

ECONOMIC FORECASTING IN THE UNITED KINGDOM

N. S. SASTRY

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TRAINING DIVISION

Department of Personnel and Administrative Reforms

Ministry of Home Affairs

New Delhi

1978

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FOREWORD

Economic forecasting is full of tremendous possibilities for a developing economy like ours. There have been some attempts to build macro-econometric models for the Indian economy. Most of these efforts are exploratory in nature and have been attempted in the context mainly of producing PhD dissertations. Lately some work in this direction has also been done in the Delhi School of Economics. However, actual forecasting work for the Indian economy has barely begun.

Shri N. S. Sastry, Deputy Director, Central Statistical Organization was sponsored under the Training Division's Manpower Development project to study economic forecasting in actual practice in the United Kingdom. He produced this paper on the basis of his explorations there. Realising the importance of disseminating this knowledge to a greater number of people interested in this and connected fields, we are bringing out this paper as a Training Monograph. It is hoped that the monograph will promote deeper appreciation and understanding of this complex subject and will be the basis for further thought, research and activity in this important area.

15 June 1978



Hari Mohan Mathur
Joint Secretary to the
Government of India
Department of Personnel & AR
Training Division
Ministry of Home Affairs
New Delhi

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1. INTRODUCTION

1.1. This report arises out of the author's study visit to United Kingdom during 23 April - 15 July, 1976 under the Manpower Development Project, jointly sponsored by the Governments of U.K. and India. The main object of the visit is to gain an understanding of the economic forecasting work in U.K. No official or non-official agency in India is engaged in forecasting work for the Indian economy. This is an area in which serious work is yet to be organised in India.

1.2 There are four principal agencies in UK which undertake economic forecasting and make available to the public their forecasts. These are (i) the Treasury, an official agency, (ii) the National Institute of Economic and Social Research (NIESR), (iii) the London Graduate School of Business Studies (LBS), and (iv) the Cambridge Economic Policy Group (CEPG) of the Department of Applied Economics, University of Cambridge. The latter three are non-official agencies.

1.3 In the Treasury short-term forecasting by quarter of the main macro-economic variables was developed during late 1950's before the development of any formal econometric model. During the 1960's the gradual accumulation of reasonably long runs of data enabled some relationships to be derived by econometric techniques. These were at first used to assist in the traditional forecasting exercises. In 1970 a computer programme was written to solve the existing set of equations. In 1973 the quarterly model for short-term forecasting and an annual model for medium term assessment were merged to form one quarterly model. The design of the existing model was to a great extent determined at that time. The latest version of this model (as on 1 October 1975) is discussed in Chapter 2 of this report.

1.4 The National Institute of Economic and Social Research has also a long history of the regular production of quarterly economic forecasts. Until recently the Institute's forecasts were based only on an eclectic approach and the first articulated model of the Institute appeared in 1971 in the book "The Analysis and Forecasting of the British Economy"

by M.J.C.Surrey. Since 1971, the model has undergone further revisions and the latest version is presented in Chapter 3. There are plans to revise the current model very soon and the new proposals are also set forth in the discussion.

1.5 The London Graduate School of Business Studies started work on economic forecasting in 1967 with the establishment of the Economic Forecasting Unit under the leadership of Prof. R.J.Ball. The first working version of a quarterly model (developed by this unit) was published in the Operational Research Quarterly in 1968. A later version, circa July 1972, appeared in a volume entitled 'Modelling the Economy' (G.A. Renton; Editor). In Chapter 4 of this report, we present the current version of the model (as of November 1975).

1.6 The forecasting performance of the three agencies, viz., the Treasury, NIESR and LBS, all of which produce quarterly economic forecasts, is compared in Chapter 5 over the period 1967-74.

1.7 In the Department of Applied Economics, University of Cambridge, a research group under the name "Cambridge Economic Policy Group" have been producing medium term assessments of the UK economy, the first of which has appeared in the Cambridge Economic Bulletin, Jan. '71 issue. Since then the group has been working on an annual macro-economic model for providing a theoretical framework to their economic assessments. The latest version of this model (as on 1 March 1976) is presented in Chapter 6 along with a discussion of the type of assessments made in their 'Economic Policy Review, March 1976 No.2'. This model is different from the Cambridge model of UK economic structure, which is based on the well known work of Prof. Stone and is designed to investigate structural changes and the inter-industry flows in the economy.

1.8 The Bank of England acquired a version of the IBS model in 1972 and modified it for its own particular purposes by including more information about certain financial flows. The Bank runs the model on its computer to carry out policy simulations but the results are not published. The Bank uses the model mainly to cross-check and absorb the Treasury version of economic forecasts so that it can enter into meaningful discussions with the Treasury on the management of the economy.

1.9 The University of Southampton has received grants from the Social Science Research Council to develop a model of the economy. For various reasons the project has run into some heavy water since its inception and has so far made no mark on the scene. A project to examine estimation methods and the application of control theory has been in operation for some time. The rump of this work is now with Imperial College of London University under Prof. Westcott.

1.10 All the macro-econometric models currently operated in UK are Keynesian models. A controversy surrounds the applicability of the Keynesian models for developing countries. Whatever the merits of the different views in the controversy, the model builder for Indian economy must recognise the fact that the national accounts data are presented in the Keynesian income-expenditure framework and any attempt to build a non-Keynesian model implies the generation of data to suit the special requirements of the model. There has been some activity to build macro-econometric models for the Indian economy by individual research workers. Most of these efforts have been of exploratory nature and in the context of producing Ph.D dissertations. An excellent survey of this research work (until 1972) was presented by Mohan J. Desai in Sankhya, the Indian Journal of Statistics, Series B, vol. 35, part 2, 1973. Dr. Desai, in this article as well as in his personal discussion with the author in London, emphasises that any future effort at model building in India should be a team effort. The crucial features of the Indian economy should dictate the nature of the models. The work should be organised both under official and non-official agencies. In this context the Econometric

Model project for India, currently in operation at the Delhi School of Economics, is a welcome development. It is hoped that official agencies would also devote enough resources to organise the work on a continuing basis.

1.11 Finally, the author wishes to thank the British Council and the Government of India for supporting the study visit. In particular, he is grateful to Shri S.S.Pison, Joint Secretary, Training Division, Department of Personnel; Shri V.R.Rao, Director, Central Statistical Organisation, India, and Dr. J.F.J. Toye of Wolfson College, Cambridge University. Mrs. C.Clissold Jones of the British Council has been extremely kind and helpful in arranging all administrative aspects of the visit. An annexe to the report contains the institutions and individuals visited during the programme.

2. TREASURY MODEL

2.1 The Treasury model is a quarterly econometric model. Its main uses are: (i) to provide forecasts of the economy for eight quarters ahead, (ii) to enable medium-term economic assessments for about five years ahead, and (iii) to quantify the effects of policy changes. The model consists of two separate but connected parts: (a) income and expenditure and (b) flow of funds. Related forecasting systems exist to provide forecasts of variables exogenous to the main model.

Income and expenditure:

2.2. In this part of the model the volume of expenditure measured in 1970 prices is determined. Current expenditure and fixed investment of public authorities are exogenous. Real personal disposable income determines consumers' expenditure. Propensity to consume is assumed to vary according to the nature of income. Thus distinction is made between earned and unearned income and if unearned whether it is current grants, imputed rent or dividends and interest receipts. Income forecasts are based on expected average earnings and the number employed. Employment is related to output and productivity trend. Personal direct taxes are a function of income. Consumers' expenditure deflator is used to deflate personal disposable income. All price indices used in the model are determined by unit wage costs, import prices and indirect taxes.

2.3 In the investment sector, stock adjustment models are used for private industrial investment and investment in private dwellings. Desired capital stock of industry is a function of 'lagged changes in output' and 'real corporate cash flow'. Investment in private housing is related to 'real personal disposable income' and 'building society advances'. The Survey of Investment Intentions, carried out by the Department of Industry, is used to qualify the forecasts of industrial investment. Similarly the data on housing starts and completions collected by the Department of Environment are used to qualify the forecasts of private housing investment. Investment in stockbuilding is related to lagged changes in output.

2.4 Imports are a function of domestic expenditure and output while exports are related to world trade (all in volumes). Changes in pressure of demand and in relative home and foreign prices and costs (which are of course influenced by any change in the exchange rate) are taken into account. In addition, export of manufactures are also influenced by changes in relative profitability of exporting.

2.5. To sum up, in the income and expenditure part of the model the main determining variables are public consumption and investment, tax rates, world trade, exchange rate and foreign average earnings. Estimates of wages and prices are also required to determine income and profits. For prices it is assumed that in the long run firms make up on unit labour costs and import costs by a constant amount. Indirect taxes are passed on without a profit mark up. This system produces both income and expenditure estimates for current price GDP. In order for these to be consistent one variable has to be treated as a residual. This variable is company profits.

The Flow of funds:

2.6 This part of the model provides forecasts for income, saving, net acquisitions, net lending and debt interest transaction for each of the main sectors (personal, company, public and overseas) of the economy. Subtraction of current income from current expenditure provides saving. Net acquisitions of financial assets are obtained by deducting capital expenditure from saving. Current income is affected in part by sectoral interest flows. These are determined by exogenous forecasts of interest rates and intersectoral lending.

2.7 Feedback between the income and expenditure part and the flow of funds part is achieved mainly through the effect on consumers' expenditure of dividends and net interest receipts, and the effect on investment by the manufacturing and distributive industries of companies' cash flow. Saving out of personal income also affects building society advances and hence private housing investment.

Related forecasting systems:

2.8 These are used to provide forecasts of variables exogenous to the main model. An interdepartmental exercise provides forecasts of world trade, import prices and competitors' export prices. In forecasting tax revenues initial estimates are produced by Inland Revenue and Customs and Excise Departments.

Estimation methods:

2.9 Linear relationships are estimated by simple regression (ordinary least squares). Equations incorporating lag structures on the independent variables are estimated by either Almon technique or rational lags. Data over the period 1958-1974 are used to derive most of the equations. Serial correlation in the error structure (normally auto-regressive) is taken into account.

2.10 The bias in the coefficients due to the existence of simultaneity is investigated only to a limited extent. Not all the parameters are estimated by time series analysis. For example, the coefficients in the price equations are almost entirely imposed as collinearity between import and wage costs results in estimated coefficients which bear no resemblance to those derived from the input-output tables. In the tax sectors, the constantly changing structure of taxation restricts the use of time series analysis.

Uses of the model:

2.11 Short-term forecasts for upto two years ahead and medium-term assessments upto five years ahead are derived from the model. The short-term results are based on the assumption of existing government policy. Additional information available from investment surveys, agreed wage settlements, retail sales etc. on the path over the next few quarters is incorporated into the forecasts. The short-term forecasts of economic activity are published in the 'Financial Statement and Budget Report' presented to the House of Commons when opening the Budget. For the medium-term assessments of the 'growth and use of resources', the model is solved for given assumptions for the level of unemployment, the current account balance of payments, public expenditure and investment

requirements, by manipulating international competitiveness and the burden of personal taxation. The results are published in the government Public Expenditure plans document in 'Part 1 - General Review'

2.12 The output of the macro-economic model is also used as input for a number of forecast exercises such as the financial and industrial forecasts. Using the sectoral surpluses and deficits generated by the model, more detailed forecasts are produced for the financial flow of funds between various sectors. If this exercise indicates any financial constraints these are fed back into the main forecast. Consistent forecasts of the demand on key industries, such as motor vehicles, engineering, etc. are worked out using the forecasts of the final expenditure components of the model. If supply constraints are indicated by the industry-wise forecasts, then the macro-economic forecast is suitably adjusted.

2.13 The macro-economic model is also of use in carrying out simulation exercises. Simulations are run showing the effect of alternative assumptions on economic behaviour, on policy objectives and on the choice of instruments. Similar exercises may be carried out to determine the effects of changes in variables outside government control such as the price of imported oil or in variables controlled by the government such as the quantity of taxation.

Other developments:

2.14 Currently a research programme is in progress to model the monetary system and to estimate its influence on expenditure and activity. It is also hoped to improve the specification of supply effects within the model by allowing investment to affect the growth of productive potential.

Miscellaneous notes:

2.15 The treasury model consists of some 500 equations. The large number of variables occurs partly because some degree of disaggregation is necessary to reflect more closely economic behaviour.

and partly because users of the forecast (such as other departments) require variables consistent with, but not essential to the solution of the model. For example the private sector is divided into manufacturing, North Sea oil, and the rest; and the public sector into central government, local authorities and public corporations. A group of 30 economists work on the model, all of them placed in the Treasury. Before finalising the forecasts, discussions are held with the departments dealing with specific aspects of the economy. Initially forecasting exercises were carried out by hand. With increasing size of the model, to ensure consistency the system was computerised. The model merely provides a framework for producing consistent forecasts. The final outcome is largely determined by judgement. This enters in two ways. The most obvious is in the forecasts of the exogenous variables. The second way judgement enters is through the extrapolation of 'residuals' produced by the equations into the future. The model is constantly being revised and improved as further information on the behaviour of the economy becomes available. For instance between October 1974 and October 1975, there have been many changes to the model. Some of these changes are due to respecification of equations, some due to the re-estimation of existing specifications and some the result of pruning sectors where there was an unnecessary number of variables. The model described in this note is as it was on 1 October 1975.

3. NATIONAL INSTITUTE MODEL

3.1 The National Institute of Economic and Social Research uses a macro-econometric model to prepare quarterly short-term forecasts of the U.K. economy, which are published and analysed in the "National Institute Economic Review". A description of the model (Model 1) currently in use is given here and some proposals to revise the model are also mentioned. Like the Treasury model, the Institute model is also a Keynesian model.

3.2 In the model government expenditure (both current and capital) is exogenous. Consumers' expenditure is explained by real personal disposable income, real value of the personal sector's net claims against all other sectors, and lagged consumption.

3.3 Investment depends on the gap between 'desired' capital stock and the actual capital stock. Desired capital stock is mainly estimated by using a constant elasticity of substitution (CES) production function. Investments in private dwellings, manufacturing industry and other industries are treated separately. Investment in private dwellings is assumed to depend on: (i) local authority rents relative to consumer prices - on the ground that the higher are local authority rents in real terms the greater is the incentive for council house tenants to try to become homeowners, (ii) the rate of increase in house prices and the post-tax interest rate on building society share accounts - these are used to proxy the extent to which house ownership provides a hedge against inflation, (iii) the initial interest rate in real terms on a mortgage, (iv) real personal disposable income and (v) a lagged variate to proxy the availability of funds to building societies. The specification of this equation is conceded to be somewhat arbitrary but in the Institute's view there does not appear to be any simple way to capture all the forces at work in the housing market. Flexible accelerator mechanisms are used to generate forecasts of investment in manufacturing and in other industries. In these equations investment depends on (i) the lagged values of the discrepancy between the actual and the desired capital stock, (ii) supply constraints of the firms and (iii) deviations from trend of a measure of the flow of cash receipts by

companies. Stockbuilding is treated as a function of total final expenditure, time, and lagged change in stocks.

3.4 In the case of exports, goods are distinguished from services. Exports of goods (volume) are a function of world trade, past and current relative U.K. export prices and capacity constraints of firms. Exports of services are determined by world trade in manufactures and past and current terms of trade for services. Export prices are related to competitor export prices and domestic prices. The Export equations are not formally included in the model but are run on a separate programme.

3.5 Imports of goods and services are also treated separately. In these equations imports at market prices are explained by measures of domestic activity, capacity, relative prices, lagged imports and the level of stocks at the start of the period. Sterling import prices are treated as if these were exogenous. It is assumed that these prices are recursively determined from truly exogenous world import prices measured in foreign currency prices and from the exogenously forecast exchange rate.

3.6 The above items of final demand are then used to obtain GDP at 1970 market prices. Factor cost adjustment less import taxes at 1970 prices is estimated separately and used to derive GDP at factor costs (1970 prices) from GDP at market prices. The model disaggregates the whole of domestic production into manufacturing and non-manufacturing industry groups. There are good reasons for treating manufacturing on its own; cyclical fluctuations in manufacturing industry account for a relatively large part of the cyclical fluctuations in the whole economy and better employment data are available for this sector than for any other. Equations are given for net outputs in manufacturing and non-manufacturing industry groups which are specified in terms of the items of final demand.

3.7 In the labour sector of the model, employment in manufacturing and non-manufacturing industry groups are estimated separately. The equations depend on output, capital stock, lagged employment and normal weekly hours of working.

3.8 In the income and taxes part of the model, 'average earnings' is exogenous. Wages and salaries are then determined as average earnings multiplied by employment. Income from self-employment is estimated on this basis of GDP (factor cost), time and lagged income from self-employment. Other income identities and equations take into account forces pay, employers' contributions to private and public schemes, rents received, dividend payments, building society share rates and deposits, mortgages and rates of mortgage. Personal taxes depend on the nominal income and the rules of the tax system. Because changes in tax rules have been so diverse, no equation is estimated which explicitly incorporates all the parameters of the tax system, and only an imposed equation is used. Real personal disposable income is then determined by means of an identity depending upon personal incomes and taxes and consumer price deflator. Indirect taxes at current prices are assumed to depend upon the average rates of indirect taxes and the composition of final expenditure.

3.9 In the 'prices' part of the model, consumer price index is related to lagged unit labour costs, trend unit labour costs, unit import costs and unit adjustment to factor costs. Prices of new houses depend on lagged bank rates and building costs. GDP deflator is worked out on the basis of lagged values for unit labour costs, trend unit labour costs and unit adjustment to factor costs.

3.10 The model described above consists of 24 behavioural equations. It has been in use since February 1974. Most of the equations are estimated using single equations instrumental variable technique and data dating back to 1966. On the modelling work, 15 staff members are employed.

Revision proposals:

3.11 The Institute has been carrying out significant research work to improve and revise the current version of the model. Very soon a revised model may be put into operation, which, however, retains the best part of the current model. Some of the proposals in the revised version are: (1) to allow for supply side effects explicitly in the model, (2) to explain bulk of exports within the model, (3) to ensure that the production functions which underlie the pricing, investment, employment and sectoral output equations are all internally consistent, (4) to provide for more disaggregation of domestic production possibly into five very broad industry groups - manufacturing, mainly public industries (mining, quarrying, gas, electricity, water, transport and communications), other private industries (distributive trades, construction, banking and financial services, agriculture, forestry and fishing), public administration and defence, and imputed services of dwellings - and to derive disaggregated and internally consistent systems of equations for explaining net outputs, investment, employment and price deflators by each industry group, (5) to include explicit equations in the model for net acquisitions of financial assets by each sector (personal, company, public and overseas), and (6) to construct a very rudimentary financial sector of the model in which the outstanding stocks of financial assets, augmented by the net acquisitions of financial assets in each period, determine the rate of return on equity which, in turn, is used in the investment equations.

4. LONDON BUSINESS SCHOOL MODEL

4.1 The Econometric Forecasting Unit at the London Business School was established in mid sixties. Its prime object was to specify and estimate a quarterly model of the UK economy that could be used for forecasting purposes and to study alternative economic strategies. Starting in 1966, the forecasts prepared by the unit appeared three times a year in the "Sunday Times". Over the period 1967-1975 the model has grown continuously. To start with the model contain 26 endogenous and 22 exogenous variables. At present the model has 251 endogenous and 135 exogenous variables. Here the current structure of the "basic" version of the model, which represents the minimum size and detail used for routine forecasting purposes, is described. Various sub-model packages are available for detailed analysis of particular areas e.g. consumption by income group and consumption category, UK trade by area, but these are not discussed here. In the beginning forecasts were made for one to two years ahead. However, experience has shown that to evaluate correctly policy packages it is necessary to look at a longer period and consequently the routine forecast period is now four to five years.

4.2 The relationships in the model (of which 113 are determined by behavioural equations and 138 by identities) are organised in five major groupings (i) expenditure on gross domestic product, (ii) factor incomes, (iii) sector accounts and the balance of payments, (iv) flow of funds and the money stock and (v) the labour market prices, interest rates, etc.

Expenditure on gross domestic product at 1970 prices:

4.3 Gross domestic product is determined from the expenditure side. It is typically assumed that production is not supply constrained and that supply adjusts to the going level of demand.

4.4 Consumption is divided between durable and non-durable expenditure. Consumption of non-durable goods depends upon current and past levels of disposable income and lagged stock of liquid assets of the

personal sector. No distinction is made between wages and other income. It is, however, assumed that all income from current grants (pensions, unemployment benefits, etc.) is spent on non-durable consumption. Durable goods consumption is related to a weighted average of current and past levels of disposable income excluding current grants (the weights declining exponentially into the past), stock of liquid assets of the personal sector, personal loans made by banks, and credit extended by hire purchase companies (represented by the minimum deposit rates of durables). Public authorities current expenditure in real terms is exogenous and determined by government policies as indicated in the White Papers on public expenditure and amended from time to time in budgets or ministerial statements.

4.5 In the investment sector, residential and non-residential public fixed investments are government policy variables and as such are exogenous to the model. Private non-residential fixed investment is disaggregated into (i) plant and machinery in manufacturing, (ii) plant and machinery in distribution, (iii) vehicles and industrial buildings, (iv) shipping (exogenous) and (v) the rest (exogenous). This is to allow for differences in the cost of capital caused by differences in the government capital allowances which applied to these various categories of investment. The theory behind the equations is the neo-classical approach wherein replacement of investment depends on existing capital stock and a 'desired' level of capital stock. The 'desired' level of capital stock is arrived at on the basis of CES production function. The estimated equations suggest rather long lags (in some cases extending upto four years) in investment behaviour. The length of these lags rather calls into question the short-term effectiveness of government policies to stimulate investment.

4.6 Private residential investment is a function of the number of houses started but not yet completed. Housing starts are related to the demand for new houses (which is increased by a rise in disposable incomes relative to the price of new houses, and decreased by a rise in the cost of borrowing), speculative supply of new houses (which depends on the price of new houses relative to costs in the economy as a whole and the

cost of borrowing) and the availability of funds (which is largely determined by the flow of new mortgages advanced by building societies). Net advances by building societies are determined on the demand side by the interest cost of mortgages and on the supply side by the funds which the building societies have been able to attract from savers. This in turn is dependent upon the yield which building societies offer to depositors relative to that offered by banks. It may be noted that the effect of the existing housing stock on new housing demand is not captured in the above specification.

4.7 Inventory investment is estimated on the basis of recent levels of GDP, stocks, and net acquisitions of financial assets by companies. This is based on the assumption that stock of inventories adjusts to recent levels of output as producers attempt to maintain their long-run desired stock-output ratio and at the same time in the short-run producers may be forced to economise on stocks if their cash flow situation in recent years has been poor.

4.8 Exports of goods are explained in aggregate. Exports of services are disaggregated into government services, shipping and other services, and travel and civil aviation. The explanatory variables in the export equations are volume of world trade in manufactures and relative prices of UK goods or services.

4.9 Aggregate imports of goods are a function of the level of final expenditure in UK. Since not all final expenditure components have the same import contents, the various categories of expenditure are entered separately into the equation. Imports of services are determined on a disaggregated basis (government, transport and travel, and other services). These are related to real disposable income in UK, the amount of visible imports that have been serviced abroad, and the price competitiveness of foreign services.

4.10 Factor cost adjustment is an estimate of what the value of taxes on expenditure and subsidies would have been at the 1970 rates per good (and not per value). Its determination in the model reflects the fact that the vast majority of such indirect taxation applies to consumers' expenditure.

Factor incomes:

4.11 Wages and Salaries account for the largest proportion of factor incomes. They are determined by multiplying wages and salaries per employee by the number of employees (as determined in employment equation). Wages and Salaries per employee are related to the average earnings index constructed by the Department of Employment. This, in turn, after adjustment for the effect of threshold payments under Stage III of the Incomes policy of 1972-74, is related to the basic hourly wage rate and the basic hour equivalent of actual hours worked. The basic hour equivalent is calculated by adjusting normal hours worked for overtime and short time and for the higher rates of pay for overtime hours. Basic hourly wage rates, when not constrained by the operation of incomes policies, depend on a distributed lag on observed inflation (as proxy for price expectations) and on the long run increase in labour productivity.

4.12 The relationship for stock appreciation is an identity which determines that part of any increase in book value caused purely by a change in the price of stocks held. The price of stocks held is determined elsewhere in the model. Rent and self employment income are simply related to the value of GNP. Employers' contributions are related to national health and insurance contributions.

4.13 Public sector gross trading surpluses are related to the value of GDP. The final element of factor incomes is then company gross trading profits excluding stock appreciation. This is equivalent to the company sector's surplus on operating account i.e. revenue less operating costs. No quarterly data are available on these two variables. But annual data suggest that company revenue (after adjustment for import costs and taxes on expenditure) and labour costs have accounted for a growing proportion of GDP and income from employment respectively, but have tended to oscillate around these trends in line with the cycle in industrial production. In the estimated equation company trading profits are related to the value of GDP, income from employment excluding forges pay, the cyclical variation of industrial production around its trend, a time trend and net accruals of selective employment tax.

Incomes, expenditure and saving by sector:

4.14 We first deal with the personal sector's current account. Personal saving is obtained as the excess of personal disposable income over the value of consumers' expenditure (which is the price of consumption expenditure - determined elsewhere - multiplied by the constant price consumption expenditure obtained earlier). Personal disposable income is the sum of income from employment (already determined), government grants, and other personal income, less contribution to national health and insurance schemes, transfers and taxes paid abroad and payments of UK income taxes. Other personal income consists of the personal sector's share of income from rent and self employment (already estimated) and its net receipts of dividends and interest are determined as a residual from total payments less receipts by other sectors. Income from current grants and payments of national health and insurance contributions are determined in the public sector current account.

4.15 In the calculation of personal tax liability, unlike other macro-econometric models, the effect of distribution of income is allowed for. On the basis of Inland Revenue data, tax units are classified by total net income, income source, marital status, number and age of children, number and type of dependents, whether blind or sighted, and whether life insurance premiums are paid or not. This cross classification defines over 20,000 cells of the population. The tax liability of a typical member is calculated for each cell using the relevant tax regulations. The tax liability of each cell is obtained by multiplying this typical liability by the number of members in each cell, and by aggregating over all cells the tax liability of the entire population is computed. Personal tax payments are then estimated as a function of current and lagged liabilities to income tax.

4.16 In regard to the company sector current account, the income side comprises gross trading profits excluding stock appreciation (as already determined), company stock appreciation, rent and non-trading income, and income from abroad. Company stock appreciation and rent income are estimated as proportions of total stock appreciation and rent income respectively (as earlier determined).

Non-trading income includes interest receipts on mortgages advanced by building societies and on personal loans made by banks. Also included are receipts of debt interest paid by the public sector and interest received on the stock of hire-purchase debt outstanding (as proxied by the minimum deposit rate). Property income from abroad is determined by grossing up "interest, profits and dividends: credits" (as determined later) for taxes paid abroad.

4.17 Company expenditures comprise payments of ordinary dividends, other payments of dividends and interest, profits due abroad and taxes paid abroad, and company tax payments. Net dividends on ordinary shares are related to the maximum possible amount of net retentions and the opportunity cost of net dividends in terms of the net retentions foregone. Other payments of dividends and interest include payments of interest on deposits at building societies and banks and payments of interest on debentures. Debenture interest payments are related to the level of long-term interest rates and a proxy for the stock of debenture debt outstanding. Profits due abroad are related to the stock of foreign direct investment in the UK and the rate of return to that investment as proxied by the variation of gross trading profits about its trend. The taxation of company income has changed significantly three times since 1961. All these various taxation schemes are programmed into the model.

4.18 Public sector current account is presented on a seasonally adjusted and an unadjusted basis. Unadjusted estimates are required to generate financial year totals and to fit in with data determining the money-stock (which is available only on an unadjusted basis). In presenting this account one of the particular interests is monitoring (forecasting) the public sector borrowing requirement and its determinants. The income side of the account comprises gross trading surpluses (as already determined), rent, receipts of dividends and interest, receipts of taxes on income (determined as payments by other sectors), taxes on expenditure, and national health and insurance contributions. Rent is determined as a proportion of rental income (earlier obtained).

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Receipts of dividends and interest are related to the long term rate of interest and a proxy for the outstanding stock of lending by the public authorities. Taxes on expenditure are determined in a fairly disaggregated manner, so as to evaluate correctly the effect of the budget on the economy. It is assumed that 50% of any increase in government grants will be financed by higher national insurance contributions. This represents approximately the government behaviour in the past.

4.19 Public current expenditure comprises public authorities current expenditure on goods and services (determined by multiplying the constant price estimate by its price index determined later), subsidies, current grants and payments of debt interest. Subsidies are related to the volume of non-durable consumption. Debt interest is related to the current level of interest rates and a proxy for the national debt. For forecasting it is assumed that the real value of government grants to persons is maintained.

4.20 In the overseas sector, the model is designed to generate estimates of the current balance of the balance of payments. Work is in progress to generate estimates of the capital account also. The visible balance is estimated by multiplying the constant price estimates of exports and imports of goods by their respective price indices (determined later). A similar procedure is followed with invisible trade. With net transfers abroad exogenous the final element in the current balance is the net inflow of interest, profits and dividends.

4.21 Interest, profits and dividends credits are divided into three categories - direct, portfolio and other. Income from direct investment is related to the stock of UK direct investment abroad and the rate of return to that investment is proxied by the variation of an appropriately weighted production index around its trend. Income from portfolio investment is related to the stock of UK portfolio investment overseas and the level of international interest rates as proxied by the US Treasury bill rate. Other investment income is dominated

by the transactions of UK oil companies. In the absence of any better model at present, it is represented by a time trend. Interest, profits and dividends debits are in the main accounted for by profits due abroad from the company sector (as already specified). To this is added an estimate of the proportion of public sector debt which is paid to overseas residents.

4.22 The mechanical and automatic effect of changes in exchange rates on valuation of the invisible accounts is allowed for in the structure of the model. With the abandonment of the official exchange parity some method had to be found to endogenise the 'float'. It is assumed that the dollar-sterling exchange rate varies so as to equate the sterling equivalent of UK and world consumption prices.

The flow of funds, money stock, and the public sector borrowing requirements:

4.23 For any sector, its net acquisition of financial assets is the excess of its saving (including capital transfers) out of current income over and above its net acquisition of fixed assets. In other words it is the lending of current purchasing power to another sector, i.e. the flow of funds.

4.24 In most macro-economic models in which money has been considered, it has been the custom to specify a demand for goods and a demand for money omitting the demand for bonds, on the assumption that this is determined by the budget identity. In the Business School model, however, the demand is specified for goods, credit and bonds leaving the demand for money to be determined by the budget identity. The behavioural relationships are consistent with the stock adjustment theory of portfolio behaviour. The desired stock of each asset held is assumed to depend upon such factors as wealth, expected yields on that and competing assets. In each period the actual stock is adjusted towards the desired stock but only by a proportion of the difference. Influences like credit rationing are taken into account.

4.25 The money supply identity may also be written as

$$\begin{array}{r} \text{Money + Bonds} = \text{Public} \quad \text{Total} \quad \text{Bank lending} \\ \text{Currency} \quad \text{Sector} \quad + \quad \text{flow} \quad + \quad \text{to non bank} \\ \text{borrowing} \quad \text{requirement} \quad \text{to non} \quad \text{private} \\ \text{private} \quad \text{sector} \\ \text{from} \\ \text{overseas} \end{array}$$

In this form it highlights the interdependency between monetary and fiscal policy. With no change in bank lending and overseas currency flow to the non bank private sector, any increase in the borrowing requirement has to be financed by either printing money or selling bonds. To hold the money supply constant, the government has to increase interest rates so as to sell more bonds. To hold interest rates constant, the government has to "print" the required amount of money. Given fiscal policy it can determine either interest rates or the money supply, but not both.

The labour market, prices and interest rates:

4.26 Employment is derived as a partial adjustment of labour productivity to an equilibrium level of productivity (determined essentially by a time trend), normal weekly hours worked, and a cyclical element represented by the ratio of GDP to its four quarter moving average. Unemployment is also obtained from a partial adjustment mechanism in which the equilibrium level is determined by the level of GDP and a time trend. In these equations the long term rate of productivity is taken up in the time trends. The labour force is determined by an identity. The amount of short time working is negatively related, and the amount of overtime worked positively related, to the pressure of demand in the economy.

4.27 The price of gross domestic product may be generated in two ways. The first is to generate price estimates for the individual expenditure categories and to weight them together using an identity. This may

give good estimates for some individual prices but it is difficult to ensure that all relevant costs are correctly passed on at the aggregate level. The second is to determine a central price as a direct function of aggregate costs, etc. and explain individual prices by adding in special factors which may cause deviations from the central price. With this procedure the aggregate pass is unambiguous. In the model estimates of prices are derived using both the procedures and then a reconciled set of price estimates is arrived at.

4.28 Initial functions are set up for the individual expenditure categories. They are constrained so that the proportions of import costs and indirect taxes contributed by each category is the same as those known for 1970 from input-output tables. All prices are related to unit labour costs. In addition the price of export is related to the price of world exports of manufactures, and the price of current government expenditure on goods and services related to productivity in the economy. Determination of the central price estimate is on a cost plus basis. Unit labour costs are entered into the function as a weighted sum to represent some measure of 'Standard' rather than actual costs.

4.29 As a result of recent world developments, a determination of import prices by commodity grouping is included. The price of fuel as determined in foreign currencies is treated as exogenous.

4.30 In regard to the interest rates, it is assumed that the authorities set the Minimum Lending Rate (MLR), and given fiscal policy stand ready to supply the amount of money demanded at this level of interest rate. Short term interest rates as represented by 91 day Treasury bills are related to the MLR. At the longer term end the important determinants are the expected short-term rate of interest and price expectations. The interest rate charged by the building societies on mortgages is equal to the cost of borrowing funds plus an allowance to cover service costs. Dividend yield is related to the short-term rate of interest and lagged dividend yield.

Estimation methods

4.31 Experiments were conducted applying different estimation techniques to the model. The results were not unambiguous and for the moment the stochastic

relationships in the model are updated using ordinary least squares. The model is solved using a Gauss-seidal algorithm. The listing of the equations gives the data base of the equations.

Uses of the model:

4.32 In addition to the preparation of regular quarterly forecasts of the economy on the basis of the econometric model, extensive simulation work is also undertaken to aid an assessment of economic policy. One example of this is contained in the 'balance of payments study' of the Unit. A current study is in hand examining the inflationary process over the period 1970-75. Other such studies relating to the effects of fiscal policy, monetary policy and strategies for full employment are planned. It is hoped to bring out a book containing all these studies in collaboration with the North Holland publishing company. A separate book on fiscal and tax policy may also appear.

Involvement in Project Link:

4.33 The making of forecasts for individual countries is complicated by the need to take a view about certain important international economic variables, especially world trade and production. Project Link is a large ambitious project which seeks to attack these problems by a joint solution of economic models for different countries and regions of the world simultaneously. The Economic Forecasting unit of the Business School participates in this project and undertakes the work on UK economy. This project is financed by the International Monetary Fund, the American National Science Foundation, the Federal Reserve Board and certain other Central Banks.

Future developments:

4.34 There is a proposal to expand the Economic Forecasting unit into an Institute of Economic Forecasting within the London Business School. Inter-industry analysis, economic analysis of specific industries and sectors of the economy, and institution of adequate training programmes for the development of

expertise in the field of 'computerised economic systems analysis and development of forecasts' are some of the additional objectives of the new set-up.

Staff:

4.35 The current research staff consist of four Principal Investigators, two Senior Research Officers, two Research Officers, three Research Assistants and a Secretary.

5. FORECASTING PERFORMANCE OF QUARTERLY MODELS

5.1 The assessment of forecasts is not a simple matter for a variety of reasons. Some of the errors that enter into the making of a forecast using a computable model of the economy may be listed as follows.

- (a) The starting point for the forecast may be incorrectly assessed due to the revisions made subsequently to data.
- (b) The input data relating to previous periods may also be incorrect.
- (c) Errors may result from errors in forecasting exogenous variables.
- (d) The model structure may be in error.
- (e) The preparation of forecasts requires a careful interaction between the model and the judgement of the forecaster and a mixture of human and machine errors is a clear possibility.
- (f) Events of significance about which there is no historical experience may occur and vitiate the forecasts.

5.2 Informative analysis of forecasts is, therefore, a complicated process and observations based on some comparisons of gross figures must be crude. The analysis that follows is thus crude but nevertheless provides some idea of orders of magnitude. The forecasts prepared by the three agencies, viz, the Treasury, NIESR (National Institute of Economic and Social Research) and the LBS (London Business School) over the eight year period 1967-74 using their quarterly econometric models are put together along with the actual outcomes and average absolute errors in the forecasts are computed. Essentially, the data relates to the forecasts made at the time of the Budget and refers to the year in which the forecast was made, i.e. the forecast for 1967 made at the time of the Budget of 1967. The forecasts discussed are all made on the assumption of unchanged policy within the forecast period. Comparable data from the three agencies are not available for some aggregates over the entire period of eight years. The data have, therefore, been divided into two periods - the first and second four years, and comparisons (wherever possible) have been attempted.

5.3 The average errors in GDP forecast for LBS and NIESR are exactly the same over the eight year period as a whole at about one percent. The NIESR performed better in the first four years, while LBS had a better record in the second four years. For the second half, the Treasury performance was approximately the same as the NIESR (about one percent).

5.4 For total real consumers expenditure, the error for the eight year period is about one percent for LBS and NIESR. In the second four year period, the performance of the LBS improved markedly and matched by that of Treasury at about half of one percent error.

5.5 In the case of exports, over 1967-70, the errors for LBS and NIESR were 2.5 and 2.1 percent. In the period 1971-74, the corresponding errors for LBS, NIESR and the Treasury were 2.0, 2.4 and 2.8 percent. For imports, over 1967-70, the errors were 3.2 and 1.3

percent for LBS and NIESR. During the period 1971-74, the corresponding errors were 1.6, 1.2 and 1.8 percent for LBS, NIESR and the Treasury. On the whole, for the balance of payments, the forecast errors by LBS and NIESR must be considered as 'large'. No official forecasts of balance of payments are issued.

5.6 In the case of private residential investment, over 1967-70 the errors recorded for LBS and NIESR were 10.0 and 4.6 percent. Similar results for 1971-74 were 6.1 and 7.0 percent respectively. For private fixed non-residential investment, over 1967-70, errors recorded were 5.4 and 5.7 percent for LBS and NIESR. Corresponding results over 1971-74 were 3.0 and 2.1 percent

5.7 For consumer deflator (proxy for inflation), over 1971-74, the errors were 2.2 and 1.6 percent for LBS and NIESR. No official forecasts are issued on this item.

6. NEW CAMBRIDGE MODEL

6.1 The New Cambridge macro-economic model is used by the Cambridge Economic Policy Group (CEPG) to produce medium-term assessments of the UK economy over a period of five years ahead at annual intervals. This model is distinctly different from the 'Cambridge model of UK economic structure' (operated under the guidance of Professor Stone) which is designed to investigate structural changes in the economy in relation to economic policy. The version of the CEPG model described here is that used to generate forecasts of the economy upto 1980 which are published in the Group's Economic Policy Review, March 1976, No.2.

6.2 The overall structure of the model is similar to that of most aggregative Keynesian models. Prices and volumes of expenditures determine output and factor incomes, which are then redistributed, mainly via the tax system, as disposable incomes. Private expenditure in money terms is mainly determined by private disposable incomes, public expenditure on goods and services in real terms is the result of government decisions, while imports and exports are functions of demand and relative costs or prices (unless import restrictions are assumed to be in force). Prices are determined by costs. The relative behaviour of domestic and world prices also influences the prices of exports and imports. Labour costs are governed mainly by wage settlements, which are themselves the outcome of a model of the bargaining process. The model contains no explicit behavioural hypothesis about the trend of productivity and industrial capacity.

6.3 In the model production sectors are classified into 'Public Services', 'Business sector' and 'North Sea' in order to provide an explicit analysis of (i) the effect of future levels of public service employment on the growth of overall productive potential and (ii) the effect of future development of the North Sea oil and gas on national output and income. Private disposable income is divided into three components: household grants, wages and salaries, and property income. The last component includes rents, income from self-employment, company profits, interests, etc. This division allows explicit account to be taken of the effects of future policies on the distribution of private income and on the timing and composition of private expenditure. Indirect taxes and subsidies are divided into two categories - sales taxes which are specific to different kinds of final expenditure, and those which feed into business costs generally. This

analysis forms the basis of a distinction between expenditure valued at market prices and at 'full cost'. The latter excludes taxes and subsidies on outputs but includes net taxes on inputs which to the business sector comprise local authority rates, protective duties on imports, royalties on North Sea supplies of oil and gas, less subsidies to public corporations. All imports, whether of intermediate or final goods, are assumed to enter the production process as inputs; imported final goods re-emerge in unchanged form but after sales taxes and addition of distributive margins, etc. The volume series for the component items of business sector domestic sales - consumers' expenditure, public current expenditure (excluding public services), public and private fixed investment (excluding the North Sea) - are measured at factor cost inclusive of the relative price effect. The price of business sector domestic sales is the basic domestic price variable in the system.

6.4 It may be noted that the definitions of the above variables in the model are somewhat different from the normally used definitions in official statistics. This necessitated reconstruction of basic data available from official statistical series to suit the requirements of the model. Such reconstructed annual data covering the period 1960-1975 formed the main data base of the model. It is claimed that the variables of the model have been chosen and defined in the above manner to permit a simple but comprehensive description of key short and medium-term objectives, instruments, exogenous conditions, and structural relationships which constrain macro-economic policy in UK. In the following paragraphs the main behavioural hypotheses of the model are briefly summarised.

Private expenditure:

6.5 Previous work by the CEPG, based on analysis of post-war UK data from 1954 onwards, has emphasised the stability of total private expenditure in relation to total private disposable income. In the model two equations are specified to determine private expenditure on consumption and fixed investment (excluding investment in the North Sea) separately at current market prices on the basis of current and lagged values of the three categories (wages and salaries, household

grants and property income) of private disposable income. The consumption equation also contains a term for the effects of hire purchase credit. The two equations when aggregated possess the overall property of private expenditure in relation to private income - i.e. the coefficients of each category of income sum to approximately unity, although the timing and composition of expenditure are sensitive to the distribution of private income. Specification of the equations in current price terms implies that the overall ratio of private net acquisition of financial assets (disposable income less expenditure on consumption and fixed investment) to disposable income is positively associated with the rate of inflation.

Stockbuilding:

6.6 The hypothesis for Stockbuilding is a conventional stock-adjustment mechanism, with total stockbuilding in volume terms depending on changes in real business output in the current and preceding years. There is an implied slow trend decline in the stock-output ratio.

Foreign trade volumes:

6.7 Imports of goods and services are divided into six categories - food, drink and tobacco, fuels, basic materials, semi-finished manufactures, finished manufactures, and others (mainly services) - and exports into fuels and other exports. Of these, imports of food, drink and tobacco and services, and exports of fuels are forecast exogenously. For the remainder the general form of equation includes a demand variable and a geometric lag term on relative prices or costs. The demand variables are world trade in goods and services in the case of exports, real business sector final sales for imports of finished manufactures, and real business output for imports of fuels, basic materials and semi-finished manufactures. Equations for the latter two also contain a stock building term.

Employment

6.8 Total employment is disaggregated into two categories corresponding to the production sectors of the model: public service employment and business sector employment. North Sea labour costs are treated

as part of imports of services produced in the UK business sector and therefore employment in the North Sea is also attributed to the business sector. Levels of employment in both the sectors are measured in terms of male full-time earnings equivalents in order to allow for changes in the composition of employment and simplify the determination of the overall wage and salary bill, which can be obtained for each sector as employment multiplied by average earnings per male full-time equivalent. Employment in public services is exogenous, apart from a small component related to the level of unemployment. Employment in the business sector partially adjusts to its desired level, with desired employment determined in relation to output and the pressure of demand. The expression for unemployment incorporates a marginal propensity to register as unemployed which varies inversely with the pressure of demand for labour in the economy.

Earnings:

6.9 Standard (cyclically-adjusted) weekly earnings per male full-time employee depend on a weighted average of current and lagged values of wages at settlement for manual and non-manual employees and on a term representing cost-of-living and threshold payments. Adjustments are made for the effects of changes in normal weekly hours. The trend coefficient in the equation represents regular additional increases in earnings (about 2% per annum) due to wage drift and structural changes in employment. The weights used in combining current and lagged values of wage settlement index for manual employees vary as a part of the adjustment of wage determination to changes in the rate of inflation, so that an increase in the rate of inflation increases the weight attached to current wage settlements. The weights also take into account the average time between settlements, the proportion of workers covered by wage settlements in the year, and the bunching of settlements at certain times during the year. Much detailed information is not available for settlements covering groups of non-manual employees.

6.10 The effects of incomes policies on wage bargaining are also accounted for. The level of money wage settlements is assumed to be set, under conditions of free collective bargaining, by attempts to achieve a particular real disposable wage at the settlement

date, allowing for the lag between the date of settlement and the date of implementation of wage awards. The operation of incomes policies is assumed to determine the level of money wages at settlement, with the real values of the wage bargain under these circumstances emerging as a consequence of inflation and fiscal drag. The desirability of incomes policies can then be assessed on the basis of their consequences for real post-tax wages.

The public sector:

The model incorporates a full set of public sector accounts.

(a) Expenditure on goods and services:

6.11 Current expenditure on goods and services is split into two components: wages and salaries (public service expenditure) and other expenditure. Public service expenditure is equal to public service employment multiplied by the average wage. Public service employment (measured in male full-time equivalents) is largely exogenous and derived from the latest Public Expenditure White paper. Average money earnings per male full-time employee in public services are projected on the basis of an assumed relativity with standard average money earnings in the business sector. Other current expenditure and fixed investment, in volume terms, are derived from official projections in the Public Expenditure White paper. Both series are inflated by the general deflator for business sector domestic sales. Public sector stock building at current prices is derived as a residual from total and private stockbuilding.

(b) Direct taxes:

6.12 Direct tax receipts (including national insurance contributions) are divided into four categories. For household grants and private property income paid abroad, tax revenue is derived by applying effective average tax rates to income. Tax on domestic property income (which includes income tax on self-employment and unearned income, as well as Corporation Tax) is calculated by applying the effective tax rate to estimated taxable income - preceding two

years gross income less investment allowances, and stock relief. Direct taxes on wages and salaries consists of both income tax and employee's and employer's national insurance contributions. Income tax revenue is estimated by applying an exogenous marginal tax rate to total income from employment, and deducting from this sum the value of income tax allowances (the average per capita value of allowances multiplied by the estimated number employed).

(c) Grants:

6.13 Household grants comprise all social security benefits and student maintenance grants. The average pension is linked, with a lag, to average money earnings. The numbers of persons receiving grants, excluding the unemployed, is expressed in terms of pensioner-equivalents (using as weights the ratio between average grant received in each category and the average pension) and projected exogenously using Government Actuary Statistics. Household grants are obtained by multiplying the weighted numbers plus the unemployed (similarly weighted) by the average pension. Other current and capital grants to the private sector, and current transfers abroad, are all derived in volume terms from the Public Expenditure White Paper and linked to general inflation.

(d) Indirect taxes:

6.14 Indirect taxes, including subsidies, are divided into those which affect business costs - local rates, protective duties and subsidies to public corporations - and those which do not, such as VAT (value added tax), specific duties and food and housing subsidies. In the latter category sales taxes on consumption are split into three components: (i) those which are income-elastic and are assumed to vary with the value of expenditure (most of VAT, car tax, betting and gaming duty and specific duties on alcoholic drink); (ii) other indirect taxes (specific duties excluding those on alcoholic drink, VAT on tobacco and hydrocarbon oil, and stamp duties) whose yield is projected in real terms; and (iii) subsidies, mainly on food and housing, which are projected in money terms on the basis of forecasts in the White Paper. For sales tax on other expenditure items, and also protective import duties, effective average rates of tax are projected exogenously.

Local authority rates are related to average earnings in public service employment; subsidies to public corporations move in line with general inflation, and are inversely related to real output.

(e) Property income and debt interest:

6.15 Trading income and rent of public corporations and other public enterprises are assumed to move in line with general inflation and with movements in real output. Gross debt interest payments in any year are expressed as payments in the previous year, plus the net addition to debt - a weighted average of this year's and last year's borrowing requirement and the debt to be rolled over, multiplied by the average current rate of interest and minus the interest saved from current redemptions. Net debt interest is then derived by deducting interest receipts, which are projected to move in line with inflation, from gross payments. The average rate of interest payable on new debt is related to the level of world interest rates (which is exogenous to the model) and to variations in the exchange rate.

(f) Public sector borrowing requirement:

6.16 Public sector disposable income consists of revenue from taxes and trading income, less all grants, transfers and debt interest. The borrowing requirement is then obtained as total expenditure on goods and services minus disposable income (equals the public sector financial deficit before capital taxes) minus taxes on capital plus asset transactions (acquisition of private sector assets through nationalisation, etc.).

The North Sea:

6.17 The volume of production of North Sea oil and gas, together with operating costs and imports of capital equipment, all expressed in real terms, are projected exogenously on the basis of latest available information. The average price of North Sea production is projected to move in line with the price of imported fuels, but taking into account a composition effect as the proportion of oil in total production rises. Royalties are assumed to be levied at $12\frac{1}{2}\%$ of total sales.

6.18 North Sea output at current factor cost is defined as sales less operating costs less royalties, and forms the base on which taxes within the ring fence (corporation tax and Petroleum revenue tax) are levied. Post-tax profits paid abroad and to the UK are projected on the basis of assumption about the distribution of future production and profits between domestic and foreign companies. Balance of payments capital inflows are projected in real terms and converted to current prices using the deflator for North Sea imports of capital equipment from abroad. There are other relationships in the model which generate various accounting magnitudes and these are used to disaggregate production between the Public Services, North Sea and the business sector.

Export and import prices:

6.19 Prices of exports and imports are determined with a lag, partly by domestic costs (adjusted for indirect taxes) and partly by foreign prices, expressed in sterling, depending on the extent to which the UK acts as a price-taker on world markets in the various commodity groups. For exports and imports of finished manufactures and services, the foreign price variable is an index of world prices of manufactured exports, while for food and basic materials an index of world prices of food and materials is used. A weighted average of these two foreign price indices is used in the equation for the price of semi-finished manufactures. Fuels (oil) have their own world price index. The relationships also allow for different lengths of lag in the adjustment of prices, with the lag being longest in the case of food.

Balance of payments:

6.20 In the model, the current account of the balance of payments and the basic balance on current and long-term capital account are determined. The current balance comprises the balance of trade in goods and services expressed at current prices (which may be determined on the basis of foreign trade volumes and prices) and net property income and transfers from abroad. Private interest, profits, dividends and transfers paid abroad from the business sector, measured before tax, are related to total private business factor income. North Sea profits paid abroad

are already treated under North Sea factor. The corresponding inflows are projected in relation to the level of activity and of prices of manufactures in the world economy. Public sector interest payments are determined by the cumulative total of deficits on the basic balance and the level of world interest rates which determine the terms on which overseas borrowing is made. Government transfers abroad are projected in volume terms on the basis of the public Expenditure White Paper and linked to general inflation.

6.21 The basic balance of payments on current and long-term capital account is required in the model to generate interest payments on overseas borrowing. Public sector net long-term capital inflows are projected exogenously, whilst capital inflows to the North Sea are discussed above. Other private inflows and outflows are projected in relation to the corresponding reverse flows of private property income, since a substantial proportion of profits earned by UK companies abroad, and by foreign companies in the UK are retained to finance investment rather than repatriated to the host country. Net trade credit is derived from changes in gross import and export credit outstanding resulting from changes in exports and imports and in trade credit ratios.

Prices:

6.22 The basic price variable used in the model is the price of business sector domestic sales at full cost. This is defined as the ratio of the sum of expenditures: consumers' expenditure, public current expenditure (excluding public services) and public and private fixed investment (excluding the North Sea), all measured at current full cost, to the sum of the equivalent items measured at constant factor cost. Movements in this average price reflect movements in taxes on business sector inputs as well as in cost of domestic factor inputs and in import prices themselves. Average market prices of the various components of domestic sales are derived where necessary by applying the appropriate sales tax rate to the full cost price. The original volume series at factor cost which are used to generate the average full cost price for past years, and which embody different implied full cost

prices, are replaced in the model by series which are inclusive of the relative price effect, i.e. which share the same full cost price.

6.23 The price of domestic sales is assumed to be determined on a cost-plus basis. Thus prices are set as a mark-up on historic normal unit costs, where historic costs are simply a lagged function of current costs, with an average lag of about one quarter. Current costs are expressed as a weighted average of an index of domestic costs per unit of normal business output and an index of import costs per unit of imports, with the weights being actual business output and actual imports respectively.

6.24 Domestic costs comprise labour costs per unit of normal output, expressed as standard money earnings per male full-time employee divided by trend productivity, together with rates, farm profits, private rents, less subsidies to public corporations, all expressed per unit of normal output. Rates and subsidies to public corporations are those indirect taxes which are treated as levied on domestic primary inputs. Farm profits are included to take account of the fact that prices of domestic agricultural products are not set on a cost-plus basis but are largely determined by EEC policies, so that domestic farm prices and profits are related to prices of food imports, the effect of which is explicitly incorporated in the equation for farm profits. Private rents are projected to move partly in line with inflation. All domestic costs are expressed per unit of normal output, on the assumption that firms set prices in relation to normal, rather than actual costs. Normal output and trend productivity are both defined by logarithmic trends. Import costs consist of the average cost of imports to the business sector, including protective duties on imports and the cost of purchase of fuel from the North Sea. Exports of fuels from the North Sea are excluded as not affecting business costs on prices except for an assumed profit margin of 20%.

Estimation methods:

6.25 The general form of behavioural relationships specified in the model is: $g(y) = \alpha_0 + \alpha_1 t + u$; $g(y) = y$ or $\ln y$, where y is the dependent variable, α_0 and α_1 are 'trend' parameters, t is a linear time trend, f is a

(non-linear) function of parameters p and current or lagged values of other variables, x , and u is a disturbance term. The values of structural parameters p are assigned a priori, generally on the evidence of time-series estimation conducted separately. These estimates are often based on more complex stochastic specifications (e.g. first or second order serial correlation or moving-average disturbances) and may also make use of additional specification of the function f , which is not incorporated in the model because of its limited relevance or cost in terms of adding extra variables. The values of the trend parameters α_0 and α_1 are obtained as OLS estimates of $g(y) = f(p, x) = \alpha_0 + \alpha_1 t + u$, over a uniform time-period (1962-74).

6.26 The model, thus constructed, is used both to interpret the causes of past developments and to obtain conditional predictions of the effects, past or future, of alternative policies and external circumstances. Its structure is verified in two main ways. First, the actual past values of variables predicted by behavioural hypotheses are compared with the values which would be predicted by the equations, taken one at a time, in the absence of disturbances or 'residual errors'. This test is strongest when applied for data which have not been used to estimate any parameters in the equations, and generally 1975 data are used for this purpose. The second kind of check on the model is to examine its properties as a complete system - for example, the response to an increase in export demand - to ensure that the overall behaviour of the model is in reasonable accord with what might be inferred from past experience. This is an important check, because a set of hypotheses each of which seems plausible on its own may easily give implausible results when the hypotheses are combined.

6.27 To obtain conditional predictions for future years from the model some extra specifications are needed. The record of residuals, u , in behavioural equations must be considered to see whether current residuals are likely to persist in future years. In the predictions the disturbances, u , are either assumed zero or carried forward by a serial correlation process, starting from the latest past value (1975), with a priori coefficients. In specifying the trend values of 'semi-endogenous' variables for each future year, the trend may either be modified or the entire term $\alpha_0 + \alpha_1 t + u$ be overwritten. Finally assumptions must be provided to define the future values of exogenous variables.

6.28 Two main advantages derive from incorporating linear trends into the specification of all behavioural relationships. First, it permits a convenient display of off-trend past behaviour in which, writing an asterisk for trend values, the values of each dependent variable can be analysed as $g(y) - g^* = f(p, x) - f^* + u$. A quick check is then possible of the extent to which the structural hypothesis $f(p, x)$ explains past fluctuations about the trend of $g(y)$. The second advantage is that projections of the behavioural relationships for future years will generally be rather robust, in that they will not be very sensitive to the exact values specified for p . Although this property is convenient for projections, not too much should be made of it. In particular, it has no relevance at all to comparisons between alternative projections for the same future year, for which purpose reasonably accurate specification of values of structural parameters is essential.

Use of the Model:

6.29 The system for analysing the model permits any subset of exogenous variables to be defined as instruments whose values in each year are to be determined so that a subset of an equal number of endogenous variables attain target values in that year. Thus, for example, taxes on consumption may be determined so as to achieve given target current balance of payments or public sector deficit, the sterling exchange rate may be determined so as to achieve a given level of cost competitiveness, or wage settlements may be determined so as to achieve a given rate of inflation. The possibility of defining a set of instruments to achieve given targets is of course limited by the structure of the model itself, because certain combinations of targets may not be feasible with the defined set of instruments. Alternative projections, whenever attempted, have been made comparable by employing the same assumptions in each, except for those differences which directly and explicitly stem from the definition of the economic strategy illustrated in each projection.

6.30 When the results of projections are used for analysis, the most important uncertainties are often indicated and a measure of the sensitivity of the predicted outcome to a change in assumptions is given. The projections are also conditional on behavioural hypotheses,

some of which would be disputed by some other macro-economists. The sensitivity of the results to changes in the main behavioural hypotheses have not been investigated, and the whole analysis is therefore clearly dependent on CERG view about how the UK economy works.

6.31 The main features of the economic situation in UK are - balance of payments deficit, low growth of output and income, high unemployment and inflation. Based on the accounting system and model described above, the CERG have provided in their March 1976. Review tables giving annual accounts for the main topics: (1) employment, output and national income, (2) disposable income and expenditure, (3) earnings, costs and prices, (4) balance of payments, (5) private sector accounts and (6) public sector accounts. These tables record historical data for 1963-75 based on the latest available official statistics (basic source National Income and Expenditure, 1964-74) as well as present the results of three projections for 1967-80 which illustrate possible outcomes under, respectively, existing arrangements, large-scale devaluation, and broadly based permanent restriction of imports (the two latter strategies being assumed to be implemented from mid-1976). Results on output, income and expenditure are all expressed at constant (1975) values. The definitions of alternative projections are briefly described in the following.

6.32 The assumptions made to derive alternative future projections can be divided into those which are common to each and those which are specific to the particular strategy illustrated.

6.33 Common assumptions:

(a) Growth of world trade at an average rate of just over 9% a year (1975-80), world prices of manufactures rising 5.5% a year (slower at first); the world price of raw materials relative to manufactures rising slightly, and the world price of oil relative to manufactures remaining constant after 1976.

(b) Growth of public expenditure as foreseen in the White Paper: public expenditure to 1979-80.

(c) Fixed tax rates (adjusted for inflation) other than taxes on consumption (used as the instrument of budgetary adjustment).

(d) Balance-of-payments current account targets improving from an expected £(1975) 2.4 billion deficit in 1976 to a surplus of £(1975) 1 billion in 1980.

6.34 The main differences between projections are in the specified targets and instruments.

(i) Existing arrangements are assumed to mean a 3% per year gain in export cost competitiveness after 1976 via depreciation of sterling, while money wage settlements fall to 10% a year and the frequency of settlement is limited to annual bargains. The balance-of-payments targets after 1976 have to be met by regulating growth of domestic demand through taxes on consumption.

(ii) Devaluation is assumed to mean a large fall in the exchange rate in mid-1976, and subsequent depreciation, so as to provide a once-and-for-all maintained change in export cost competitiveness sufficient to reduce unemployment to 900,000 by 1980. Money wage settlements are limited to 7.5% a year from 1977 onwards. The same balance-of-payments targets have to be met by regulation of domestic demand through taxes on consumption.

(iii) Restriction of imports is assumed to mean direct limitation of imports of manufactures to fulfill the common balance-of-payments targets while taxes are adjusted to reduce unemployment to 1,050,000 in 1977, falling to 900,000 in 1980. For comparative purposes the same money wage settlements are assumed as under (i). The exchange rate is adjusted to maintain cost competitiveness at its 1975 level. Trade restrictions by other countries are assumed to reduce the level of UK exports (excluding fuels) by about 3% in each year from 1977 onwards below what would be expected in the absence of restrictions.

6.35 The analysis emerging from an examination of the tables giving historical data and results of alternative forecasts may be summarised as follows.

import ← 6.36 Conventional policies (existing arrangements) cannot reverse the past trend of low export growth and penetration to the extent necessary to achieve fast economic growth. Devaluation and import restriction are both in principle effective methods of solving this

problem but neither is possible, on the scale required, under existing institutional arrangements.

6.37 Neither a large-scale devaluation of sterling nor the imposition of broad import restrictions would prima facie be acceptable to the EEC and other major countries and international institutions. Attempted devaluation might also invite sanctions from oil-producers with large sterling holdings.

6.38 Domestically the problem of the inflationary gap will remain acute for at least another two years, whatever strategy is adopted. A strategy of protection (import restriction) would be the least damaging to real wages and the least vulnerable, in terms of its ability to bring down unemployment, to any future acceleration of inflation. Under conventional policies, and still more after large-scale devaluation, the control of future inflation is a vital pre-requisite for economic growth. Yet these strategies would sharply reduce real wages, making future limitation of money wage settlements far more difficult.

6.39 Whether either strategy (devaluation or import restriction) should be attempted, and if so which, is a fundamental political issue involving other considerations besides the economic effects discussed here.

6.40 If any viable arrangement can be reached which removes the balance-of-payments obstacle to future growth of demand, the British economy should now be capable of a period of very fast growth (by the standard of past performance) at a sustained rate of 5% a year or more for

/many years.
This would
provide the
opportunity
for

a transformation of industry and the economy in which the critical structural problems existing today could be resolved. In CEPG's view it is essential that the agent of expansion for a sustainable growth strategy should be rising exports or reduced import penetration.

Staff:

6.41 Ten research workers are engaged in the development and operation of the model. They are located in the Department of Applied Economics of the Cambridge University.

Institutions and Individuals visited

1. University of Cambridge: J.F.J. Tove, Wynne Godley, Martin Fetherston, Kenneth Coutts, Roger Tarling, Frank Wilkinson, W. Peterson, V. Woodward.
2. London Graduate School of Business Studies: R.J. Ball, G.A. Renton, T. Burns, J.R. Eaton.
3. National Institute of Economic and Social Research: Mrs. K. Jones, Miss. D. Osborn.
4. H.M. Treasury: H.P. Evans, Mrs. J.M. Marquand, P.N. Sedgwick, C.J. Riley, A.J.C. Britton, J.T. Caff, G. Horton.
5. Bank of England: C.T. Taylor, J.A. Bispham, J.C. Dorrington, Ash.
6. University of Oxford: M.F. Scott.
7. University of Leicester: J. Bonner, S. Ghatak.
8. Central Statistical Office: J. Hibbert, A.A. Sorrell, R.W. Green, M.J.G. Lockyer.
9. London School of Economics and Political Science: Meghnad J. Desai.
10. Civil Service College: K.J. Wigley, R. Harris of Institute of Economic Affairs, P.W. Robinson of the Commission of European Communities.