# V

# The Economy as a Whole

# 12

# Models of the whole economy

## 12.1 INTRODUCTION

Running a model of the UK economy can be a large task, requiring considerable financial support. There are thus a fairly small number of organizations, many receiving government funding, that run them. These include the National Institute of Economic and Social Research (NIESR), the London Business School (LBS), City University Business School, Liverpool University, Her Majesty's Treasury (HMT) and the Bank of England. Some of these models are very large: the NIESR model, for example, has 320 variables; the LBS model has 770; the Bank of England model has 800; and the Treasury model 1275 variables. In contrast the Liverpool model has only 50 variables. As we shall see later on, each of these models has its own distinctive characteristics.

### Why are the models so large?

In principle a model of the UK economy could be very small. We could, for example take the basic income-expenditure model, based on the identity $Y = C + I + G$, estimate the consumption function and take investment and government spending to be exogenous. If we thought we knew what was going to happen to investment and government spending we could then use this model to forecast the level of income. This model would perhaps not be very interesting (everything depends on what we expect to happen to autonomous spending, which is determined outside the model), and we might hesitate before calling such a simple model a model of the whole economy, but what is going on here is essentially the same as what is going on in more complicated models.

To clarify what is going on, and to explain why models of a real economy can rapidly become more complicated than textbook models, suppose we were to use an income expenditure model to predict output using some of the equations discussed in earlier chapters. To keep things simple, suppose that we want to use a consumption function from chapter 2 and an import function from chapter 5, and that we are content to take investment, government spending and exports as exogenous. We would then obtain a model such as the following one.

$$TFE = Consumption + Investment + Government\ spending + Exports$$

$$GDP = TFE - Imports$$

$$RPDI = GDP - Taxes + Subsidies$$

$$Consumption = 9.0 + 0.86RPDI$$

$$Imports = 0.34TFE_{t-1} + 0.39RULC_{t-2} - 0.55(GDP - Full\text{-}capacity\ GDP) - 78.7$$

In this model we have:

- ❑ Twelve variables, of which five are endogenous (determined by the model — *TFE*, *Consumption*, *GDP*, *Imports* and *RPDI*) and seven are exogenous (we take them as given, determined outside the model — *Investment*, *Government spending*, *Exports*, *Taxes*, *Subsidies*, *RULC* and *Full capacity GDP*).

- ❑ Two behavioural equations (the consumption and import functions).

- ❑ Three identities (describing relationships that are true by definition — the definitions of *TFE*, *GDP* and *RPDI*).

This shows that even in a model which is essentially nothing more than the simplest income-expenditure model we are beginning to get something that, at first sight, looks more complicated than many textbook models. We have three identities, for example, because we have what are essentially three definitions of income, each relevant for a different purpose. As models become more complicated such identities proliferate.

All the models listed above, however, have far more than 12 variables. These additional variables arise because several things need to be introduced to get a useful model.

- *Disaggregation*. All the components of GDP in the model we have just discussed are often broken down into smaller components. Consumption, for example, is usually broken down into spending on durable goods and non-durables, on the grounds that the determinants of these are quite different from each other. Investment is divided into housing, fixed investment and stock-building. Housing can in turn be divided into public and private, and the other categories of investment into government, manufacturing and non-manufacturing. Similarly, exports and imports are often subdivided into manufacturing, oil and other items. Thus, instead of five categories ($C$, $I$, $G$, $X$ and $M$) we already have 16. In some models the level of disaggregation is taken even further. The Treasury model has a particularly detailed treatment of the public sector, which is the main reason why it has so many more variables than any of the other models.

- *The financial sector*. Interest rates and the exchange rate are important variables which have to be determined. Here too, it is possible to disaggregate, having equations to determine not simply 'the' interest rate, but a whole spectrum of interest rates and asset prices.

- *The labour market*. Employment and unemployment are key variables in any forecast, and equations are needed to link these to output. In addition, factors such as labour scarcity may feed back into output and prices.

- *Prices and wages*. Here too there is not just one wage rate and one price level to be determined. Important price levels include the GDP deflator, wholesale prices and the retail price index. Prices may be linked to costs, bringing in import prices and the exchange rate, productivity and the level of productive capacity (high capacity utilization may cause prices to rise faster). Wages may be different for different types of labour (e.g. manual and non-manual) and for different sections of the workforce (e.g. men and women).

When all, or even some, of these factors are taken into account it is easy for models to become quite large. Of the models mentioned above, the Liverpool model stands out because there is virtually no disaggregation in it: this is the reason why it is so much smaller than all the other models.

## Why do the models differ?

One reason why models differ is that economists can easily form different views about which equations provide the best account of the data. Different statistical techniques give different results, and even where modellers can agree on what are the appropriate techniques, there is still scope for disagreement as to what constitutes the best model. It may be, for example, that we can capture the effects of inflation on consumption by bringing either the inflation rate, or some measure of the inflation tax into the consumption function. However, even if these worked equally well in explaining past consumption behaviour, they may cause us to obtain different predictions in the future.

A more important reason why the models differ is that different modellers have different views as to the structure of the economy, and as a result they construct different models. Consider three examples.

- *The LBS model* is centred around the identity whereby GDP is determined by adding up the various components of aggregate demand. It has a very detailed financial sector, in which there is a demand equation for each of a large number of assets, these demand equations determining the prices of different assets, and hence both interest rates and the exchange rate. Rational expectations are assumed in financial markets, but not in the economy as a whole. North Sea oil appears in the model, but does little more than affect tax revenues.

- *The NIESR model* is, like the LBS model, centred on the identity linking components of aggregate demand to GDP. It differs from the LBS model in that the exchange rate depends not on demands for assets, but on interest rate differentials, expectations of future exchange rate movements and changes in the balance of trade. As with the LBS model, North Sea oil production is separated out, oil production affecting tax revenues. In addition, the value of oil reserves (which depends on the price of oil) can affect the exchange rate.

- *The Liverpool model* is different from these two models in that it is a 'New Classical' model, based on the assumption that individuals have rational expectations and that supply and demand are equal in all markets, including the labour market. All the equations are thus constructed so as to embody rational expectations: wherever behaviour depends on expectations, these expectations are the same as what the model forecasts. Thus people expect inflation to be what the model forecasts that it will be. Other features that are distinctive in the model are that consumption depends on wealth, not on income, and that the PSBR and the average tax rate, not the level of government spending, are taken as exogenous.

This gives an idea of the nature of the differences between the models, though to describe the differences in any detail would take a lot more space. In addition, a catalogue of differences would mean very little without some indication of what these differences mean in practice. To see the significance of differences between models, therefore, it is best to see what happens when the models are used to predict the effects of various changes in the exogenous variables (those describing either the world economic situation or government policy). This is done in the following section.

## 12.2 COMPARISONS BETWEEN THE MODELS

### Government expenditure

The first change to be considered is the effect of a £2 billion rise in government current expenditure (i.e. not government investment). Government current spending is assumed to be £2 billion higher than it would otherwise have been in 1989 and every year after that. The multipliers resulting from the three models we shall be considering here are shown in table 12.1. All the multipliers are positive, but the

**Table 12.1** Government expenditure multipliers

| Time period | 1 year | 5 years |
|---|---|---|
| LBS | 1 | 2 |
| NIESR | 1.4 | 0.4 |
| HMT | 1 | 1 |

*Source:* G. A. MacDonald and D. Turner *The PC-Ready Reckoner Program Manual*. Coventry: University of Warwick, Macroeconomic Modelling Bureau, 1990, p. 47.

way in which government spending affects the economy is different in each of the three models.

To explain why these multipliers differ, figure 12.1 shows the effects of the rise in government spending on the growth rate of GDP, the inflation rate and the real exchange rate (the nominal exchange rate multiplied by UK prices relative to world prices). What is shown in figure 12.1 is the difference between what the models forecast with and without the £2billion rise in government spending.

- *The LBS model.* The rise in government spending raises output. This means that the real exchange rate must fall, and because the model assumes forward-looking behaviour in financial markets, this means that there is a substantial, immediate fall in the real exchange rate. This raises net exports, stimulating demand and raising the multiplier. Inflation responds only slowly, which means that the fall in the real exchange rate is not reversed by inflation, and that the rise in demand is sustained. This explains why in the LBS model the multiplier after 5 years is twice as large as the multiplier after 1 year.

- *The NIESR model.* In this model there is a large and immediate fall in the real exchange rate, similar to that which occurs in the LBS model, and output initially grows more rapidly as a result of the rise in government spending. In this model, however, the fall in the exchange rate causes a sharp rise in the inflation rate (because of its effects on import prices), which in turn leads to a reduction in the multiplier: from 1991 to 1993 growth is *lower* than it would have been had there been no rise in government spending. After 5 years the multiplier is only 0.4.

- *The Treasury model.* This contrasts with the other two models in that it does not predict any fall in the real exchange rate. There is thus no immediate effect on inflation. However, the fall in unemployment which results from the rise in GDP does eventually produce a rise in inflation.

The major reason why these three models produce different predictions of the effects of a rise in government spending is their different treatments of the exchange rate. This can be demonstrated by going through the same exercise, but instead of allowing the exchange rate to be determined by the model, assuming a constant real exchange rate.

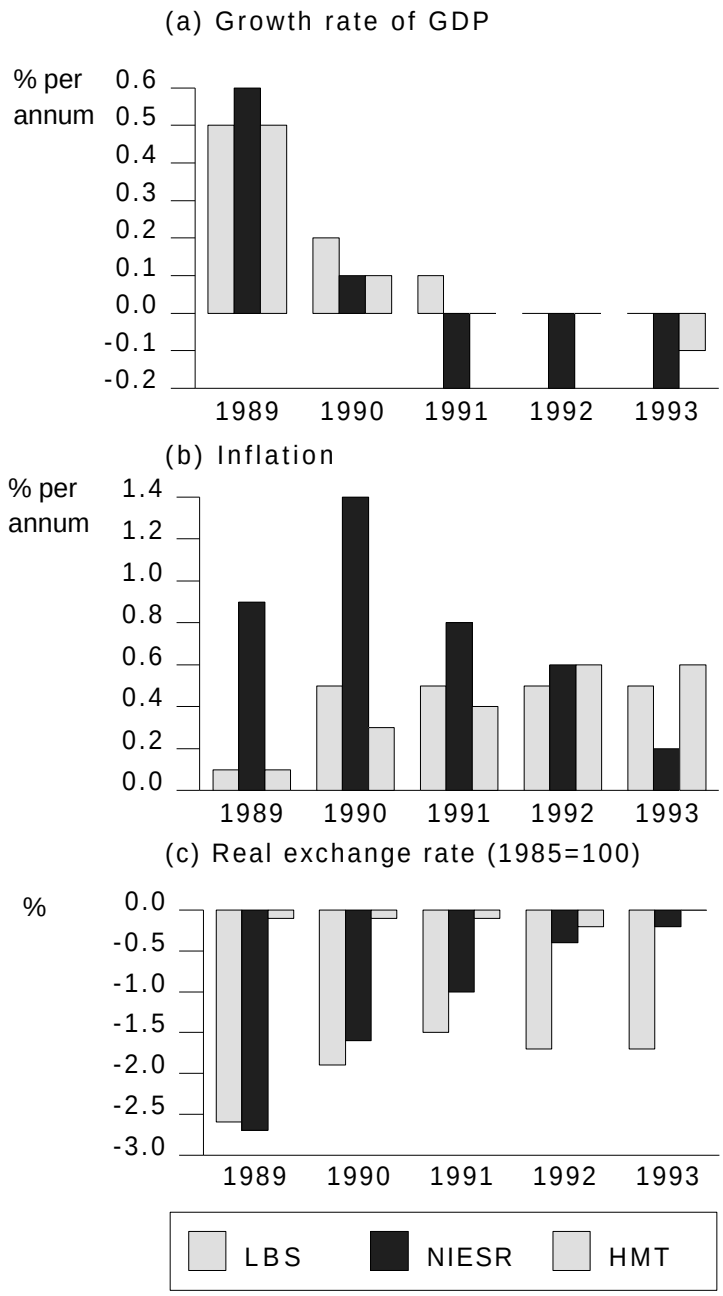


**Figure 12.1** The effects of a £2 billion rise in government spending

*Source:* Calculated using PC Ready Reckoner.

This cuts out the effects of real exchange rate changes on demand. When this is done, the multipliers produced by all three models are much closer together (all around 1).

## Interest rates

Interest rates, represented in these models by the interest rate on 3-month treasury bills, have direct effects on aggregate demand (particularly consumption and investment). In addition, interest rate changes have indirect effects through affecting variables such as wealth and the exchange rate, both of which have strong effects on demand. The direct effects are strongest in the LBS model, followed by the Treasury model, with the weakest effects being in the NIESR model. Furthermore, for some categories of spending, the effects of interest rate changes on spending are felt only after a long period of time.

Figure 12.2 shows the effect of a 1 percentage point cut in interest rates in the three models. In all of them the effect is a rise in the growth rate of GDP of about 4 per cent in each of the first two years. From the third year onwards the effects are much smaller, and in years four and five they are negative in all three models. Notice that although the *growth rate* of GDP falls in later years, the *level* of GDP is still higher than it would otherwise have been, for in all the models this fall in GDP is smaller than the initial increase (to get the overall effect on GDP we add up the changes shown in figure 12.2).

In the NIESR model an interest rate cut has effects on GDP similar to those in the other models, despite the NIESR model's very low interest-elasticities of consumption and investment. The reason for this is that the interest rate cut produces a fall in the exchange rate, which in turn stimulates demand. The mechanism whereby this happens is worth considering in detail, because it is very similar to what is happening in the exchange rate overshooting model discussed in box 11.2. The model assumes that interest rate parity holds, so that the domestic interest rate plus the expected appreciation of the exchange rate equals the world interest rate. It is further assumed that the interest rate cut will last for the five years that are being forecast, and that interest rates will revert to their normal levels after that. For interest rate parity to hold, therefore, the exchange rate must immediately fall (i.e. in 1989) just far enough that it can rise at 1 per cent per annum for the next four years and return to its original level. This means that the exchange rate has to fall by very nearly 4 per cent in 1989, rising at 1 per cent a year from 1990 to 1993. This is

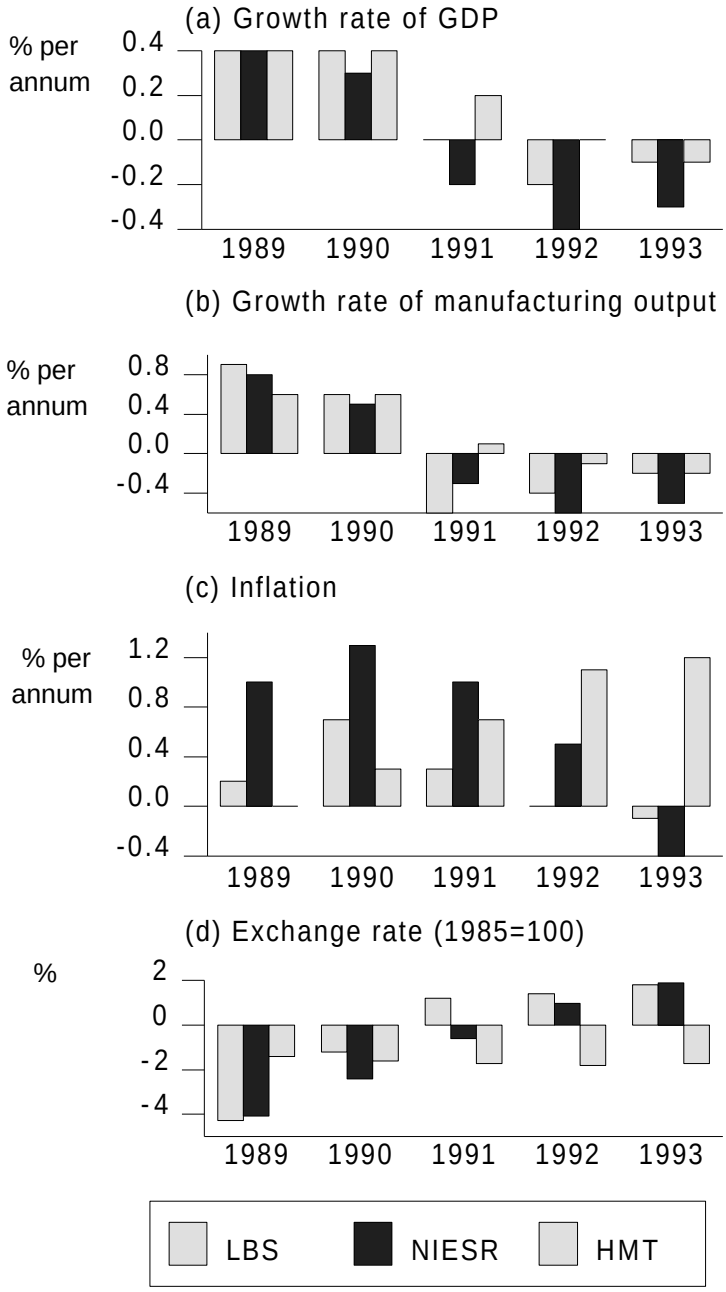


**Figure 12.2** The effects of a 1 per cent cut in short term interest rates

*Source:* Calculated using PC Ready Reckoner.

approximately what is shown in figure 12.2(d) (because other things are going on in the model as well as this, the effects are slightly different).

It is worth noting that in the Treasury model the exchange rate effects are small, but against this interest rate cuts have larger effects on demand via the income effects of lower mortgage payments.

In all the models lowering interest rates raises inflation, as is shown in figure 12.2(c). The LBS model assumes that prices are relatively sticky, so the inflation effect is very small. In the NIESR model there is a large initial effect, because the exchange rate affects import prices. The Treasury model predicts increased inflation towards the end of the five-year period, this being the result of lower unemployment. Note that the inflation rate given here is the consumer price index (i.e. it covers those items of consumer spending which enter GDP). Normally this gives results similar to the RPI, but in this case the two indices behave differently, the reason being that interest rates affect mortgage costs, which appear in the RPI but not in the consumer price index.

### North Sea oil production

In view of the discussion in chapter 9 it is interesting to consider the effects of changes in oil production in these models. Figure 12.3 shows the effect of a cut in oil production of 10 million tonnes (about 10 per cent of production). We do not consider the effects of a change in the price of oil because, although it appears in the models, an important aspect of any change in oil prices is its effect on the world economy. These models contain no means of predicting how a change in oil prices will affect either world inflation or the level of world demand.

In all the models the fall in oil production produces a fall in GDP of about 0.4 per cent. This is the direct effect caused by oil production being a component of GDP. There are then small effects in subsequent years, these being the result of the fall in the real exchange rate (figure 12.3d) stimulating demand. There is a small fall in the real exchange rate in the LBS model, a larger one in the NIESR model, and none at all in the Treasury model. If the real exchange rate were held constant, changes in North Sea oil production would have virtually no effect on the rest of the economy.

## 12.3 THE USEFULNESS OF LARGE-SCALE MACROECONOMIC MODELS

Evaluating macroeconomic models such as those discussed in this chapter is a very complicated exercise. The obvious way of doing this is

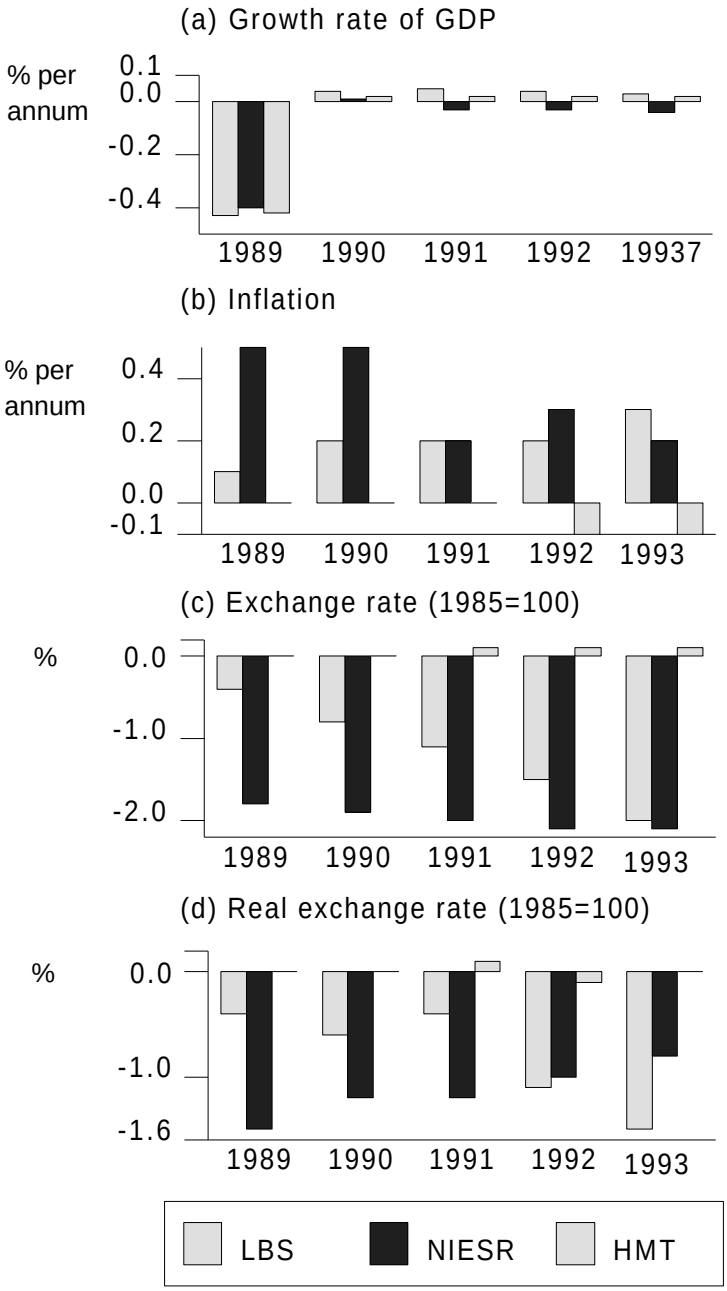


**Figure 12.3** The effects of a 10 million tonnes reduction in North Sea oil production

*Source:* Calculated using PC Ready Reckoner.

through their forecasting performance, working on the assumption that a better model will forecast better than a poor one. This is, however, a much more complicated task than it might seem. There are several reasons why the forecasts produced using a particular model can be wrong: the exogenous variables may have been predicted incorrectly; the forecasters may have made inappropriate *ad hoc* adjustments to the models' predictions; or the models may be inadequate.

- ❑ The exogenous variables may have been predicted incorrectly. This is not always the fault of the forecasters. For example, the NIESR's forecasts are based on the assumption of unchanged government policy. If the forecast is of, say, high inflation, this may cause policy to change, with the result that the forecast is not fulfilled. This does not reflect badly on the forecasters. In addition, some variables are inherently difficult to predict. Movements in the price of oil, which depend on political factors, are a good example: it would have been difficult for economists to predict the extent and timing of the major oil price changes which took place during the 1970s and 1980s.

- ❑ The forecasters may have made *ad hoc* adjustments to the forecasts generated by the models. The need for this arises because forecasters frequently have reasons to believe that the outcome is going to be different from what the model predicts. They thus adjust the predictions, using extra information to improve on the model's predictions. Usually this process reduces forecast errors, but if forecasters get it wrong it contributes to them. This and the problem of forecasting exogenous variables means that assessing forecasts made by a forecasting team using a particular model is not the same as assessing the model's forecasts.

- ❑ The model may be inadequate in that the equations may be incorrectly specified, important variables may have been left out or estimates of coefficients may be incorrect.

If the model is inadequate in the sense that its predictions are inaccurate even when the exogenous variables are correctly forecast and when any inappropriate adjustments are taken away, this may be due to a number of reasons. It may be that the model is wrong, in that the equations simply do not describe the way the economy works. Alternatively, it may be that crucial data have been changed. GDP figures, for example, are estimates and are routinely revised, sometimes

by substantial amounts. Or it may be that there has been a structural change in the way the economy works: that the model was adequate, but is so no longer.

A further problem arises in that we are concerned with a range of macroeconomic variables. Any assessment of different models thus depends on how these variables are weighted: on which of them is most important. During the mid-1980s, for example, the LBS was the best at predicting growth and inflation, whereas the NIESR was best at predicting unemployment.

The result of this is that it is difficult to use forecasting performance to say with any degree of certainty which model provides the best analysis of how the economy works. This does not mean that these models cannot be used to draw conclusions about economic policy. They can. It means rather that great care must be exercised when drawing conclusions from the models: results should not be accepted without understanding what features of the models generated them.

## FURTHER READING

Straightforward introductions to forecasting models and to the major UK models are given by Giles Keating *The Production and Use of Economic Forecasts* (London: Methuen, 1985); K. Holden, D. A. Peel and J. L. Thompson *Modelling the UK Economy* (Oxford: Martin Robertson, 1982); M. J. C. Surrey 'Modelling the economy', in D. Morris (ed.) *The Economic System in the UK*, 10th edition, 1985, chapter 14. The major work on evaluating and comparing different forecasting models is undertaken by the Macroeconomic Modelling Bureau at the University of Warwick. The most recent assessment of comparative model properties is P. G. Fisher, D. S. Turner, K. F. Wallis and J. D. Whitley 'Comparative properties of models of the UK economy', *National Institute Economic Review*, 133, August 1990, pp. 91-104. The previous such survey was in the *National Institute Economic Review*, 129, August 1989, pp. 69-87. Before that the surveys, together with other exercises in evaluating the different models, were published in a series of books under the title *Models of the UK Economy: a [Second/Third/Fourth] Review*

*by the ESRC Modelling Bureau* (Oxford: Oxford University Press, various dates).

Anyone wishing to understand the way the models can be used to evaluate the effects of changes in macroeconomic policy and in the world environment should explore the 'Ready Reckoner' programme produced by G. A. MacDonald and D. Turner, available from the Macroeconomic Modelling Bureau for (at the time of writing) a nominal charge. Accompanying the programme is *The PC-Ready Reckoner Program Manual* (Coventry: University of Warwick, Macroeconomic Modelling Bureau, 1990). This is more than just a programme manual, for it explores what is happening in the model. The important parts of chapter 12 were based on this manual.