Econometric Macro-Model Building in the Irish Context

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SECTION 4: ECONOMETRIC MACRO-MODEL BUILDING IN THE IRISH CONTEXT

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Building an econometric macro-model of any country involves a major commitment of resources—research and clerical manpower, and computer time. This is so because, if it is to be useful, the model must reflect as accurately as possible, and in some detail, the complex interaction of forces that generate the time path of the national economy. This can only be done—if it can be done at all—by a close union of detailed, expert opinion on the structure of each sector of the economy and ingenious, tedious experimentation in the econometric field. A model of the national economy is more than a collection of sector by sector studies because great care must be taken to specify the interaction of the sectors, but the link between the macro-model builders and the economists who have specialised in various facets of the economy (such as consumption-savings behaviour, price formation etc.) must be very close. Since it may not be unreasonable to spend over a year producing a worthwhile study of one aspect of the national economy, obviously the time to be allocated for producing a useful macro-model must be measured in years. Klein puts it as follows:

> To build a realistic model of the American economy requires a year in data collection and preparation, another year in estimation with much experimentation following both false and fruitful leads, and finally years more of testing the model, applying it to practical problems. Every two or three years the model must be revised to keep it up to date. The magnitude of the effort involved is a definite drawback of the approach. [7, p. 269].

Unfortunately, the effort required is in no way proportional to the size of the country!

What will a satisfactory completed model look like?

The answer to this question changes with the growth of experience in model-building. Economic theory continually suggests new relationships to be included, more data are continually becoming available (the greatest change in this area has been the growing availability of quarterly series), and data processing facilities grow in size and productivity.

Most macro-models are attempts to translate the skeleton of the Keynesian system into a usable, quantified picture of how an economy actually works. For this reason, the following basic framework is still discernable beneath even the most elaborate of the macro-models that have been built: a consumption (or savings) function, an investment function, a demand for money equation, a production function, and a demand for labour equation. A model of this sort can preserve the main features of the Keynesian or post-Keynesian system and allow simultaneous determination of key macro-economic variables such as Income, Consumption, Interest and Employment. (cf. Klein, [6, Chapter 8]). These variables are 'explained' in terms of 'given' magnitudes, the so-called 'exogenous variables' (e.g. foreign economic conditions, technical change, weather), and lagged values of the endogenous variables. It is not an injustice to say that all macro-models are basically elaborations of this framework, elaborations suggested by the need to recognise specific characteristics of the country under study (in the Irish case, for example, very special care would have to be devoted to the specification of labour demand and supply equations), and by the hope to increase accuracy by disaggregation (considering the different components of investment separately perhaps, instead of merely an aggregate investment function). All too often, compromises with theoretical preferences regarding the specification of the model are forced on the model-builder by the limitations of available data.

These points can be concretely illustrated by considering the evolution of various models of the U.S. economy in the last thirty years. (My discussion draws on Nerlove's convenient article [12] and dispenses with references to the original sources). Tinbergen's League of Nations model (1939) was based on 13 annual observations, used to 'explain' the behaviour of 14 endovariables. The Klein and Klein-Goldberber models (1955) used 20 observations (annual), including pre- and post-war years, to 'explain' 14 endovariables: the main improvement over Tinbergen consisted in the use of a more elaborate statistical procedure and incorporation of more sophisticated post-Keynesian theories in many equations. Suits' model (1962) used annual first differences (that is, the year to year changes in annual data) for 14 years to 'explain' 21 endovariables. Finally, the Brookings-SSRC model (1965 and ongoing) based mainly on quarterly data, used 60 observations, to 'explain' 272 endovariables. The progression has been towards the use of more data, far greater sophistication in the theoretical underpinnings of the equations, and disaggregation into smaller and smaller subsectors (this latter development especially noticeable in the Brookings model). Most spectacular of all, perhaps, but somewhat peripheral to the economic content of the models, has been the elaboration of statistical procedures used, from Ordinary Least Squares, to Limited Information Maximum Likelihood or Two Stage Least Squares, the last two techniques having been developed specifically by econometricians to deal with the problems arising from simultaneous equation estimation.

The contrast between the Klein-Goldberber investment function [8, p. 10] and the corresponding section of the Brookings model [4, Part II] illustrates the advances in econometrics in the post-war period: the K-G model made gross private domestic capital formation a function of lagged disposable non-wage income plus depreciation allowances and retained business profits, lagged value of end-of-year stock of capital equipment, and lagged end-of-year company liquid assets (all expressed in constant prices). In the Brookings model, producer investment decisions are dealt with for four separate sectors (durable and non-durable manufacturing, the distribution sector, and the rest of the economy), and each sector has an inventory investment equation, a fixed capital formation *intentions* (appropriations) equation, and an equation relating actual capital expenditures to intentions (realization function). In addition, there are separate supply and demand equations for new residential construction, consumer durable (especially car) expenditure, and of course farm investment is treated extensively in the separate sub-model of the agricultural sector. Each of these groups of equations has been worked on separately by one expert or more who were established authorities on the sector in question. A further elaboration of the model is to translate the disaggregated demand variables obtained from the main model into required output on the industry level through linkage with an input-output model (Cf. David T. Kresge's contribution in [4a]).

One of the reasons for the enormous increase in the complexity of macro-models over the post-war period has been the tendency to disaggregate, so that many more sectors and sub-sectors are dealt with in separate sub-models. The logic of this course of action is appealing, since it allows so much more detail to be incorporated into the model. However, the pay-off of disaggregation in terms of more accurate forecasts has not been firmly demonstrated, and it is possible to maintain that if predictions of the main macro-variables is to be the primary application of the model then a fairly highly aggregated specification may perform no worse than a very disaggregated one.

I have given this somewhat detailed discussion of the existing work on model-building in order to gain perspective on the task facing Irish model-builders. We can gain from the experience of those who have tried the same task in other countries, but we face the disadvantage of some serious lacunae in the available data and the lack of a strong tradition of empirical work on various sectors of the economy. In addition, the increased theoretical and statistical sophistication of model-builders today compared with a generation ago prevents us from being justified in taking too simple-minded an approach to the problem.

What may reasonably be expected from a good econometric model?

The attempt to understand the way in which a particular economy works, and to specify this knowledge in a set of functional relationships, is obviously an important exercise in itself. A major consequence of this attempt could be increased awareness of gaps in existing knowledge about the economy and the need for further research on individual topics. Important as these benefits are, no doubt the chief attraction of macro-model-building lies in its promise of increased accuracy in the preparation of forecasts of the national economy: it is in this area that most users of models will seek the justification for the expense and trouble incurred in their construction.

The best models are explicitly acknowledged to be experimental, in a constant process of revision. They are not intended for mechanical application in forecasting or planning—that role must be reserved for the Input-Output models used by some Soviet-type planners for determining material balances in the absence of a price system. On the other hand, used sparingly and in conjunction with other, traditional sources of information for forecasting, a model can be of great benefit. A good example of this limited application was the use made of Brookings and other models of the U.S. economy in helping to pin down the impact of the 1964 tax-cut on consumption [4a, Part VII]. The Dutch have used their models over the years to help formulate fiscal and monetary policy, especial care being taken to evaluate the measures needed to correct balance of payments difficulties.

The Dutch have a long tradition of sophisticated applied econometrics and long experience in the area of using models as an aid to macro-management (the first macro-model was published in 1955, and is continually being improved and worked on). The main application of the Dutch model is to obtain forecasts of the key macro-variables for one year ahead. The actual data (when they become available) are then compared with the forecasts, and the performance of the model evaluated in this light. All of the equations are specified as year to year percentage changes. Despite all these advantages, the performance of the model has recently been summarized as 'hardly a brilliant record', with average prediction errors running about 40 per cent of the normal rate of change of the variables [10, pp. 295 ff.]. Of course, the accuracy of the predictions varies between the different sectors of the economy: personal consumption has generally been very accurately forecast, for example, while a poor performance has been recorded for inventory investment and non-wage income. The general tendency appears to be for the overall performance of the models to have improved over time.

A more complete, systematic evaluation of econometric models has been reported by Stekler [16]. He compared the forecasts obtained from some of the moderately elaborate U.S. models with those obtained by various naive methods (basically, using the assumption that the change in a variable from this period to the next would be the same as that from last period to this). The results were mixed, and the reader is referred to the original article for a detailed commentary and quantified evaluation of the various models. The overall conclusion may be cited: "The combination of all the results suggests that econometric models have not been entirely successful in forecasting economic activity". (Ibid. p. 463). Stekler's research shows how hard it is to establish a clear-cut superiority for econometric-based forecasts over those relying on naive methods.

The burden of this discussion is not to suggest complete scepticism as regards the value of model-building, but rather to underline the magnitude of the task and its cost, and the comparatively small results that may be hoped for in the initial stages. On the other hand, I am firmly convinced that much, if not all, applied econometrics derives its main justification from its potential contribution to a usable macro-model. If we seriously believe that we can explain the behaviour of individual sectors and sub-sectors of the Irish economy, then some day we should be able to incorporate our partial insights into a workable model of the whole economy. At the same time it seems to me that an equally valid viewpoint consists in saying that the time has not yet come for the step of model-building, since too much is still unknown on the sectoral level. In any event it is indisputable that the commitment to model-building will result in a waste of resources unless it is understood to be ongoing, providing funds for continual revision and updating.

The Irish Context

At the onset, the particular problems facing the model-builder in Ireland must be stressed. National accounts data are available on an annual basis only. Over the post-war period the economy has been undergoing considerable structural change—associated with industrialization and changing emphases in government economic policy—and it may be questioned whether the underlying behavioural patterns have remained sufficiently stable to allow us to treat even the small number of observations at our disposal as forming one sample. Irish data (like all others) are subject to serious revisions, so that it is always many years after the publication of preliminary estimates before the final figure becomes available: in the 1963 *National Income and Expenditure* (published in 1964), for example, the preliminary figure for national income in 1963 was £672 million, while the 1968 *NIE* (published in 1970) gave a figure of £677.2 million for 1963 national income, and further revisions will probably be made. In comparison with many countries that have developed working econometric macro-models based on national accounts data, the time lag in the publication of even the preliminary estimates of the Irish national income data is so long as virtually to exclude the use of a macro-model for the preparation of helpful forecasts. If one uses an estimated model to 'predict' two years beyond the sample period for which it was estimated, in the Irish case the 'forecasts' thus prepared would at best apply to the national income magnitudes of the year in which the 'forecasts' were being prepared. Using the model to prepare genuine forecasts of future levels of GNP would involve using it for further beyond the sample period than can normally be expected not to result in serious inaccuracy.

In addition to data problems, the Irish model-builder is also hampered by the paucity of empirical studies of individual sectors of the economy. Although there has been a very dramatic increase in the output of empirical economic research in Ireland in the last decade, there are still some important sectors of the economy on which there is no usable empirical work.

Despite the fairly sceptical note I have sounded up to this point, I should like to present an outline of a model which I believe has some merit as a starting point for discussion. Originally this specification formed part of a larger project,* in which the model was estimated and applied to the task of forecasting: some references to the outcome of these tests will be made below, but for the most part the present discussion is deliberately non-empirical. The main point of this discussion is pedagogic, and it will have attained its purpose if it serves merely as a starting point for other ventures in this area.

Technical Note

The model discussed below is a simultaneous equation system, which shares with most macro-models the property of over-identification. The single-equation estimation technique of Ordinary Least Squares (OLS) yields biased and inconsistent estimates of the parameters of such a system. A great deal of effort has been devoted in recent years to experimentation with alternative procedures, with Two Stage Least Squares (TSLS) finding some favour as a convenient and 'well-behaved' alternative. TSLS estimates are also biased, although they are consistent. In a model of the sort presented below, however, with only 19 observations and 25 predetermined variables, it is impossible to estimate the reduced-form equations (the endogenous variables each expressed as a function of all the predetermined variables), and thus only a modified form of TSLS is feasible, whose sampling properties are not well established. A possible solution to this problem consists in performing a principal component analysis of the predetermined variables and using the first half-dozen or so components as regressors in the reduced-form equations (cf. the discussion of estimation problems by Franklyn M. Fisher, in [4]).

The Structural Equations

Using annual observations, 1944-62, the following relationships were estimated. The data on earlier years were included at serious risk of errors in measurement, and if the model were to be re-estimated these years would no doubt be replaced with more up-to-date observations. Only the specification of each equation is recorded here, since the main focus of the discussion is on the type of model that should be specified. The general specification of each equation was dictated by broad theoretical considerations, but the form of the equation finally incorporated in the model frequently reflects feedback from the empirical results. For example, the decisions to use an output variable to help explain industrial capital formation is in keeping with a broad class of accelerator-type models of investment, but the actual choice of $\frac{1}{2}(Q + Q_{-1})$ instead of Q, Q_{-1} or ΔQ, for instance, was dictated by the results from experimentation with the various alternatives.

The variables are defined as they were incorporated in the model, but it by no means follows that this is how they would be defined if the model were to be up-dated. The availability of an official, constant price series on national income going back to 1947 now makes it feasible to substitute this series for the various deflated series I had to use. The implicit price deflators of GNP could now be substituted for the price indexes I used.

Equation No.

1. Industrial Production Function
$$Q = a + b\,(E_i H) + c\,(M_{nc}P_m) + d\,(t)$$

2. Industrial Production Decision
$$Q = a + b\,(C+V+G)/P + d\,(X_{na}/P_{na})$$

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* This model was completed in 1966 as part of my work for a Ph.D. degree at Boston College. I am grateful to Professor Kanta Marwah (now of Carleton University, Ottawa) for her extensive involvement with this work.

3. Agricultural Production Function

$(A/E_a) = a + b\,(R/E_a)$

4. Agricultural Production Decision

$A = a + b\,(X_a/P_a) + b\,(S/AP_a)_{-1} + c\,(A)_{-1}$

5. Consumption Function

$(C/NP) = a + b\,(AP_a/E_aP) + c\,(Z/E_iP) + d\,(WH/P)$

6. Industrial Capital Formation

$(V_m/P) = a + b\,(N) + c\,(Z'/P) + d\,\tfrac{1}{2}\,(Q + Q_{-1})$

7. Agricultural Inputs Demand

$R = a + b\,(AP_a)_{-1} + c\,(R)_{-1}$

8. Consumption Imports Demand

$(M_c/P_m) = a + b\,(C/P) + c\,(T_mP_m/MP)$

9. Non-Consumption Imports Demand

$(M_{nc}/P_m) = a + b\,(Q) + c\,(T_mP_m/MP)$

10. Agricultural Exports Demand

$(X_a/P_a) = a + b\,(X_a/P_a)_{-1} + c\,(GNP_{uk})$

11. Non-Agricultural Exports Demand

$X_{na}/P_{na} = a + b\,(GNP_{uk}) + c\,(P_{na}/P_{wuk})$

12. Profit Level Determination

$(Z/P) = a + b\,(Z/P)_{-1} + c\,(Q/E_iH) + d\,(\Delta Q)$

13. Company Savings Functions

$Z' = a + B(Z) + c\,(Z - Z' - T_z)_{-1}$

14. Wage Rate Determination

$\Delta WH = a + b\,(\Delta P) + c\,(U + Em) + d\,(\Delta Z)$

15. Non-Agricultural Price Formation

$P_{na} = a + b\,(WHE_i/Q) + c\,(P_m) + d\,(T_i/QP_{na})$

16. Agricultural Price Formation

$P_a = a + b\,(P_a)_{-1} + c\,(S/AP_a)$

17. Interest Rate Determination

$r = a + b\,(M_s/GNP) + c\,(r_d) + d\,(A_e/L)$

18. Labour Supply

$LS = a + b\,(W/P) + c\,(N)$

19. Hours worked

$H = a + b\,(\Delta Q) + c\,(H)_{-1}$

20. Weights of Price Index

$P = a\,(P_{na}) + b\,(P_a)$

21. National Income Identity

$GNP = C + G + V + X_a + X_{na} - M_c - M_{nc} +$ (Balance of Payments, non-merchandise) + (Value of physical Changes in Stocks).

List of Variables Used in Model (Alphabetical Order)

A^*	=	Volume of net output of agriculture, excluding changes in livestock.
A_e	=	Net external assets of the banking system.
C^*	=	Personal Consumption expenditures on goods and services.
E_a^*	=	Number of males engaged in farm work, June census.
E_t^*	=	Employment in transportable goods industries.
G	=	Net expenditure by public authorities on current goods and services.
GNP_{uk}^*	=	Gross domestic product, UK, 1953 prices.
H^*	=	Average hours worked by adult wage earners in transportable goods industries.
L	=	Within-the-state liabilities of the banking system.
LS	=	Labour supply (= sum of employment, unemployment and emigration).
M_s	=	Money supply (= current outstanding plus within-the-state current deposits of commercial banks).
M_{nc}^*	=	Imports of non-consumption goods, value c.i.f.
Mc^*	=	Imports of consumption goods, value c.i.f.
N	=	Estimated mid-year population.
P^*	=	Consumer price index (all items).
P_a^*	=	Price index of agricultural products.
P_m^*	=	Import price index.
P_{na}^*	=	Price index of output of industry.
P_{wuk}	=	UK wholesale price index.
Q^*	=	Index of volume of output of transportable goods industries.
R^*	=	Value of (non-labour) input of agriculture (i.e. purchases and feeding stuff, fertiliser, etc.).
r^*	=	Weighted average of Irish government security yield.
r_d	=	Central Bank discount rate.
S	=	Value of major items of livestock on farms.
T_i	=	Excise and Sales tax receipts.
T_m	=	Value of duties on imports.
T_z	=	Value of Profit Tax receipts.
t	=	Time, in years—1944.
$U+E_m$	=	Sum of percentage of labour force unemployed and net emigration rate per 100 population.
V	=	Gross domestic fixed capital formation.
V_m^*	=	Gross domestic capital formation in manufacturing industry.
W^*	=	Index of hourly wage rates, industrial occupations.
X_a^*	=	Value of agricultural exports.
X_{na}^*	=	Value of non-agricultural exports.
Z^*	=	Trading profit of (private and public) companies.
Z'^*	=	Value of after-tax profits, less dividends.

* = endogenous variable. (All variables were included as index numbers to base 1953 = 100 in the estimated model.)

Space does not permit an adequate discussion of the data and transformations used in constructing the time series, but the following important points may be noted. A number of the series were not available continuously for the sample period, and various methods were resorted to reconcile the available series. For example, the volume index of agricultural net output for the years 1944-45 had to be linked to the new series to base 1953. The same problem arose with R (value of agricultural inputs) and P. V_m was obtained from UN data for the earlier years, and this series is likely to be seriously inaccurate for the pre-1947 period. P_{na} was calculated for the pre-1953 years on the basis of the old series for 'simply transformed' and 'more elaborately transformed' goods and their correlation with the price of output of industry since 1953. S was based on Nevin's figure for 1954 [13], updated through the figures published annually for changes in the value of livestock on farms.

The structure of the model can be explained through an equation-by-equation discussion, although it should be emphasised that the system is an inter-dependent set of equations, and hence looking at each equation in turn is only part of the story: the whole should be more than the sum of the parts. The 21 endogenous variables are Q, E_i, H, A, E_a, M_{ne}, R, M_c, C, P, Z, Z′, W, V_m, X_a, X_{na}, r, P_{na}, U, P_a, GNP. The agricultural and industrial production and production decision functions aim at the determination of output and the labour input in each of these sectors. The industrial production function relied heavily on an omnibus trend variable, while the agricultural production function tried to overcome the problem of the strong negative trend in the agricultural labour force by specifying the relationship between input and output in *per caput* terms. Ideally, the industrial production function would contain an explicit measure of the capital services input to the manufacturing sector. The agricultural production sector should be specified in much greater detail (distinguishing between the various livestock and crops products, with a far more detailed specification of the non-agricultural input demand, perhaps linked into an input-output model of the farm sector). Some progress has been made in this area recently [5, 15]. The consumption function was specified so as to isolate the impact of increases in three different types of income on C, namely agricultural income, profits and wages income. No simple marginal propensity to consume can be calculated because the impact of an increase in income on consumption is seen to depend on the sector distribution of this increase. The specification could be improved, perhaps, by addition of a variable measuring the distribution of the labour force between agriculture and the rest of the economy.

Industrial investment was 'explained' in terms of company profits, a moving average of production and of interest rates. It would clearly be desirable to experiment with alternative specifications of the financial variables, using more up-to-date series, because their inclusion in this equation is crucial in establishing a link between the 'monetary' and 'real' sectors of the economy, and hence facilitating measures of the impact of monetary policy. All investment other than V_m is treated as exogenous in this model, but it would be worthwhile attempting to include items such as housing expenditures, as well as those parts of the government's capital budget that might be influenced by economic considerations. In the light of recent experience in Ireland, a usable model would also have to attempt to include a balance of payments sector, with emphasis on the capital flow: the difficulties of this extension need hardly be stressed.

The two-sector import equations relate imports to a domestic activity variable and a relative price variable (the use of the same price variable in the two equations was dictated by data availability for the earlier years). Recent work on imports by McAleese, and Baker and Durkan [11, 1] go far beyond these equations in detail and refinement, and suggest improvements that could be readily incorporated into the model.

Company profits were related to productivity and changes in output, the latter as a measure of the effect of cyclical changes in output on profits. Company saving is related to total profits and lagged distributed profits (the negative coefficient for the latter variable indicating that the higher past dividends were, other things being equal, the lower current savings are: companies try to maintain their level of dividends).

Adequate specification of a wages-prices sector is of crucial importance in allowing us to understand the process by which inflation is generated in the Irish economy. In this area in particular the need for explicit recognition of interdependence is great, since neither 'cost-push' nor 'demand-pull' by itself constitutes more than one blade of a scissors. It seems *a priori* more reasonable to discuss changes in wages, rather than their level. The role of unit labour costs, import prices and indirect taxation in determining industrial prices on the one hand, and price increases, profits changes and the condition of the labour market in determining the rate of change of wages, on the other, have been explored in much greater detail (but with substantially similar conclusions) by O'Herlihy, Cowling, and Black, Simpson and Slattery [2, 3, 14]. This segment of the model could be dissaggregated by industry, although the increase in predictive accuracy might not warrant the extra work involved. A simple extension that would add greater realism to the labour supply equation would include Em as an endogenous variable, along the lines studied by O'Herlihy and Walsh [14, 18].

The agricultural price formation equation relied exclusively on a distributed lag relationship with livestock levels to indicate supply conditions. An alternative would be to specify agricultural prices as exogenously determined in the U.K. market, but it was found that even if U.K. prices were used instead of $(P_a)_{-1}$, the stock variable still added significantly to the explained variance. The interest rate-liquidity preference function showed a positive relationship between income-velocity and interest, with the discount rate an important influence on the interest rate. The value of the British Bank Rate gave equally good results when substituted for r_d. The ratio of (net) external assets to domestic liabilities of the banking system exerted a negative influence on the interest rate. This is a very simplified monetary sector, and additional work would probably move in the direction of including M_s, A_e, L and r_d as endogenous variables. This extension of the model, taken in conjunction with the additional work on the determinants of investment demand outlined above, would be very desirable from the viewpoint of studying the role of monetary policy in controlling the economy.

The labour supply equation as specified is not very satisfactory. There is need for far more detailed statistics on the size and composition of the labour force before it will be possible to explore fully the relationship between changes in population and in measured labour force. Certainly, emigration should be included as an endogenous variable and possibly also population, since in the Irish case the principal determinant of short-run fluctuations in the domestic population is the level of net migration. If employment, emigration and population were endogenously determined it would be possible to study the year-to-year changes in participation rates and to extend the concept of measured unemployment to include the 'discouraged workers'.

The role of the industrial production function is to determine the demand for labour in the industrial sector, given the level of output (from the industrial decision function) and the level of non-labour inputs (trend is exogenous, and non-consumption imports are determined in the import equation). Similarly, the agricultural production function determines the demand for agricultural labour, although clearly the existence of under-employment in family farming means that the actual level of agricultural employment reflects non-market considerations to a very important extent. A major gap in the present model is the fact that the remainder of employment in Ireland (namely employment in the service and government sectors) is assumed exogenous: it would be relatively easy, of course, to describe the pattern of this employment over time using a trend variable, or linking it to GNP, but there is a need to try to develop production functions for these sectors of the economy.

When applied to the task of forecasting the values of endogenous variables for years outside the sample period the model's performance was reasonably satisfactory. In a number of cases the actual values of the exogenous variables were not known for the post-sample years (a factor that should be kept in mind in building models of this type is how easy or difficult it will be to obtain the values of key exogenous variables for forecasting purposes), and their values had to be estimated or assumed from a number of sources. Some simplifications of the model's structure were necessary, since the non-linearities in the original presented difficulties in the process of solving for the values of the endogenous variables. The forecasts obtained were reasonably accurate for the majority of the endogenous variables with a mean absolute forecast error equal to 3.4 per cent of the actual values in the first post-sample year. The forecasts for agricultural exports, unemployment, non-consumption imports and company savings were noticeably inaccurate: omitting these variables the mean absolute forecast error was 2.1 per cent.

The highly inter-related nature of the structural equations becomes very clear when the model is applied to the task of forecasting. With a few exceptions it is not possible to express the endogenous variables as functions of the exogenous variables alone. Almost all the equations contain more than one endogenous variable, and hence groups of equations have to be solved simultaneously. It is possible to deal with one block first — that containing the two export equations, the agricultural production, production decision and price level equations. When the equations of this block had been solved, the resulting values of the relevant endogenous variables could be used as 'exogenous' to the block comprised by the remaing equations, with the consumption function providing the link. An important feature of the model is that although the consumption function and import and export equations are specified in real terms, the import and one of the export equations contains relative price terms, and thus the wage-price formation equations are not a separate block of equations, unlinked to the 'real' sector of the model.

The model is reasonably complete as far as the expenditure side of the national accounts is concerned: C, V_m, X_a, X_{na} are all endogenous variables. Non-manufacturing investment, however, is assumed exogenous, and this represents a serious gap which could be partly closed by an equation explaining the behaviour of housing investment. It would obviously also be helpful if G were included as endogenous, perhaps along with the various tax receipts variables. On the production side only Q and A are endogenous, and the output of the non-manufacturing, non-agricultural sector is treated as exogenous. As stressed earlier, it is very desirable that explicit production functions be estimated for this sector, although the data and conceptual problems involved are very considerable. A similar point may be made with respect to foreign trade: the model confines its attention to merchandise trade flows, partly for the very simple reason that these are better documented than the rest of the balance of payments. In view, however, of the crucial role of invisible trade and capital flows in the Irish economy, there is a high priority for work on these aspects of the foreign sector.

Conclusion

This article has aimed at providing an appreciation of the role of one type of applied economics in the formulation of economic policy. A review of the difficulties inherent in macro-economic model building has been presented and illustrated by reference to an outline model of the Irish economy. The opportunity has also been availed of to discuss how recent empirical research on the Irish economy might be incorporated into an econometric model, and the nature of the major gaps in research that remain.

An alternative approach to econometric forecasting, which is complementary to the type of model-building discussed in the present paper, has been applied by Leser to the Irish economy [9]. The approach taken by Leser was designed to check the consistency of an overall forecast of economic growth with the behaviour of the components of final demand rather than to study the behavioural structure of the economy. The sort of model that has been discussed in this article is concerned above all with allowing policy-makers study the impact of changes, for example, in exports, government spending, taxation or interest rates on the various components of GNP. The greater disaggregation and more elaborate specifications involved in this approach may not immediately pay off in terms of more accurate forecasts of the behaviour of the economy, but in the long-run they hold promise of such returns.

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