rate of indirect tax | Proxy by rate of value added tax: see UK FSBR (Financial Statement and Budget Report) |
| RLB | MLR/base rate | Use minimum lending rate up until its abolition, then replace with clearing banks' base rate. Minimum lending rate/bank rate is in *Economic Trends* annual supplement; base rate is in *Financial Statistics* |
| TIME | Time trend | — |
| TRYC | Marginal tax rate on non-wage income | Proxy by basic rate of corporation tax, see FSBR (financial statement and budget report) |
| TRYW | Marginal tax rate on wage income | Basic rate of income tax plus contracted out rate of national insurance contributions. *Annual Abstract of Statistics*. |

ACKNOWLEDGEMENTS

The author wishes to thank colleagues in Economics Division at the Bank of England and at the Bank for International Settlements for help, encouragement and advice, particularly J. S. Alworth, P. S. Andersen, G. Bingham, P. S. O'Brien, G. I. Evans, W. W. Easton, J. S. Flemming, K. Gardiner, C. A. E. Goodhart, N. H. Jenkinson, S. Key, P. D. Mortimer-Lee, G. Midgley, I. M. Michael, K. D. Patterson, J. Ryding, I. D. Saville and C. T. Taylor, also the editor of this journal and two anonymous referees. The errors remain his own responsibility.

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