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A SURVEY OF MACROMODELS OF THE  
IRISH ECONOMY, 1958-1981

By

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## I. INTRODUCTION

It is often thought that scientific knowledge accumulates progressively and that the stock of knowledge is, at the very least, a monotonic function of time. If this were the case for example with macroeconomic research in Ireland, then any macroeconomic model (of whatever type) constructed at some time would incorporate all relevant insights and knowledge of models (of the same type) which were constructed at any prior time. However, it is our opinion that this highly desirable situation did not apply when one examines the history of model building in Ireland over the past two decades. In the light of this a thorough survey of macromodel building in Ireland is necessary for a number of reasons.

First, the survey is simply a statement of the historical record of work done and by whom. This is important because in many cases the research findings were never (or only incompletely) published. In addition, models were often published in a form which rendered it difficult to examine and understand from a comparative point of view, i.e. too long, too short, too cryptic, too mathematical, etc. Second, a survey is an attempt at stocktaking - where have we been, where are we now, where should we go from here? Such a stocktaking exercise attempts to distil from accumulated model research the best techniques and insights, and isolate any deficiencies which may have existed in previous work. Finally, the survey should assist in developing a "view" of the Irish economy as a result of past interactions between economic theory, actual experience, and economic data. For the purposes of this survey we have limited its scope to macromodels of the economy and have excluded models of the inter-industry (or input-output) type.

The examination of macroeconomic models is greatly facilitated by the formal and explicit way in which such models are stated. The mechanisms used

In these models and the manner in which hypotheses are formulated and tested are quite transparent. (Difficulties due to size and complexity might arise in tracing through all the channels of influence.) Indeed, if the model data were made available to other researchers, it should be possible to replicate the model construction and to arrive at the same conclusions based on use of the model.

However, in certain cases a model is not stated formally and, indeed, there may be more than one model underlying some analysis. Two such cases are included in this survey: ED - 1958 and Kennedy and Dowling - 1975. Here models of the economy are not stated explicitly and it is necessary to interpret the text in order to identify or formulae the 'underlying model'. Hence, the model is not objective in the sense of being stated by the authors. Rather it is our subjective evaluation of key variables and main causal relationships. For this reason, i.e. the non-availability of the model other-wise, we provide a schema of our version on which we base our comments. Thus, our own interpretations can also be subject to evaluation.

The main advantage of such informal or implicit approaches to modelling is that they allow for the inclusion of relationships that it may not be feasible to include by mathematical or estimation techniques. Thus special and subtle detail could easily be lost if a more stylised formal modelling approach were adopted. This indeed was the justification advanced in Kennedy and Dowling (1975) for their approach. However, what is gained in detail in this approach may hinder the development of an overall view of how the various aspects of the economy interrelate and of possible major directions of causation. In addition, a descriptive approach, where a ranking of influences and the interrelationships between them may be hidden under detail, makes it difficult to examine policy alternatives and possible future impacts of trends and development within the economy. Furthermore, there can be no empirical testing of

postulated relationships or indications of their strength and importance. In fact, even with the informal descriptive approach, it may be difficult to avoid theoretical models. The very process of data collection and examination is usually performed under the influence of model hypotheses which are often quite formalised. An example is the Kennedy and Dowling treatment of consumption and savings where a formal econometric equation was used.

For the above reasons, and in order to include implicit models on a similar footing to formal models, we identify a "core" model which is based on our interpretations of the relevant text. In this way we avoid making an extensive precis. No matter what criteria we use to identify such core models the end result remains a subjective interpretation of the authors intentions. In addition, the core model is only suggestive since, if it were to be fully formalised, it would change in size due to disaggregation and reorganisation in the light of estimation.

The remainder of this survey is organised into three sections. In section 2 a comparative overview of the macromodels proposed during 1958 - 1981 is presented. This is done in three parts. First, is a chronological bibliography of all the macromodels we were able to identify; second, a summary comparison of these models is given in Table 1. This table gives information about data periodicity, sample periods, estimation techniques, model size (equations and variables), validation, and purpose and use. Third, a more detailed overview of the coverage of eleven of these models is given in the Tables following Table 1. This is done by means of a standard table which identifies, on a macroeconomic accounting basis, the variables modelled and permits a quick evaluation of the range and depth of coverage of any model. In addition we summarise any testing or validation information which is available for a model (tracking performance, multipliers, etc.) and comment on the use to which the model was put. Section 3 contains a more

detailed description and examination of these eleven models. This is done under a set of standard headings stating purpose, main features (including discussion of key properties), validation, use, and some general comments. It should be noted that the purpose of the survey is not a critical evaluation of the individual macroeconomic models per se, although some comments with the benefits of hindsight, it should also be emphasised, are made. We are primarily concerned with surveying rather than evaluating the work done. Any attempt at proper evaluation would have to address, more closely than we can do here, the purposes for which a specific model was constructed. Our perspective is simple, the very broad one of "Models of the Economy". The models reported here were selected to be representative of the range of models constructed but also reflect the degree to which available documentation made their inclusion a matter of convenience. CB and DoF - 1981 is used as an example of the four models listed as being constructed in the Central Bank and Department of Finance. Likewise, for example, Lennan - 1972 and Norton - 1975 are taken as representative of the fiscal orientated models such as those by Clarke - 1971 and Teehan - 1972.

Since to present a complete algebraic formulation of all models would involve the design of a totally uniform algebraic notation, we have opted for a more informal approach to describing the main behavioural equations of models. Ultimately, of course, recourse must be had to the original publications and the approach here will assist in interpretation and comparison of models. As well as describing, we comment also on the properties of models and, where appropriate, on the analysis and results of using models. The final section includes some concluding remarks. A more discursive review is to be found in Connell Fanning and John Bradley, Twenty five years of Macromodelling the Irish Economy - Retrospected Prospect (mimeo 1982; Journal of Statistical and Social Inquiry Society of Ireland, forthcoming.)

II

COMPARATIVE OVERVIEW OF MACROMODELS

1958 - 1981

## Chronological Bibliography of Macromodels

ECONOMIC DEVELOPMENT-1958

Ireland. Economic Development, Stationery Office, Dublin, 1958.

Ireland. Programme for Economic Expansion, Stationery Office, Dublin, 1958.

GEARY-1964

R. C. Geary. Towards an Input-Output Decision Model for Ireland.  
Journal of Statistical and Social Inquiry Society of Ireland  
XXI (2): 1-49, 1963/4.

LESER-1964

C.E.V.Leser. The Irish Economy in 1964 and 1965. Research Paper No. 27,  
Economic and Social Research Institute, Dublin, 1965.

T. J. Baker and J. Durkan. The Updating of Certain Econometric Models.  
Quarterly Economic Commentary: 19-34. Economic and Social Research  
Institute, Dublin, September 1970.

WALSH-1966

B. M. Walsh. An Econometric Model of Ireland 1944-1962. Ph.D.  
Dissertation. Boston College, USA, 1966.

B. M. Walsh. Econometric Macro-Model Building in the Irish Context.  
Quarterly Economic Commentary: 16-26. Economic and Social Research  
Institute, Dublin, June 1970.

LESER-1967

Economic and Social Research Institute. The Irish Economy in 1967.  
Research Paper No. 39: Appendix I. Economic and Social Research  
Institute, Dublin, August 1967.

T. J. Baker and J. Durkan. The Updating of Certain Econometric Models.  
Quarterly Economic Commentary: 19-34. Economic and Social Research  
Institute, Dublin, September 1970.



STRONGE-1971

William B. Stronge. Macroeconometric Simulation of Irish Dependence on the United Kingdom. Ph.D. Dissertation. Iowa State University, 1971.

William B. Stronge. Macroeconometric Simulation of Irish Dependence on the United Kingdom. Proceedings of the American Statistical Association, Business and Economic Statistics Section: 461-466, 1972.

CLARKE-1971

E. A. Clarke. Public Capital Expenditure and Fixed Capital Formation in the Last Two Decades. Ph.D. Dissertation. University College, Dublin, 1971.

CLARKE-1972

- A. Fiscal Model.
- B. Income-Expenditure Model.

E. A. Clarke. Fiscal Model, Mimeo. n.d. 1972.

TEEHAN-1972

P. Teehan. A Macroeconometric Model for Ireland, Mimeo, 1972.

LENNAN-1972

L. K. Lennan. The Built-in Flexibility of Irish Taxes and their Contribution to Economic Stability. M.Litt.Thesis. Trinity College, Dublin, 1971.

L. K. Lennan. The Built-in Flexibility of Irish Taxes. Economic and Social Review 3 (4): 581-603, 1972.

L. K. Lennan. The Flexibility of Irish Taxes on Incomes. In A. Tait and J. Bristow, editors. Ireland: Some Problems of a Developing Economy: 68-97. Gill and Macmillan, Dublin, 1972.

ISS-1972

J. Kooyman and J. V. Alarcon, supervisors. A Macro-Economic Model for Short-Term Planning in Ireland. Mimeo. Institute of Social Studies, The Hague, 1972.

NORTON-1973

D. Norton. The Macro Stage in Irish Planning, 1958-1972: A Study in the Quantitative Theory of Economic Policy. Ph.D. Dissertation. University of California, Berkley, 1973.

D. Norton. Fiscal Policy and Growth in an Open Economy: The Case of Ireland. Public Finance XXIX(2): 168-183, 1974.

D. Norton. Estimation of the Short-Run Effects of Fiscal Policy in Ireland, 1960-1970. Economic and Social Review 6 (3): 367-386, April 1975.

SMYTH-1974

D. J. Smyth. A Simple Short-Run Macroeconomic Model of a Small Open Economy: Ireland. Mimeo. Central Bank of Ireland, Dublin, 1974.

DESMOS-1974

J. Waelbroeck and A. Dramais. DESMOS: A Model for the Co-ordination of Economic Policies in the EEC Countries. In A. Ando, et al. International Aspects of Stabilisation Policies. Conference Series No.12. Federal Reserve Bank of Boston, Boston, 1974.

SPENCER/HARRISON-1975

J. Spencer and M. Harrison. The Structure and Behaviour of the Irish Economies with an Illustrative Model. In N. Gibson and J. Spencer, editors. Economic Activity in Ireland: A Study of Two Open Economies: 1-39. Gill and Macmillan, Dublin, 1977.

KENNEDY/DOWLING-1975

Kieran A. Kennedy and Brendan R. Dowling. Economic Growth in Ireland: The Experience since 1947. Gill and Macmillan, Dublin, 1975.

WEFA-1975

Wharton Econometrics and Forecasting Associates. An Econometric Model of Ireland. Mimeo. W.E.F.A., Philadelphia, 1975.

GEARY/McCARTHY-1976

Patrick T. Geary and Colm McCarthy. Wage and Price Determination in a Labour-Exporting Economy: The Case of Ireland. European Economic Review 8: 219-233, 1976.

COMET-1976

A. Barten, G. d'Alcantara, G. Carrin. COMET: A Medium-Term Macroeconomic Model of the European Community. European Economic Review 7: 63-115, 1976.

A. Barten, et al. The COMET III Model. European Economic Community, Document II, 295/80/C. EEC, Brussels, 1980.

CENTRAL BANK-1977

A. MAXI

B. MAXI (Revised)

Research Department Staff. The Central Bank's Macroeconometric Model: A Progress Report. Technical Paper 2/RT/77. Research Department, Central Bank of Ireland, Dublin, March 1977.

J. Bradley, R. Kelleher and C. McCarthy. The Central Bank's Macroeconometric Model: Revised Estimates and Results of a Validation Exercise. Technical Paper No. 13/RT/77. Research Department, Central Bank of Ireland, Dublin, December 1977.

C. McCarthy. The Central Bank's Macroeconometric Model. Central Bank of Ireland Quarterly Bulletin: (4): 76-87, Winter 1977.

J. Bradley, C. McCarthy and T. O'Connell. The Central Bank's Macroeconometric Model: Structure, Estimation and Application. Central Bank of Ireland Quarterly Bulletin: (4): 73-98, Winter 1978.

Research Department, Central Bank of Ireland. Modelling the Irish Economy: A Progress Report on the Central Bank's Macroeconometric Model. Journal of the Statistical and Social Inquiry Society of Ireland, XXIV (I): 1-39, 1978.

C. MINI

J. Bradley and R. Kelleher. MINI-A Truncated Version of the Central Bank's Macroeconomic Model. Technical Paper No. 10/RT/77. Research Department, Central Bank of Ireland, Dublin, August 1977.

John Bradley and Robert Kelleher. Studies in Optimal Control I - Modifications to the MINI Model and a Preliminary Specification of a Welfare Function. Technical Paper 7/RT/78. Research Department, Central Bank of Ireland, Dublin, June 1978.

J. Bradley and J. Sexton. Stochastic Simulation with the Central Bank's MINI Econometric Model. Technical Paper No. 10/RT/78. Research Department, Central Bank of Ireland, Dublin, September 1978.

J. Bradley and J. D. FitzGerald. A Simulation and Multiplier Analysis of a Revised Version of the Central Bank's MINI Econometric Model: 1960-1976. Technical Paper No. 12/RT/78. Research Department, Central Bank of Ireland, Dublin, December 1978.

J. Bradley and C.O'Raifeartaigh. Optimal Control and Policy Analysis with a Model of a Small Open Economy: The Case of Ireland. Mimeo. Presented 3rd IFAC/IFORS Conference on Dynamic Modelling and Control of National Economies, Warsaw, 1980.

FANNING-1979

C.M. Fanning. The Irish Economy: An Econometric Description of Structures and Processes, 1954-1974: OLS Regression Estimates, Variables List and Data Sources for a Medium-Term Macroeconometric Model. Working Paper 7902. Department of Economics, University College, Cork, 1979.

C.M. Fanning. The Irish Economy: An Econometric Description of Structures and Processes, 1954-1974: Specification of the Main Structural Relations. Working Paper 7903. Department of Economics, University College, Cork, 1979.

C.M. Fanning. The Irish Economy: An Econometric Description of Structures and Processes, 1954-1974: Model Evaluation. Working Paper 7904. Department of Economics, University College, Cork, 1979.

C.M. Fanning. The Irish Economy: An Econometric Description of Structures and Processes, 1954-1974: Policy Simulations. Working Paper 8001. Department of Economics, University College, Cork, 1980.

CENTRAL BANK/DEPARTMENT OF FINANCE - 1981

J. Bradley, C. Digby, J.D. Fitzgerald, O. Keegan, K. Kirwan. Description, Simulation and Multiplier Analysis of the MODEL-80 Econometric Model of Ireland. Research Paper 2/81. Department of Finance, Dublin, 1981.

J.D. Fitzgerald and O. Keegan. The Behavioural Characteristics of the MODEL-80 Model of the Irish Economy. Journal of the Statistical and Social Inquiry Society of Ireland, forthcoming. Mimeo, 1982.

Table 1: Summary Comparison of Irish Macromodels, 1958-1981<sup>a</sup>

MODEL DESIGNATION AND YEAR	DATA		ESTIMATION	SIZE		VALIDATION <sup>b</sup>		PURPOSE/USE	
	Periodicity	Sample Period		Equations		Variables			
				Behavioural	Identities etc.	Endogenous	Exogenous		
1. E.D. - 1958	- <sup>c</sup>	-	-	-	-	-	-	-	
2. GEARY - 1964	Annual	1947-1961	OLS, Averages	6	3	9	1	-	Policy Analysis
3. LESER - 1964	Annual	1948-1962	OLS	6	0	6	3	1	Forecasting
4. WALSH - 1965	Annual	1944-1966	OLS, TSLS	20	1	21	17	1, (4)	Forecasting and Policy Analysis
5. LESER - 1967	Annual	1953-1965	OLS	4	1	5	7	1	Forecasting
6. STRONGE - 1971	Quarterly	1961:1 - 1968:4	OLS	11	6	17	17	1, 2, 5	Policy Analysis
7. CLARKE - 1971	Annual	1958-1968	OLS	23	4	27	18	1, 2	Policy Analysis
8. CLARKE - 1972									
A. Fiscal	Annual	1954-1969	OLS	NA	NA	NA	NA	NA	Accounting Framework
B. Inc./Expend	Annual	1858-1969	OLS	2	5	26	NA	NA	Accounting Framework
9. TEEHAN - 1972	Annual	1955-1970	OLS, TSLS	15	14	29	17	2, 5	Policy Analysis
10. LENNAN - 1972	Annual	1953-1968/9	OLS	16	11	27	29	1, 4	Policy Analysis
11. ISS - 1972	Annual	1950-1968	OLS	33	15	48	19	4, 5	Forecasting
12. NORTON - 1973	Annual	1958-1970	OLS, I.V.	9 <sup>d</sup>	3	11	28	1, 2	Policy Analysis
13. SMYTH - 1974	Annual	Not Estimated	-	-	-	-	-	-	Policy Analysis
14. DESMOS - 1974	Annual	Not Stated	OLS	23	15	38	24	1, 5	Policy Analysis
15. SPENCER/HARRISON - 1975	-	Not Estimated	-	9 <sup>e</sup>	8	17	7	-	Policy Analysis
16. KENNEDY/DOWLING - 1975									
A. Inc/Expend	-	-	-	-	-	-	-	-	Policy Analysis
B. Growth	-	-	-	-	-	-	-	-	Policy Analysis
17. WEFA - 1975	Annual	1958-1973	OLS	79	13	92	13	NA	Forecasting
18. GEARY/McCARTHY - 1976	Annual	1951-1971	NLTSLS	4	3 <sup>f</sup>	7	6	1 <sup>g</sup>	Policy Analysis
19. COMET - 1976	Annual	1953-1972	OLS	31	37	68	9	1, 3, 5	Policy Analysis
20. CENTRAL BANK - 1977									
A. MAXI	Annual	1953-1974	OLS	50	43	93	76	1	Policy Analysis and Forecasting
B. MAXI (Rev.)	Annual	1953-1975	OLS	53	54	107	89	1, 2, 3	Policy Analysis and Forecasting
C. MINI	Annual	1953-1974	OLS	9	17	26	43	1-5	Policy Analysis and Forecasting
21. FANNING - 1979	Annual	1954-1974	OLS	79	114	193	85	1, 2, 3, 5	Policy Analysis
22. CB/Dept. of Fin. - 1981	Annual	1960-1978	OLS, TSLS	77	191	268	117	1 - 5	Forecasting and Policy Analysis

(a) Based on published information

(b) The following was used to indicate roughly the type of validation carried out on a model:

1. Single Equation statistics
2. Within-sample static simulations
3. Within-sample dynamic simulations
4. Out-of-sample dynamic simulations
5. Multiplier and elasticities analysis

(c) Indicates not applicable

(d) 4 stochastic

(e) All non-stochastic

(f) Two of these convert rates of growth to levels of variables

(g) Analysis of comparative static properties.

**I GNP BY EXPENDITURE**

	BS	I
<b>A. <u>Current Expenditure on Goods and Services</u></b>		
1. Personal	1	0
2. Government	1	0
<b>B. <u>Gross Domestic Fixed Capital Formation</u></b>		
1. Sectoral		
a. Industry*		
b. Services*		
c. Government*	1	0
d. Agriculture*		
e. Household (Residential)*		
2. Type of Asset		
a. Machinery and Equipment		
b. Building and Construction		
c. Residential Construction		
<b>C. <u>Stock Changes</u></b>		
<b>D. <u>Exports</u></b>		
1. Goods*	1	0
2. Services*		
<b>E. <u>Imports</u></b>		
1. Goods*	1	0
2. Services*		
<b>F. <u>Other Components</u></b>		
<b>G. <u>Aggregate GNP</u></b>	1	0

**II LABOUR SECTOR**

	BS	I
<b>A. <u>Labour Demand</u></b>		
1. Industry		
2. Services		
3. Government		
4. Agriculture		
<b>B. <u>Labour Supply</u></b>		
1. Population		
2. Migration		
3. Participation		
<b>C. <u>Unemployment</u></b>		

**III PRICES**

	BS	I
<b>A. <u>Goods</u></b>		
1. Expenditure		
2. Output		
<b>B. <u>Labour</u></b>		
1. Industry		
2. Services		
3. Government		
4. Agriculture		

**IV OUTPUT**

	BS	I
<b>A. <u>Industry</u></b>		
<b>B. <u>Services</u></b>		
<b>C. <u>Government</u></b>		
<b>D. <u>Agriculture</u></b>		
<b>E. <u>Aggregate</u></b>		

**V GOVERNMENT**

	BS	I
<b>A. <u>Current Revenue</u></b>		
1. Taxes on Income		
2. Taxes on Expenditure		
3. Other Taxes		
<b>B. <u>Current Expenditure</u></b>		
1. Goods and Services		
2. Personal Transfers		
3. National Debt Interest		
4. Subsidies		
<b>C. <u>Capital Revenue</u></b>		
<b>D. <u>Capital Expenditure</u></b>		

**VI INCOME**

	BS	I
<b>A. <u>Corporate Profits</u></b>		
<b>B. <u>Dividends</u></b>		
<b>C. <u>Depreciation</u></b>		
<b>D. <u>Wages and Salaries</u></b>		
<b>E. <u>Rent</u></b>		
<b>F. <u>Totals</u></b>		

**VII MONETARY AND FINANCIAL**

	BS	I
<b>A. <u>Money Stock</u></b>		
<b>B. <u>Interest Rates</u></b>		
<b>C. <u>Exchange Rates</u></b>		

**VALIDATION**

No systematic tracking performance presented. Model re-estimated by Baker and Durkan, 1970, with some modifications.

**USE**

Forecasting out-of-sample.

**I GNP BY EXPENDITURE**

	BS	I
<b>A. Current Expenditure on Goods and Services</b>		
1. Personal	1	0
2. Government	0	0
<b>B. Gross Domestic Fixed Capital Formation</b>		
1. Sectoral		
a. Industry	1	0
b. Services	0	0
c. Government	0	0
d. Agriculture	1	0
e. Household (Residential)	0	0
2. Type of Asset		
a. Machinery and Equipment	0	0
b. Building and Construction	0	0
c. Residential Construction	0	0
<b>C. Stock Changes</b>		
<b>D. Exports</b>		
1. Goods	2	0
2. Services	0	0
<b>E. Imports</b>		
1. Goods	2	0
2. Services	0	0
<b>F. Other Components</b>	0	0
<b>G. Aggregate GNP</b>	0	1

**II LABOUR SECTOR**

	BS	I
<b>A. Labour Demand</b>		
1. Industry	2	0
2. Services	0	0
3. Government	0	0
4. Agriculture	1	0
<b>B. Labour Supply</b>		
1. Population	0	0
2. Migration	0	0
3. Participation	0	0
<b>C. Unemployment</b>	1	0

**III PRICES**

	BS	I
<b>A. Goods</b>		
1. Expenditure	0	0
2. Output	3	0
<b>B. Labour</b>		
1. Industry	1	0
2. Services	0	0
3. Government	0	0
4. Agriculture	0	0

**IV OUTPUT**

	BS	I
<b>A. Industry</b>	1	0
<b>B. Services</b>	0	0
<b>C. Government</b>	0	0
<b>D. Agriculture</b>	1	0
<b>E. Aggregate</b>	0	0

**V GOVERNMENT**

	BS	I
<b>A. Current Revenue</b>		
1. Taxes on Income	0	0
2. Taxes on Expenditure	0	0
3. Other Taxes	0	0
<b>B. Current Expenditure</b>		
1. Goods and Services	0	0
2. Personal Transfers	0	0
3. National Debt Interest	0	0
4. Subsidies	0	0
<b>C. Capital Revenue</b>	0	0
<b>D. Capital Expenditure</b>	0	0

**VI INCOME**

	BS	I
<b>A. Corporate Profits</b>	2	0
<b>B. Dividends</b>	0	0
<b>C. Depreciation</b>	0	0
<b>D. Wages and Salaries</b>	0	0
<b>E. Rent</b>	0	0
<b>F. Totals</b>	0	0

**VII MONETARY AND FINANCIAL**

	BS	I
<b>A. Money Stock</b>	0	0
<b>B. Interest Rates</b>	1	0
<b>C. Exchange Rates</b>	0	0

**VALIDATION**

No within-sample system simulations. Restricted type of out-of-sample dynamic simulations for 1963-1965. No multipliers.

**USE**

1. Preparation of forecasts for 1963-1965.
2. Investigation of interactions between the Industrial and Agricultural sectors.
3. Influence of sectoral income distribution on consumption.
4. Systematic structural framework and quantitative estimates for analysis of growth problems of the economy.

**I GNP BY EXPENDITURE**

ES I

A.	<u>Current Expenditure on Goods and Services</u>		
1.	Personal	1	0
2.	Government	0	0
B.	<u>Gross Domestic Fixed Capital Formation</u>		
1.	Sectoral		
	a. Industry		
	b. Services		
	c. Government		
	d. Agriculture		
	e. Household (Residential)		
2.	Type of Asset		
	a. Machinery and Equipment		
	b. Building and Construction		
	c. Residential Construction		
C.	<u>Stock Changes</u>	0	1
D.	<u>Exports</u>		
1.	Goods		
2.	Services		
E.	<u>Imports</u>		
1.	Goods*		
2.	Services*	1	0
F.	<u>Other Components</u>		
G.	<u>Aggregate GNP</u>	1	0

**II LABOUR SECTOR**

ES I

A.	<u>Labour Demand</u>
1.	Industry
2.	Services
3.	Government
4.	Agriculture
B.	<u>Labour Supply</u>
1.	Population
2.	Migration
3.	Participation
C.	<u>Unemployment</u>

**III PRICES**

ES I

A.	<u>Goods</u>
1.	Expenditure
2.	Output
B.	<u>Labour</u>
1.	Industry
2.	Services
3.	Government
4.	Agriculture

**IV OUTPUT**

ES I

A.	<u>Industry</u>
B.	<u>Services</u>
C.	<u>Government</u>
D.	<u>Agriculture</u>
E.	<u>Aggregate</u>

**V GOVERNMENT**

ES I

A.	<u>Current Revenue</u>
1.	Taxes on Income
2.	Taxes on Expenditure
3.	Other Taxes
B.	<u>Current Expenditure</u>
1.	Goods and Services
2.	Personal Transfers
3.	National Debt Interest
4.	Subsidies
C.	<u>Capital Revenue</u>
D.	<u>Capital Expenditure</u>

**VI INCOME**

ES I

A.	<u>Corporate Profits</u>
B.	<u>Dividends</u>
C.	<u>Depreciation</u>
D.	<u>Wages and Salaries</u>
E.	<u>Rent</u>
F.	<u>Totals</u>

1 0

**VII MONETARY AND FINANCIAL**

ES I

A.	<u>Money Stock</u>
B.	<u>Interest Rates</u>
C.	<u>Exchange Rates</u>

**VALIDATION**

No systematic within sample tracking performance presented in original document. Examination by Geary, 1969 indicated poor tracking performance over period 1947-1953.

**USE**

Used for performing single year ahead ex-ante forecasting of main expenditure aggregates.



**I GNP BY EXPENDITURE**

	BS	I
<b>A. Current Expenditure on Goods and Services</b>		
1. Personal	1	0
2. Government	0	0
<b>B. Gross Domestic Fixed Capital Formation</b>		
1. Sectoral		
a. Industry *		
b. Services *		
c. Government *	1	2
d. Agriculture *		
e. Household (Residential) *		
2. Type of Asset		
a. Machinery and Equipment		
b. Building and Construction		
c. Residential Construction		
<b>C. Stock Changes (Incl. in B.1)</b>		
<b>D. Exports</b>		
1. Goods	2	0
2. Services	0	0
<b>E. Imports</b>		
1. Goods	3	0
2. Services	1	0
<b>F. Other Components</b>		
<b>G. Aggregate GNP</b>	0	1

**II LABOUR SECTOR**

	BS	I
<b>A. Labour Demand</b>		
1. Industry		
2. Services		
3. Government		
4. Agriculture		
<b>B. Labour Supply</b>		
1. Population		
2. Migration		
3. Participation		
<b>C. Unemployment</b>		

**III PRICES**

	BS	I
<b>A. Goods</b>		
1. Expenditure		
2. Output		
<b>B. Labour</b>		
1. Industry		
2. Services		
3. Government		
4. Agriculture		

**IV OUTPUT**

	BS	I
<b>A. Industry</b>		
<b>B. Services</b>		
<b>C. Government</b>		
<b>D. Agriculture</b>		
<b>E. Aggregate</b>		

**V GOVERNMENT**

	BS	I
<b>A. Current Revenue</b>		
1. Taxes on Income	1	0
2. Taxes on Expenditure	1	0
3. Other Taxes	0	0
<b>B. Current Expenditure</b>		
1. Goods and Services	0	0
2. Personal Transfers	0	0
3. National Debt Interest	0	0
4. Subsidies	0	0
<b>C. Capital Revenue</b>	0	0
<b>D. Capital Expenditure</b>	0	0

**VI INCOME**

	BS	I
<b>A. Corporate Profits</b>		
<b>B. Dividends</b>		
<b>C. Depreciation</b>	1	0
<b>D. Wages and Salaries</b>		
<b>E. Rent</b>		
<b>F. Totals</b>	0	2

**VII MONETARY AND FINANCIAL**

	BS	I
<b>A. Money Stock</b>	0	0
<b>B. Interest Rates</b>	0	0
<b>C. Exchange Rates</b>	0	0

**VALIDATION**

Within sample tracking performance and comparison with various "naive" models. Multipliers with respect to exogenous shifts in exports.

**USE**

Examination of the impact on the Irish economy of various growth rates of UK autonomous exports and or UK policy actions to reduce consumer imports.

**I GNP BY EXPENDITURE**

	BS	I
<b>A. Current Expenditure on Goods and Services</b>		
1. Personal	1	0
2. Government	0	0
<b>B. Gross Domestic Fixed Capital Formation</b>		
1. Sectoral		
a. Industry		
b. Services		
c. Government		
d. Agriculture		
e. Household (Residential)		
2. Type of Asset		
a. Machinery and Equipment		
b. Building and Construction		
c. Residential Construction		
<b>C. Stock Changes</b>		
<b>D. Exports</b>		
1. Goods	1	0
2. Services		
<b>E. Imports</b>		
1. Goods		
2. Services		
<b>F. Other Components</b>		
<b>G. Aggregate GNP</b>		

**II LABOUR SECTOR**

	BS	I
<b>A. Labour Demand</b>		
1. Industry	1	1
2. Services		
3. Government		
4. Agriculture	0	0
<b>B. Labour Supply</b>		
1. Population		
2. Migration		
3. Participation		
<b>C. Unemployment</b>		

**III PRICES**

	BS	I
<b>A. Goods</b>		
1. Expenditure	2	0
2. Output	0	0
<b>B. Labour</b>		
1. Industry	1	0
2. Services		
3. Government	0	0
4. Agriculture	0	0

**IV OUTPUT**

	BS	I
<b>A. Industry</b>		
<b>B. Services</b>		
<b>C. Government</b>		
<b>D. Agriculture</b>		
<b>E. Aggregate</b>		

**V GOVERNMENT**

	BS	I
<b>A. Current Revenue</b>		
1. Taxes on Income	1	4
2. Taxes on Expenditure	6	1
3. Other Taxes	2	0
<b>B. Current Expenditure</b>		
1. Goods and Services	0	0
2. Personal Transfers	0	1
3. National Debt Interest	0	0
4. Subsidies	0	0
<b>C. Capital Revenue</b>	0	0
<b>D. Capital Expenditure</b>	0	0

**VI INCOME**

	BS	I
<b>A. Corporate Profits</b>	1	1
<b>B. Dividends</b>	0	0
<b>C. Depreciation</b>	0	0
<b>D. Wages and Salaries</b>	0	0
<b>E. Rent</b>	0	0
<b>F. Totals</b>	0	3

**VII MONETARY AND FINANCIAL**

	BS	I
<b>A. Money Stock</b>	0	0
<b>B. Interest Rates</b>	0	0
<b>C. Exchange Rates</b>	0	0

**VALIDATION**

Only a linearised version was solved. No tracking performance is available. Short-run and long-run elasticities with respect to GNP were calculated by means of the linearised reduced form equations.

**USE**

Quantification of short-run and long-run elasticities of GNP on several major sources of government revenue (i.e., taxes on expenditure, corporation tax, personal income tax, social insurance contributions, total tax revenue).

**I GNP BY EXPENDITURE**

	<u>BS</u>	<u>I</u>
A. <u>Current Expenditure on Goods and Services</u>		
1. Personal	1	0
2. Government	0	0
B. <u>Gross Domestic Fixed Capital Formation</u>		
1. Sectoral		
a. Industry*		
b. Services*	1	0
c. Government		
d. Agriculture*		
e. Household (Residential)*		
2. Type of Asset		
a. Machinery and Equipment		
b. Building and Construction		
c. Residential Construction		
C. <u>Stock Changes</u>		
D. <u>Exports</u>		
1. Goods		
2. Services		
E. <u>Imports</u>		
1. Goods*	1	0
2. Services*		
F. <u>Other Components</u>		
G. <u>Aggregate GNP</u>	0	2

**II LABOUR SECTOR**

	<u>BS</u>	<u>I</u>
A. <u>Labour Demand</u>		
1. Industry		
2. Services		
3. Government		
4. Agriculture		
B. <u>Labour Supply</u>		
1. Population		
2. Migration		
3. Participation		
C. <u>Unemployment</u>		

**III PRICES**

	<u>BS</u>	<u>I</u>
A. <u>Goods</u>		
1. Expenditure	0	1
2. Output		
B. <u>Labour</u>		
1. Industry		
2. Services		
3. Government		
4. Agriculture		

**IV OUTPUT**

	<u>BS</u>	<u>I</u>
A. <u>Industry</u>		
B. <u>Services</u>		
C. <u>Government</u>		
D. <u>Agriculture</u>		
E. <u>Aggregate</u>		

**V GOVERNMENT**

	<u>BS</u>	<u>I</u>
A. <u>Current Revenue</u>		
1. Taxes on Income	0	2
2. Taxes on Expenditure	0	1
3. Other Taxes	0	0
B. <u>Current Expenditure</u>		
1. Goods and Services		
2. Personal Transfers		
3. National Debt Interest		
4. Subsidies		
C. <u>Capital Revenue</u>		
D. <u>Capital Expenditure</u>		

**VI INCOME**

	<u>BS</u>	<u>I</u>
A. <u>Corporate Profits</u>	1	0
B. <u>Dividends</u>		
C. <u>Depreciation</u>		
D. <u>Wages and Salaries</u>		
E. <u>Rent</u>		
F. <u>Totals</u>	0	1

**VII MONETARY AND FINANCIAL**

	<u>BS</u>	<u>I</u>
A. <u>Money Stock</u>	0	0
B. <u>Interest Rates</u>	0	0
C. <u>Exchange Rates</u>	0	0

**VALIDATION**

Single period simulations for the period 1960-1970 showing actual vs. predicted real GNP.

**USE**

Examination of the short-run effects on real GNP and on the balance of payments, of fiscal policy using the methodology of Hansen (1968).

**I GNP BY EXPENDITURE**

	BS	I
<b>A. Current Expenditure on Goods and Services</b>		
1. Personal	1	0
2. Government	0	0
<b>B. Gross Domestic Fixed Capital Formation</b>		
1. Sectoral		
a. Industry*		
b. Services*	1	1
c. Government*		
d. Agriculture*		
e. Household (Residential)*		
2. Type of Asset		
a. Machinery and Equipment		
b. Building and Construction		
c. Residential Construction		
<b>C. Stock Changes</b>	1	0
<b>D. Exports</b>		
1. Goods	8	0
2. Services	1	0
<b>E. Imports</b>		
1. Goods	2	0
2. Services	0	0
<b>F. Other Components</b>		
<b>G. Aggregate GNP</b>	0	8

**II LABOUR SECTOR**

	BS	I
<b>A. Labour Demand</b>		
1. Industry*		
2. Services*	1	1
3. Government*		
4. Agriculture*		
<b>B. Labour Supply</b>		
1. Population		
2. Migration		
3. Participation		
<b>C. Unemployment</b>		

**III PRICES**

	BS	I
<b>A. Goods</b>		
1. Expenditure	4	5
2. Output	0	0
<b>B. Labour</b>		
1. Industry*		
2. Services*	1	0
3. Government*		
4. Agriculture*		

**IV OUTPUT**

	BS	I
<b>A. Industry</b>		
<b>B. Services</b>		
<b>C. Government</b>		
<b>D. Agriculture</b>		
<b>E. Aggregate</b>	0	1

**V GOVERNMENT**

	BS	I
<b>A. Current Revenue</b>		
1. Taxes on Income		
2. Taxes on Expenditure		
3. Other Taxes		
<b>B. Current Expenditure</b>		
1. Goods and Services		
2. Personal Transfers		
3. National Debt Interest		
4. Subsidies		
<b>C. Capital Revenue</b>		
<b>D. Capital Expenditure</b>		

**VI INCOME**

	BS	I
<b>A. Corporate Profits</b>		
<b>B. Dividends</b>		
<b>C. Depreciation</b>		
<b>D. Wages and Salaries</b>		
<b>E. Rent</b>		
<b>F. Totals</b>	1	1

**VII MONETARY AND FINANCIAL**

	BS	I
<b>A. Money Stock</b>		
<b>B. Interest Rates</b>		
<b>C. Exchange Rates</b>		

**VALIDATION**

No within-sample simulations presented. Various multipliers calculated for entire linked system.

**USE**

Examination of the international transmission of economic fluctuations, and the coordination of EEC economic policies. In particular they sought to determine the feasibility of synchronized community economic policy.

**I GNP BY EXPENDITURE**

	BS	I
<b>A. <u>Current Expenditure on Goods and Services</u></b>		
1. Personal	1	0
2. Government	0	0
<b>B. <u>Gross Domestic Fixed Capital Formation</u></b>		
1. Sectoral		
a. Industry*		
b. Services*		
c. Government*	2	0
d. Agriculture*		
e. Household (Residential)*		
2. Type of Asset		
a. Machinery and Equipment		
b. Building and Construction		
c. Residential Construction		
<b>C. <u>Stock Changes</u></b>		
<b>D. <u>Exports</u></b>		
1. Goods*	1	0
2. Services*		
<b>E. <u>Imports</u></b>		
1. Goods*	1	0
2. Services*		
<b>F. <u>Other Components</u></b>	0	0
<b>G. <u>Aggregate GNP</u></b>	0	3

**II LABOUR SECTOR**

	BS	I
<b>A. <u>Labour Demand</u></b>		
1. Industry*		
2. Services*		
3. Government*	1	0
4. Agriculture*		
<b>B. <u>Labour Supply</u></b>		
1. Population		
2. Migration		
3. Participation		
<b>C. <u>Unemployment</u></b>	0	2

**III PRICES**

	BS	I
<b>A. <u>Goods</u></b>		
1. Expenditure	1	0
2. Output	0	0
<b>B. <u>Labour</u></b>		
1. Industry*		
2. Services*		
3. Government*	1	0
4. Agriculture*		

**IV OUTPUT**

	BS	I
<b>A. <u>Industry</u></b>		
<b>B. <u>Services</u></b>		
<b>C. <u>Government</u></b>		
<b>D. <u>Agriculture</u></b>		
<b>E. <u>Aggregate</u></b>		

**V GOVERNMENT**

	BS	I
<b>A. <u>Current Revenue</u></b>		
1. Taxes on Income	1	0
2. Taxes on Expenditure		
3. Other Taxes		
<b>B. <u>Current Expenditure</u></b>		
1. Goods and Services	0	1
2. Personal Transfers	0	0
3. National Debt Interest	0	1* (Borrowing)
4. Subsidies	0	0
<b>C. <u>Capital Revenue</u></b>		
<b>D. <u>Capital Expenditure</u></b>		

**VI INCOME**

	BS	I
<b>A. <u>Corporate Profits</u></b>		
<b>B. <u>Dividends</u></b>		
<b>C. <u>Depreciation</u></b>		
<b>D. <u>Wages and Salaries</u></b>		
<b>E. <u>Rent</u></b>		
<b>F. <u>Totals</u></b>	0	1

**VII MONETARY AND FINANCIAL**

	BS	I
<b>A. <u>Money Stock</u></b>		
<b>B. <u>Interest Rates</u></b>		
<b>C. <u>Exchange Rates</u></b>		

**VALIDATION** Not applicable

**USE** Comparative static analysis of the impact of a tax rate change on unemployment and output; an increase in borrowing on unemployment; an increase in GB real GNP on unemployment; an increase in GB prices on Irish prices.

BS I

## I GNP BY EXPENDITURE

	BS	I
A. <u>Current Expenditure on Goods and Services</u>		
1. Personal	1	1
2. Government	1	1
B. <u>Gross Domestic Fixed Capital Formation</u>		
1. Sectoral	1	1
a. Industry		
b. Services		
c. Government		
d. Agriculture		
e. Household (Residential)		
2. Type of Asset		
a. Machinery and Equipment		
b. Building and Construction		
c. Residential Construction		
C. <u>Stock Changes</u>	1	1
D. <u>Exports</u>	1	5
1. Goods	1	1
2. Services		
E. <u>Imports</u>		
1. Goods	8	5
2. Services	1	1
F. <u>Other Components</u>	0	0
G. <u>Aggregate GNP</u>	0	7

## II LABOUR SECTOR

	BS	I
A. <u>Labour Demand</u>	2	0
1. Industry		
2. Services		
3. Government		
4. Agriculture		
B. <u>Labour Supply</u>		
1. Population		
2. Migration		
3. Participation	1	1
C. <u>Unemployment</u>		

## III PRICES

	BS	I
A. <u>Goods</u>		
1. Expenditure	8	9
2. Output	0	0
B. <u>Labour</u>	1	0
1. Industry		
2. Services		
3. Government		
4. Agriculture		

## IV OUTPUT

	BS	I
A. <u>Industry</u>		
B. <u>Services</u>		
C. <u>Government</u>		
D. <u>Agriculture</u>		
E. <u>Aggregate</u>	1	0

## V GOVERNMENT

	BS	I
A. <u>Current Revenue</u>		
1. Taxes on Income		
2. Taxes on Expenditure		
3. Other Taxes		
B. <u>Current Expenditure</u>		
1. Goods and Services		
2. Personal Transfers		
3. National Debt Interest		
4. Subsidies		
C. <u>Capital Revenue</u>		
D. <u>Capital Expenditure</u>		

## VI INCOME

	BS	I
A. <u>Corporate Profits</u>	0	1
B. <u>Dividends</u>	0	0
C. <u>Depreciation</u>	1	0
D. <u>Wages and Salaries</u>	0	1
E. <u>Rent</u>	0	0
F. <u>Totals</u>	1	2

## VII MONETARY AND FINANCIAL

	BS	I
A. <u>Money Stock</u>		
B. <u>Interest Rates</u>		
C. <u>Exchange Rates</u>		

## VALIDATION

Within sample dynamic simulations for 1964-1972 for major endogenous variables and tracking performance analysis. Detailed estimation results also published for entire model.

## USE

Out-of-sample forecast for 1973-1980. Model sensitivity analysis with respect to changes in isolated country models (exchange rate changes, investment changes and changes in growth rate of world imports).

<u>I GNP BY EXPENDITURE</u>		<u>BS</u>	<u>I</u>
		21	49
<b>A. <u>Current Expenditure on Goods and Services</u></b>			
1.	Personal	5	6
2.	Government	0	0
<b>B. <u>Gross Domestic Fixed Capital Formation</u></b>			
1. <u>Sectoral</u>			
	a. Industry	1	3
	b. Services	1	2
	c. Government	1	3
	d. Agriculture	0	1
	e. Household (Residential)	1	1
2. <u>Type of Asset</u>			
	a. Machinery and Equipment*	0	2
	b. Building and Construction*	0	2
	c. Residential Construction	0	2
<b>C. <u>Stock Changes</u></b>			
<b>D. <u>Exports</u></b>			
1.	Goods	3	2
2.	Services	2	4
<b>E. <u>Imports</u></b>			
1.	Goods	5	3
2.	Services	2	4
<b>F. <u>Other Components</u></b>			
<b>G. <u>Aggregate GNP</u></b>			

<u>II LABOUR SECTOR</u>		<u>BS</u>	<u>I</u>
		5	5
<b>A. <u>Labour Demand</u></b>			
1.	Industry	1	0
2.	Services	1	0
3.	Government	0	0
4.	Agriculture	0	0
<b>B. <u>Labour Supply</u></b>			
1.	Population	1	2
2.	Migration	1	0
3.	Participation	1	1
<b>C. <u>Unemployment</u></b>			

<u>III PRICES</u>		<u>BS</u>	<u>I</u>
		26	0
<b>A. <u>Goods</u></b>			
1.	Expenditure	17	0
2.	Output	6	0
<b>B. <u>Labour</u></b>			
1.	Industry	1	0
2.	Services	1	0
3.	Government	1	0
4.	Agriculture	0	0

<u>IV OUTPUT</u>		<u>BS</u>	<u>I</u>
		3	16
<b>A. <u>Industry</u></b>			
<b>B. <u>Services</u></b>			
<b>C. <u>Government</u></b>			
<b>D. <u>Agriculture</u></b>			
<b>E. <u>Aggregate</u></b>			

<u>V GOVERNMENT</u>		<u>BS</u>	<u>I</u>
		14	26
<b>A. <u>Current Revenue</u></b>			
1.	Taxes on Income	2	4
2.	Taxes on Expenditure	4	3
3.	Other Taxes	2	0
<b>B. <u>Current Expenditure</u></b>			
1.	Goods and Services	1	1
2.	Personal Transfers	4	2
3.	National Debt Interest	0	1
4.	Subsidies	0	1
<b>C. <u>Capital Revenue</u></b>			
<b>D. <u>Capital Expenditure</u></b>			

<u>VI INCOME</u>		<u>BS</u>	<u>I</u>
		7	12
<b>A. <u>Corporate Profits</u></b>			
<b>B. <u>Dividends</u></b>			
<b>C. <u>Depreciation</u></b>			
<b>D. <u>Wages and Salaries</u></b>			
<b>E. <u>Rent</u></b>			
<b>F. <u>Totals</u></b>			

<u>VII MONETARY AND FINANCIAL</u>		<u>BS</u>	<u>I</u>
		3	6
<b>A. <u>Money Stock</u></b>			
<b>B. <u>Interest Rates</u></b>			
<b>C. <u>Exchange Rates</u></b>			

**VALIDATION** Prediction error analysis for selected endogenous variables, within sample; single-period simulations for 1959-1971: Two-period simulations for 1959-1971: Three period simulations for 1959-1971: Full dynamic simulation for 1959-1971: Impulse multipliers and cumulative sustained multipliers with respect to government investment and government current expenditure.

**USE** The relative effectiveness of the main aspects of aggregate employment policy were quantitatively assessed by using the model to estimate dynamic elasticities with respect to government spending, public sector employment expansion, industrial exports expansion, industrial import situation, and wage control policy in industry.

Table 11: FANNING - 1979

**I GNP BY EXPENDITURE**

	BS	I
<b>A. Current Expenditure on Goods and Services</b>		
1. Personal	3	5
2. Government	0	0
<b>B. Gross Domestic Fixed Capital Formation</b>		
1. Sectoral		
a. Industry		
b. Services		
c. Government		
d. Agriculture		
e. Household (Residential)		
2. Type of Asset		
a. Machinery and Equipment	1	4
b. Building and Construction	1	4
c. Residential Construction	1	2
<b>C. Stock Changes</b>	4	11
<b>D. Exports</b>		
1. Goods	1	2
2. Services	0	2
<b>E. Imports</b>		
1. Goods	4	12
2. Services	1	2
<b>F. Other Components</b>	0	3
<b>G. Aggregate GNP</b>	0	4

**II LABOUR SECTOR**

	BS	I
<b>A. Labour Demand</b>		
1. Industry	3	2
2. Services	1	0
3. Government	0	0
4. Agriculture	0	0
<b>B. Labour Supply</b>		
1. Population	1	0
2. Migration	1	0
3. Participation	1	0
<b>C. Unemployment</b>	0	2

**III PRICES**

	BS	I
<b>A. Goods</b>		
1. Expenditure	17	46
2. Output	2	3
<b>B. Labour</b>		
1. Industry	1	2
2. Services	1	1
3. Government	1	1
4. Agriculture	0	0

**IV OUTPUT**

	BS	I
A. Industry	2	4
B. Services	1	3
C. Government	1	0
D. Agriculture	0	0
E. Aggregate	0	2

**V GOVERNMENT**

	BS	I
<b>A. Current Revenue</b>		
1. Taxes on Income	3	5
2. Taxes on Expenditure	14*	30 (* incl. tax-bases)
3. Other Taxes	1	1
<b>B. Current Expenditure</b>	0	1
1. Goods and Services	0	4
2. Personal Transfers	3	1
3. National Debt Interest	1	9 (incl. borrowing)
4. Subsidies	0	5
<b>C. Capital Revenue</b>	0	1
<b>D. Capital Expenditure</b>	0	1

**VI INCOME**

	BS	I
A. Corporate Profits	1	1
B. Dividends		
C. Depreciation		
D. Wages and Salaries	0	7
E. Rent		
F. Totals	0	3

**VII MONETARY AND FINANCIAL**

	BS	I
A. Money Stock	3	3
B. Interest Rates	3	0
C. Exchange Rates	0	1

**VALIDATION**

Extensive validation results are available. Detailed within-sample tracking performance by means of single-equation, single period and multiple period simulations. A wide range of model multipliers are calculated.

**USE**

The model has been used extensively within the Government and Central Bank for budgetary analysis, etc. An interesting published example of its use is available in the Quarterly Economic Commentary, October, 1981.



III

MAIN FEATURES OF SELECTED MODELS

ED - 1958

## PURPOSE AND APPROACH :

This model is derived from Economic Development (Ireland, 1958).

Economic Development was the seminal document in economic programming and the analysis and policy prescriptions contained in it provided the basis for the (First) Programme for Economic Expansion. The expressed aim was not to draw up a detailed plan of national development but

"rather (a) to highlight the main deficiencies and potentialities of the economy and (b) to suggest the principles to be followed to correct the deficiencies and realise the opportunities, indicating a number of specific forms of productive development which appear to offer good long-term prospects." (ED: 1)

Although a model is not specified explicitly in the manner of a mathematical or macroeconometric model the overall approach does have an affinity to these types of models. There is a dual aspect to the study:

1. a policy or planning aspect which prescribes the optimal use of available resources in order to achieve certain goals; and
2. an analysis of resources - the manner in which they can be mobilized and the extent to which they are likely to be forthcoming.

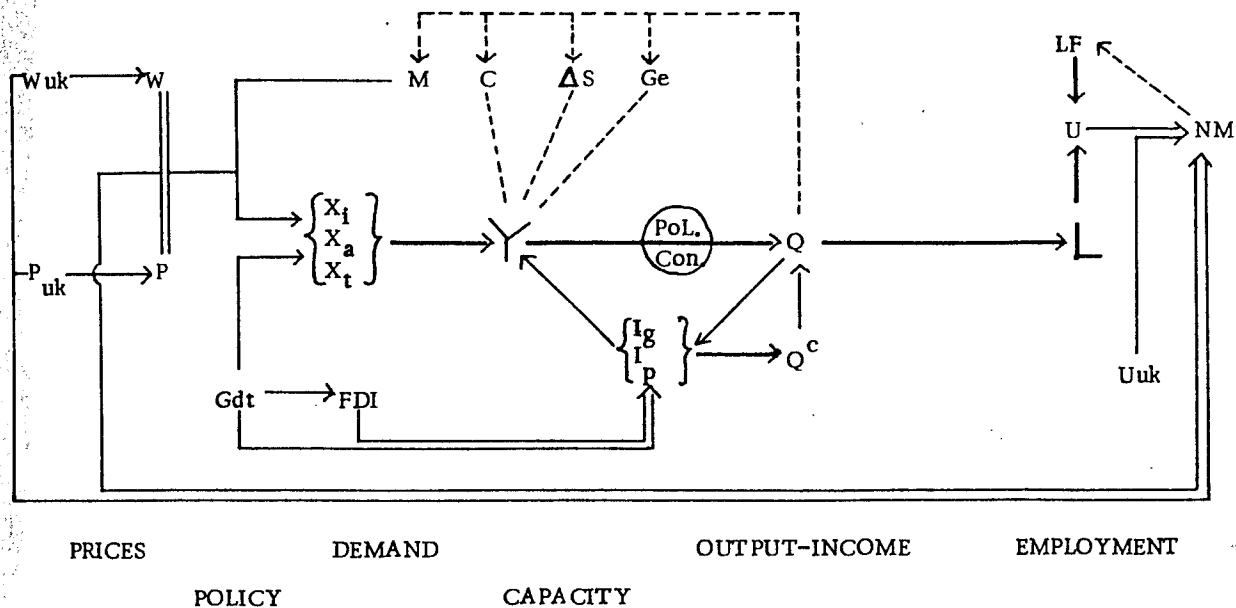
In modelling terms, the first aspect would fall into the domain of planning/resource allocation models. Macroeconometric models are suitable tools for approaching the second, mobilisation of resources, aspect. Being based on historical data and explicit behavioural relations they permit analysis of what resources are likely to be forthcoming given past experience. It is from this element of the study that we seek to identify the core model. The first section of ED sets out the framework for policy prescriptions "by taking a quick glance at the economy generally, with an eye particularly

on the features most relevant to a study of potentialities for development" (ED: 11). Thus the underlying 'model' is one for developing the economy, with emphasis on the role of Government in inducing expansion of output and employment over the medium-term (5 years).

It is a model quite unlike others in this survey in that, while it may be based on theoretical and empirical analysis of the Irish economy, it was not specified, estimated, or, most importantly, tested in the manner of macroeconomic models. Rather the 'testing' of this model was undertaken by direct application to the economy. There was no a priori evaluation of the relationships or quantitative effects of changes in policy variables. (Limited ex post evaluation was conducted in Fanning, 1979: Part IV).

The approach taken in Economic Development, while reviewing the state of the economy extensively, is not explicitly analytical and poses particular difficulties in formulating a core model. The best approach seemed to be to diagram the primary flows explicitly stated and more often than not, suggested or only hinted at. Thus, the criterion used to isolate the main causal relations is based, for example, on explicit statements about action that will be, or has been, undertaken to achieve stated effects. It was not sufficient that some variables was deemed to be relevant. In the case of wage increases, ED and the Programme for Economic Expansion contain a number of references to the need to ensure that wage increases are "appropriate" to maintain competitiveness. However, there is no reference to any instrument, mechanism or action being undertaken to influence wage rates. Thus they are taken to be effectively exogenous in the model postulated. Where appropriate, on the other hand, we have used standard definitions to fill in the model in a reasonable manner (such flows are indicated by broken arrows). The model scheme and notation is given in Figure 1.

Figure 1: Scheme of 'Core' Model, ED - 1958



## NOTATION

C	-	Personal Consumption	I <sub>P</sub>	-	Private Investment	Q	-	Output (Value Added)
FDI	-	Foreign Direct Investment	L	-	Employment	Q <sup>c</sup>	-	Capacity Output
G <sub>e</sub>	-	Endogeneous Government Expenditures and "Non-Productive" Investment	LF	-	Labour Force	X <sub>a</sub>	-	Agricultural Exports
Gdt	-	Government 'Development' Transfers (Capital Grants etc., Training, Trade Promotion etc.)	M	-	Imports	X <sub>i</sub>	-	Industrial Exports
I <sub>g</sub>	-	Gov. "Productive" Investment	NM	-	Net Migration	X <sub>t</sub>	-	Tourism Exports
			P	-	Price	S	-	Stocks (Δ : change)
					Price in U.K.	U	-	Unemployment
			PoL. Con.	-	Policy Constraints, (Balance of Payments, Government Borrowing)	W	-	Wage Rate
						X	-	G. N. P.

(Subscript UK denotes British variables)

**MAIN FEATURES**

1. Economic expansion is demand induced in the sense that "the initial advance has rarely been the result of capital expenditure: it has far more commonly followed the expansion of markets, especially foreign markets ..." (Cairncross, quoted in ED:7). Moreover, in Ireland the declining population has deprived the economy of the stimulus of an expanding home market (ED:5,11). Therefore exports are assigned a crucial role.
2. Furthermore, the key sector identified is industry (and therefore industrial exports as the driving force) because the "usual sequence of events is that a step forward is made in one sector of the economy and that this makes it easier for the rest of the economy to advance..." (ED:7).
3. Output expansion, especially manufacturing industry generates the need for greater capacity and employment. Employment expansion would also come from growth of tertiary industries (especially tourism); but there is little possibility of absorbing labour into agricultural employment (ED: 11, 20).
4. A major role in expanding capacity was assigned to foreign investment and imported equipment and technology because of resource and technology constraints.
5. This, together with the emphasis on exports, indicates an important role for government activity in the promotion of foreign investment and exports by means of subsidies and grants, direct promotion activities, and productive investment.

6. The openness of the economy is reflected in
  - (a) the relationship between Irish wage rates and prices and foreign, i.e. British, wage rates and prices (ED: 11-12, 26),
  - (b) the impact of Irish wage and unemployment rates relative to those of Great Britain on the labour market via emigration (ED: 2, 5, 10-12),
  - (c) fixed exchange rate, at parity between Irish £ and Sterling £, and interest rates largely determined by British rates, (not in Figure 1).
7. The policy constraints perceived to be particularly binding, were the balance of payments and the government borrowing requirement.
8. The remaining flows complete the GNP accounting identities in the standard manner, e.g. savings (consumption) fluctuates with variations in the distribution and level of national income (ED: 16, 18).

The main property of the model is that it is basically an export-led growth model, with a key facilitating role assigned to government policy. As is stated in ED, the expansion of "real national income depends on capital and labour being devoted to industrial and agricultural development, particularly for export, ..." (ED: 3). Thus for this sequence to operate in a positive manner it is essential to ensure competitiveness if exports were to be the key component of aggregate demand. This means that an appropriate relationship must hold between the growth of exogenously determined money wages and labour productivity, as well as price setting behaviour, so that domestic prices rise less, or no faster, than foreign prices.

## VALIDATION

Not Applicable

## USE

' Model' underlying (First) Programme for Economic Expansion (Ireland, 1958).

## COMMENTS

From a narrow macroeconometric modelling perspective, in particular that of surveying models of the Irish economy, the fundamental criticism to be made is that a model was not formulated explicitly and tested.

It is recognised that when part of the intention is to change behaviour and relationships this may pose difficulties. However, no attempt was made to formalise and quantify existing relationships as a basis for historical and current situation assessments. This is still a notable feature of the national policy-making process in Ireland.

GEARY - 1964**PURPOSE**

The construction of a simple macroeconomic growth model of the Irish economy on the basis of a few aggregate parameters.

**MAIN FEATURES**

The model attempts to explain the expenditure side of the national accounts by means of simple and robust behavioural equations in a growth context. Since it is a small model, we restate it (with slightly revised notation) below and explain the individual equations.

<u>Notation:</u>	$Y_t$	=	Net National Product (constant market prices)
	$C_t$	=	Total Consumption
	$I_t$	=	Total net fixed capital formation
	$\Delta S_t$	=	Change in stocks (total)
	$X_t$	=	Exports
	$MINV_t$	=	Interest payable (or receivable) in respect of foreign investment
	$MOTH_t$	=	Total Other Imports
	$N_t$	=	Net Investment from Abroad
	$SAV_t$	=	Total Savings

Equations:**1: Accounting Identities:**

Product Account:  $Y_t = C_t + I_t + X_t - MINV_t - MOTH_t + \Delta S_t$

External Account:  $X_t - MINV_t - MOTH_t + N_t = 0$

Capital Savings Account:  $I_t + \Delta S_t = SAV_t + N_t$

Consumption Account:  $C_t + SAV_t = Y_t$



## 2: The Growth Equation:

$$Y_t = (1 + r)^t Y_0$$

i.e. an exogenous and constant rate of growth,  $r$ , is assumed.

## 3: The Consumption (and Savings) Function:

$$C_t = (1 - s) Y_t$$

$$SAV_t = s Y_t$$

where  $s$  is the savings ratio.

## 4: Investment Function:

This is derived from the incremental capital-output ratio,

$$k = I_t / (Y_{t+1} - Y_t)$$

$$\text{Hence, } I_t = k(Y_{t+1} - Y_t)$$

$$\text{yielding } I_t = krY_t$$

## 5: Stock-Change Equation:

If  $p$  is the stock-output ratio,

$$S_t = p Y_t$$

$$\therefore \Delta S_t = p \Delta Y_t$$

$$\text{i.e. } \Delta S_t = p r Y_t$$

## 6: Investment From Abroad:

Using the Capital-Savings account identity and equations for  $I_t$ ,  $\Delta S_t$  and  $SAV_t$ , yields

$$N_t = (kr + pr - s) Y_t$$

## 7: External Investment Equation:

If  $n$  is the rate of interest, then

$$\text{MINV}_t = n \sum_{t'=0}^{t-1} N_{t'}$$

i.e. 
$$\text{MINV}_t = \frac{n}{r} (kr + pr - s) (Y_t - Y_0)$$

The MINV variable is isolated with a view to dealing with the situation of a persistent import excess due to a period of rapidly increasing capital formation.

## 8: The Import Equation:

$$\text{MOTH}_t = m_t Y_t$$

where the import-output ratio,  $m_t$ , is allowed to be a function of time.

## 9: The Export Equation:

Using the external account identity,

$$X_t = \left[ \left(1 - \frac{n}{r}\right)(S - kr - pr) + m_t \right] Y_t - \frac{n}{r} (kr + pr - s) Y_0$$

Hence, the model endogenises nine variables by means of the income-expenditure

identity and equations 2 - 9. The six behavioural equations for  $Y_t$ ,  $C_t$ ,  $I_t$ ,  $\Delta S_t$ ,  $N_t$  and

$\text{MOTH}_t$  use six parameters:

- $r$  = rate of growth of GNP
- $s$  = savings ratio
- $k$  = ICOR coefficient
- $p$  = stock - GNP ratio
- $n$  = rate of interest
- $m_t$  = import - GNP ratio

The values attributed to these parameters determine how the economy behaves

either of its own accord or as a result of conscious direction. Data for 1947 - 1962 yields the following numerical values for the parameters:

	Value	Estimation Method
s	9.1	Average for 1957-61
k	5.02	OLS
p	0.6	Average for 1957-61
$m_t$	0.4	Average for 1957-61

### VALIDATION

Parameters estimated as shown above and no formal validation procedures followed. However using the equation

$$\Delta Y_t = (1/k) I_t = (0.2) I_t$$

for assessing the degree to which fixed capital was underutilised, Geary calculated the predicted value of net national product and provided the actual value for comparison.

The results are given below, where  $Y_t^*$  is actual net national product recorded:

Year	(1) $\Delta Y_t$	(2) $Y_t$	(3) $Y_t^*$	(4) $(Y_t - Y_t^*)$
1955	13	518	516	+2
1956	11	531	508	+31
1957	8	542	512	+30
1958	8	550	496	+54
1959	8	558	517	+41
1960	9	566	547	+19
1961	11	575	574	+1
1962	12	586	588	-2
1963	-	598	609	-11

Source : Geary (1963/64: 8) for columns (1) - (3)

## USE

Alternative scenarios were examined using this aggregate consistency framework. For example, in the 'breakeven case' of  $N_t = 0$  (i.e. zero import excess)

$$N_t = 0 \Rightarrow s = r(k + p)$$

and taking  $p$  fixed at 0.6,

$$s = r(k + 0.6)$$

allows the analysis of mutually compatible values of  $s$ ,  $r$ , and  $k$ .

## COMMENTS

The GEARY - 1964 model would appear to be the first formal macro model of the Irish economy. In fact it was available even earlier as, R.C. Geary, A Simple Macro-economic growth Model: Part 1 (ESRI, Memorandum Series No. 3, June 1962).

LESER - 1964

Short-term forecasting of components of GNP by expenditure approach.

## MAIN FEATURES

(all variables in nominal percentage change form)

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I.	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Personal Consumption	Final demand (C + I + G + X) Difference between consumption and GNP (lagged)
A.2	Government Consumption	Final Demand Difference between government consumption and GNP (lagged)
B.1	Investment	Final Demand Lagged Investment
D.	Exports	Final Demand Difference between exports and imports (lagged)
E.	Imports	Final Demand Difference between GNP and import deflators Difference between imports and final demand (lagged)
G.	GNP	Final Demand Difference between GNP and import deflators Difference between GNP and final demand (lagged)

---

The most important feature of the model is that the main "exogenous" variable is final demand. Consistency between the ex-ante exogenous value of final demand and the model solution for final demand is ensured by an additive constant which is adjusted after the simulations. It is the same for all equations but differs from year to year. The lagged terms in each equation adjust for over- and under-shooting from year to year.

**VALIDATION**

No systematic tracking performance presented. Model re-estimated by Baker and Durkan (1970) with some modifications.

**USE**

Forecasting out of sample.

**COMMENTS**

Various ad-hoc modifications to the basic model were made by Baker and Durkan (1970) by adding extra lagged terms, a revised investment equation, extra price change terms, dummy variables, and specifying the model in real terms. Forecasts for 1969 and 1970 were prepared and agreed well with preliminary out-turns.

However, the model has little or no structural economic content and, since final demand can hardly be held to be independent of the other expenditure components of GNP, the OLS estimation may have been suspect. Furthermore the forecasting procedure using this model involves having a forecast of GNP itself which is then used to forecast its components.

**PURPOSE**

Examination of the structural development and growth of the Irish economy.

**MAIN FEATURES**


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<b>I.</b>	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Personal Consumption	Real industrial wage bill Real per capita agricultural output Real per capita corporate profits
B.1.a	Industrial Investment	Interest rate Real corporate savings Industrial output
B.1.d	Agricultural Investment	Lagged agricultural output Lagged investment
E.1	Imports (consumption goods)	Real consumption Tariff rate Relative prices
E.1	Imports (non-consumption)	Industrial output (vol.) Tariff rate Relative prices
D.1	Exports (agricultural)	UK demand UK relative prices Lagged exports
D.1	Exports (non-agricultural)	UK demand UK relative prices Lagged exports
<b>II.</b>	<u>Labour Sector</u>	<u>Determinants</u>
A.1	Industrial Employment (inverted production function)	Industrial output (vol.) Non-consumption imports (vol.) Time trend
A.1	Hours worked in industry	Unemployment Industrial output (vol.) Lagged hours
A.4	Agricultural Employment (simplified inverted production function)	Agricultural output Agricultural inputs
C.	Unemployment	Population Total employment Real wage

III.	<u>Prices Sector</u>	<u>Determinants</u>
A.2	Non-agricultural Output Price	Labour cost per unit of output Import prices Real rate of indirect tax receipts
A.2	Agricultural Output Price	Agricultural stock levels (change) Lagged Price
A.2	Total Output Price	Weighted average of above
B.1	Industrial Wage Level	Total output price Unemployment plus emigration Corporate profits
IV.	<u>Output Sector</u>	<u>Determinants</u>
A.	Industrial Output	Domestic demand (C + I + G) Non-agricultural exports (X)
D.	Agricultural Output	Agricultural exports Stock-output ratio in agriculture
VI	<u>Income Sector</u>	<u>Determinants</u>
A.	Corporate Profits	Labour productivity Industrial output (changes) Lagged profits
A.	Corporate Savings	Corporate profits Corporate taxation
VII.	<u>Monetary and Financial Sector</u>	<u>Determinants</u>
B.	Interest rate	Discount rate (short-term) Ratio of money supply to GNP Ratio of external reserves to bank liquidity

---

Two sectors are endogenous. Industry and Agriculture.

Within each of these sectors, employment, production and exports are explicitly modelled; the interaction, growth and change of the two sectors are thereby made explicit.

In conjunction with the export equations, the impact of foreign trade on the economy is analysed.



Consumption and non-consumption imports are distinguished and each category follows a separate growth pattern. The industrial production function and non-consumption imports reflect the import requirements of industrial expansion. The consumption function and consumption imports shows the relation between the growth of imports and the expansion of real income per person.

Other external influences consist of the impact of emigration on the industrial wage level and of external assets on the domestic interest rate.

Inflationary-growth interactions are allowed for in the wage rate and industrial price mark-up equations.

Tariff rates, indirect tax rates and government expenditure policy instruments are also available.

#### VALIDATION

No within sample simulations. Restricted type of out-of-sample dynamic simulations for 1963-1965. No multipliers.

#### USE

Preparation of forecasts for 1963-1965. Investigation of interaction between the Industrial and Agricultural Sectors. Influence of sectoral income distribution on consumption. Systematic structural framework and quantitative estimates for analysis of growth problems of the economy.

#### COMMENTS

This was the first large-scale macroeconomic model of the Irish economy to be built. It was impossible to solve the model in its full form since the model is non-linear and non-recursive and would have required fairly sophisticated non-linear routines which were not available at the time. Partial dynamic simulations were performed, where various simplifications were made (e.g. industrial productivity

was exogenised and various exogenous-endogenous variable ratios were fixed.) Hence, in the absence of full dynamic simulations and multiplier analysis, it is difficult to quantitatively evaluate the model. Nevertheless, the equation-by-equation analysis of behavioural coefficients and the limited simulations provide much interesting structural information, e.g.,

High marginal coefficients in import equations combined with low price and tariff elasticities, underline the difficulty of curtailing Irish imports, and the consequent balance-of-payments problems.

Exports had a high income elasticity of demand in the UK market, and surprisingly, agriculture performed better in this respect than non-agriculture.

The strong connection between Irish prices and import prices.

The high interest rate effect on industrial investment.

The manner of determination of interest rates (i. e., related to discount rates and levels of external assets.)

LESER - 1967**PURPOSE**

To explain short-term movements in some of the key national accounts variables by means of a totally recursive linear model.

**MAIN FEATURES**


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<b>I.</b>	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Consumption (nominal)	Disposable income Lagged savings ratio
E.	Total Imports (nominal)	Gross domestic fixed capital formation (nominal) Total exports (nominal) Agricultural stocks (nominal)
G.	Total GNP (nominal)	Government expenditure on goods and services (nominal) GDFCF (nominal) Total exports (nominal) Agricultural stocks (nominal) Index of weekly earnings in transportable goods industries.
<b>VI.</b>	<u>Income Sector</u>	<u>Determinants</u>
F.	Personal Disposable Income	Nominal GNP net of government expenditure on goods and services

---

The model is fully recursive.

The order of solutions is : Imports  $\rightarrow$  GNP  $\rightarrow$  Personal Disposable Income  $\rightarrow$  Consumption.

All equations are estimated in terms of first differences.

For the consumption function, the short-run marginal propensity to consume is estimated at 0.67 and the long-run at 0.94.

**VALIDATION**

No systematic within-sample tracking performance presented in original document. Examination by R.C. Geary (Is the Science of Econometrics any use for Short-term Forecasting? An enquiry based mainly on Irish Educational Statistics 1947-1967, Economic and Social Review 1(1): 1-28, October 1969), indicated poor tracking performance over the period 1947-1953.

**USE**

Single year ahead ex ante forecasting of main expenditure aggregates.

**COMMENTS**

A simple rationale is given for each equation; for example equation I.G above is viewed as a production decision function where the coefficient on government expenditure is constrained to be unity (i.e., no multiplier effect) and where the earnings term is seen as a cost indicator.

This model was re-estimated by Baker and Durkan (1970) using an extended data sample (1953-1968). The coefficients turned out to be highly unstable, a finding to be expected with such a reduced form model. Baker and Durkan commented that the "model is best regarded as an interesting experimental exercise, rather than as an actual forecasting tool".

STRONGE - 1971**PURPOSE**

The 'analysis of movements in Irish macrovariables', in particular, the study of the dependence of the Irish economy on that of the United Kingdom.

**MAIN FEATURES**

(all variables in real or deflated terms)

I.	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Personal Consumption	Personal disposable income Lagged consumption
B.1	Gross Physical Capital Formation	GNP Capital Stock Lagged Investment
D.1	Exports of Consumer Goods to UK	UK imports of consumer goods Lagged exports
D.1	Exports of Producers' Non-durable Goods to the UK	UK imports of producer non-durables Lagged exports
E.1	Imports of Consumption Goods	Consumption Lagged imports
E.1	Imports of Producers' Durables	Investment Lagged imports
E.1	Imports of Producers' Non-Durables	GNP Lagged imports
E.2	Imports of Services	GNP Lagged imports
V.	<u>Government Sector</u>	<u>Determinants</u>
A.2	Total Expenditure Tax Revenue	Consumption Lagged consumption
A.1	Total Personal Income Tax	Personal income Lagged personal income
VI	<u>Income Sector</u>	<u>Determinants</u>
E.	Depreciation	Capital stock

The quarterly national accounts data were derived by interpolation methods and using a range of expenditure indicators. Only GNP by expenditure was included.

Relative price effects are excluded from the trade equations.

The model consists entirely of real sector.

Within sample tracking performance and comparison with various 'naive' models. Multiplier with respect to exogenous shifts in exports.

#### USE

Examination of the impact of the Irish economy of various growth rates of UK autonomous exports and UK policy actions to reduce consumer imports.

#### COMMENTS

The aim of the modelling exercise was to examine the dependence of the Irish economy on that of the UK. However, the only Irish-UK transmission mechanism included are the relationships between Irish exports of consumption goods and producers' non-durables and the corresponding UK imports.

Thus, no account has been taken of other important transmission mechanisms, e.g. invisible exports, factor movements (particularly the Irish-UK labour market interaction), financial flows and prices (including wages) transmission mechanisms.

The construction of a macromodel of the UK economy (paralleling the Irish model) was superfluous since the UK imports of consumer goods and of producers non-durables are exogenous to the Irish economy model.

LENNAN - 1972**PURPOSE**

Analysis of the flexibility of Irish Taxes by calculating elasticities of tax revenues with respect to GNP.

**MAIN FEATURES**

(Variables, where appropriate, are in real or deflated terms)

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I.	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Personal Consumption	Disposable income Lagged Personal Consumption
D.1	Imports of Goods and Services	Relative import/consumption price GNP Time trend
II.	<u>Labour Sector</u>	<u>Determinants</u>
A.	Non-Agricultural employment	Non-agricultural GDP Population
III.	<u>Prices Sector</u>	<u>Determinants</u>
A.1	Consumption Price	Total expenditure tax revenue Private non-agricultural wages Import prices
A.1	Tobacco Price	Consumption price Tobacco tax rate
B.	Wages (non-governmental agriculture)	GDP (non-agricultural) Non-agricultural unemployment
V.	<u>Government Sector</u>	<u>Determinants</u>
A.1	Personal Tax	Non-agricultural personal income Lagged income
A.2	All six expenditure tax bases (petrol, beer, spirits, tobacco, whole-sale and turnover tax)	Personal consumption

A.3	Corporate Income Tax	Undistributed profits
A.3	Corporate Profits Tax	Total company profits Corporate tax rate
VI.	<u>Income Sector</u>	<u>Determinants</u>
A.	Corporate Profits	GNP

---

## VALIDATION

Only a linearised version was solved. No tracking performance was published. Short-run and long-run elasticities with respect to GNP were calculated by means of the linearised reduced form equations.

## USE

Quantification of short-run and long-run elasticities of GNP on several major sources of government revenue (i.e. taxes on expenditure, corporation tax, personal income tax, social insurance contributions, total tax revenue.)

## COMMENTS

The model was constructed with the sole purpose of examining the flexibility of the taxation system, i.e. how tax revenues vary with income. We therefore consider the model in terms of its adequacy for the stated purpose.

A major criticism of the model is that GNP is exogenous with, on the expenditure side, only personal consumption and imports endogenous.

The author wished to calculate elasticities of various tax revenues with respect to changes in real and nominal GNP. Hence the use of an exogenous GNP variable. A better procedure, would have been to calculate such elasticities, in the context of a model with endogenous GNP, by means of "indirect multipliers".



The price sector is rudimentary with very simple specifications used.

For example, the crucial consumption price equation is:

$$PC = a_0 + a_1 \text{TEXP} + a_2 \text{RW} + a_3 \text{PM}$$

where PC is the consumption price, TEXP is total revenue from expenditure taxes, RW is the real non-agricultural wage rate, and PM is the import price index.

This may be mis-specified as to the form of the indirect tax effect on prices and in the manner in which wages influence prices.

Furthermore, the coverage of the economy is sketchy in some relevant and important areas, e.g. there is no feedback from prices to wages, which equation is not necessary in the model since it is effectively exogenous:

NORTON - 1973**PURPOSE**

Construction of a general purpose macromodel of the Irish Economy.

Analysis of the short-run effects of fiscal policy for the period 1960-1970.

**MAIN FEATURES**


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<b>I.</b>	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Personal Consumption (vol)	Change in real personal disposable income Real personal disposable income (lagged)
B.1	Gross Private Fixed Investment (vol.)	Real undistributed profits after tax Real capital transfer by government to households and to enterprises Lagged change in GNP (vol.)
E.1	Total Imports (vol.)	Total investment (vol.) Demand measure (consumption plus exports plus stock changes)

<b>VI.</b>	<u>Income Sector</u>	<u>Determinants</u>
A.	Undistributed Company Profits before Tax	Nominal GNP Difference between rate of growth of nominal GNP and of nominal industrial earnings

---

In addition, three nonstochastic behavioural equations relate indirect tax revenue, direct personal income, and corporation tax revenue to tax bases and marginal tax rates:

$$T_l = t_l \cdot (P.C)$$

$$T_d^p = t_d^p \cdot (YV)$$

$$T_d^c = t_d^c \cdot (PROF_{t-1})$$

Where	$T_i$	=	Total indirect tax revenue, less subsidies
	$T_d^p$	=	Total direct personal tax revenue
	$T_d^c$	=	Total direct tax revenue from companies
	$P$	=	Net of indirect tax consumption price deflator
	$YV$	=	Nominal GNP
	$PROF$	=	Undistributed profits of companies before tax

and the  $t$ 's are the relevant marginal tax rates.

In order to use the model for short-run fiscal policy analysis seven policy instruments are isolated. These are:

- (nominal) government expenditure on goods and services;
- (nominal) government investment;
- (nominal) capital transfers to companies and households;
- Marginal indirect tax rate;
- marginal rate of direct personal taxation;
- marginal rate of corporation tax;
- other transfer incomes.

Government fiscal policy is defined as "non-discretionary" when all nominal quantities and marginal tax rates are fixed at the previous years values.

The difference between the actual out-turn for real GNP (actually, the model simulated value) and the non-discretionary out-turn is defined as the "discretionary" effect.

Using this approach, Norton determined that, on average, about one half of the growth rate for the period 1960-1970 was due to expansionary fiscal measures.

## VALIDATION

Single period simulations for the period 1960-1970 showing actual vs predicted real GNP.

## USE

Examination of the short-run effects on real GNP and on the balance of payments of fiscal policy using the methodology of Hansen (B. Hansen assisted by Wayne Snyder, Fiscal Policy in Seven Countries, 1955-1965, OECD, Paris, 1968.)

## COMMENTS

This study was the first attempt to use an explicit endogenous and simultaneous framework for analysing the impact of Irish government policy over some historical period. However, rather than comment on the analytical framework, i.e. the Hansen framework for analysing the discretionary and non-discretionary impact of the government budget as used by Norton, we confine our remarks to the economic structure of the model:

- the consumption function is of the standard permanent income type with an estimated short-run MPC of 0.74 and a long-run MPC of 0.80;
- the investment equation is a hybrid type with a marginal net-of-tax undistributed profits coefficient of 0.27, a marginal real capital transfer coefficient of 3.04 and an accelerator coefficient of volume change in GNP of 0.23.

The capital transfer effect is very high and, in the absence of lags, is unrealistic. The main expansionary effect of the model may be operating through this coefficient.

The imports equation essentially assigns weights to two components of domestic demand, i.e. 0.78 to total investment and 0.55 to the sum of private consumption, exports, and stocks. However the import content of real government expenditure on goods and services is ignored. Hence the impact of this instrument of growth may be greatly exaggerated.

SMYTH - 1974**PURPOSE**

To modify the conventional short-run comparative-static macroeconomic model to allow for the key characteristics of the Irish economy.

**MAIN FEATURES**


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I.	<u>GNP by Expenditure (Real)</u>	<u>Determinants</u>
A.1	Consumption	Real income Real tax revenues
B.	Total Investment	Rate of Interest
D.	Exports (Net) to United Kingdom	Irish price level UK price level Output Other UK variables
	Exports (Net) to Other Countries	Irish price level Foreign (non-UK) price level Output
II.	<u>Labour Sector</u>	<u>Determinants</u>
A.	Labour Demand	Marginal product of labour Price level UK variables
B.	Labour Supply	Real wage Price level UK variables
IV.	<u>Output</u>	<u>Determinants</u>
E.	Aggregate	Employment (Capital Stock Fixed)

---

The key characteristics of the Irish economy identified and emphasised are:

- the Irish rate of interest is determined by the UK interest rate, i.e. the LM curve is horizontal and monetary policy has no independent role:

- a higher proportion of Irish trade is with the UK
- the Irish pound exchange rate with sterling is fixed
- labour moves between Ireland and the UK in response to relative economic conditions.

The specified relationships define aggregate demand and supply schedules which determine equilibrium price and output.

The aggregate demand curve for the Irish economy is stated in the form

$$\begin{aligned}
 Y &= G + I + \bar{G} + U + V \\
 C &= C(Y, \bar{T}), \quad 0 < C_Y < 1, \quad C_T < 0 \\
 I &= I(\bar{R}), \quad I_R < 0 \\
 U &= U(\bar{P}, \bar{B}, Y, \bar{Z}), \quad U_Y < 0, \quad U_P < 0, \quad U_B > 0 \\
 V &= V(\bar{P}, \bar{A}, Y), \quad V_Y < 0, \quad V_P < 0, \quad V_A > 0
 \end{aligned}$$

where

Y	=	output (volume)
C	=	consumption
I	=	Investment
G	=	government expenditure
U	=	net exports from Ireland to the U.K.
V	=	net exports from Ireland to rest of world
$\bar{R}$	=	rate of interest
$\bar{P}$	=	Irish price level
$\bar{B}$	=	UK price level
$\bar{A}$	=	rest of world price level
$\bar{Z}$	=	other UK variables (e.g. unemployment, etc)
$\bar{T}$	=	tax revenues

The linearised form is

$$(1 - C_Y - U_Y - V_Y) dY - (U_P + V_P) dP = C_T dT + dG + I_R dR + U_B dB + V_A dA + U_Z dZ$$

The aggregate supply curve is derived as follows.

In the short-run,

$$Y = Y(E)$$

where

$E$  = Employment, and

$$MPL = Y_E > 0$$

The supply of labour is written as

$$E = E\left(\frac{W}{P}, P, Z\right)$$

where  $W$  = nominal wage rate. The case of no money illusion means  $E_P = 0$ :

money illusion means  $E_P > 0$ .

Assuming profit maximization and competition, the labour market equilibrium will mean that

$$MPL = W/P$$

Hence,

$$E = E(MPL, P, Z), \quad E_P = 0, \quad E_{MPL} > 0$$

and the linearised supply function becomes

$$dY - MPL \cdot E_P dP = MPL \cdot E_{MPL} dMPL + MPL \cdot E_Z dZ.$$

## VALIDATION

Not applicable

## USE

Comparative-static analysis of the Irish economy. Output and price multipliers, with respect to taxes, government spending etc., and UK. Variables, especially the price level, are derived and analysed. These results are summarised in Table 1.

Table 1: Price and Output Multipliers

	$E_P > 0$ [ $\Delta =$ $-NE_P(1-C_Y-U_Y-V_Y) + (U_P + V_P)$ ]	$E_P = 0$ [ $\Delta = U_P + V_P$ ]	$E_P > 0$ [ $\Delta =$ $-NE_P(1-C_Y-U_Y-V_Y) + (U_P + V_P)$ ]	$E_P = 0$ [ $\Delta = U_P + V_P$ ]
$\frac{dY}{dT}$	$\frac{-C_T NE_P}{\Delta} < 0$	0	$\frac{dP}{dT}$ $\frac{-C_T}{\Delta} < 0$	$\frac{-C_T}{\Delta} < 0$
$\frac{dY}{dG}$	$\frac{-NE_P}{\Delta} > 0$	0	$\frac{dP}{dG}$ $\frac{-1}{\Delta} > 0$	$\frac{-1}{\Delta} > 0$
$\frac{dY}{dR}$	$\frac{-I_R NE_P}{\Delta} < 0$	0	$\frac{dP}{dR}$ $\frac{-I_R}{\Delta} < 0$	$\frac{-I_R}{\Delta} < 0$
$\frac{dY}{dB}$	$\frac{-U_B NE_P}{\Delta} > 0$	0	$\frac{dP}{dB}$ $\frac{-U_B}{\Delta} > 0$	$\frac{-U_B}{\Delta} > 0$
$\frac{dY}{dA}$	$\frac{-V_A NE_P}{\Delta} > 0$	0	$\frac{dP}{dA}$ $\frac{-V_P}{\Delta} > 0$	$\frac{-V_A}{\Delta} > 0$
$\frac{dY}{dN}$	$\frac{NE_N(U_P + U_P)}{\Delta} > 0$	$\frac{NE_N(U_P + V_P)}{\Delta} > 0$	$\frac{dP}{dN}$ $\frac{NE_N(1-C_Y-U_Y-V_Y)}{\Delta} < 0$	$\frac{NE_N(1-C_Y-U_Y-V_Y)}{\Delta} < 0$
$\frac{dY}{dZ}$	$\frac{N\{E_Z(U_P + V_P) - E_P V_Z\}}{\Delta} \cong 0$	$\frac{NE_Z U_P}{\Delta} \cong 0$	$\frac{dP}{dZ}$ $\frac{NE_Z(1-C_Y-U_Y-V_Y) - X_Z}{\Delta} \cong 0$	$\frac{NE_Z(1-C_Y-U_Y-V_Y) - X_Z}{\Delta} \cong 0$



DESMOS - 1974

## PURPOSE

The construction of nine macromodels of the members of the EEC to study the interaction of policies and economic developments in the EEC. For this the models were specified in a similar way. They also sought to have reliable short- and medium-term properties.

## MAIN FEATURES

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I.	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Personal Consumption (vol.)	Real disposable income Lagged consumption
B.1	Gross Fixed Capital Formation (vol.)	Ratio of change in nominal GDP to cost of capital (lagged) Above, lagged twice Real capital stock (lagged)
C.	Stock changes (vol.)	Change in GNP (vol.)
D.1	Exports of Goods (separate equations for eight member states and rest of world)	Relative export and import prices Relative production capacities Relative pressures of demand Various dummy variables related to trade organisations (EFTA, EEC, etc.)
D.2	Exports of Services (vol.)	Total exports of goods (vol.)
E.	Imports of Goods and Services (vol.)	Final expenditure weighted by import content (vol.) Relative prices
E.	Imports of Goods (vol.)	Imports of goods and services (vol.)
II.	<u>Labour Sector</u>	<u>Determinants</u>
A.	Total Employment	GDP at factor cost (vol.) Capital stock (vol.) Time trend Lagged employment

III.	<u>Prices Sector</u>	<u>Determinants</u>
A.1	Consumption (private)	Wages Import prices
A.1	Consumption (public)	Wages
A.1	Gross Fixed Capital Formation	Wages Import prices
A.1	Exports (in national currency)	Wages Import prices
B.	Wages	Unemployment Consumption prices
VI.	<u>Income Sector</u>	<u>Determinants</u>
F.	Disposable Income (value)	GNP (value)

Each country sub-model in DESMOS consists of four blocks of equations:

- (i) a factor demand block
- (ii) an income and expenditure block
- (iii) a wage-price block
- (iv) a trade linkage block

The factor demand block determines total investment and employment. The original intention to use the Hickman-Coen joint factor demand approach failed for Ireland uniquely for the EEC countries; FANNING - 1979 contains estimates of the Hickman-Coen joint factor demand system for the Industry sector. Investment was determined by a Jorgenson type neoclassical equation and employment was estimated by imposing the production function parameters (separately estimated) on the Hickman-Coen formulation, leaving only adjustment lags to be estimated. Unemployment is determined as the difference between labour demand and an exogenous labour supply.

The consumption function is of standard permanent income type. Note that disposable income is estimated as a function of nominal GNP, thereby obviating the need to model the government sector in any detail. Changes in stocks were estimated as 10 per cent of GNP plus an intercept.

In the wage-price block, wages are linked to prices and unemployment and prices are determined by cost push formulas, as functions of wages and import prices.

In the trade block exporters are assumed to be price setters and quantity takers. Imports are determined by final expenditure weighted by import content. Irish exports of goods to each of the other eight members of the EEC and to the rest of the world are modelled by means of bilateral trade flow equations. Exports of services are then made a function of total goods exports.

The multiplier analysis carried out with DESMOS examines the impact of synchronised economic policies within the EEC. However, single country multipliers are also presented.

#### VALIDATION

No within-sample simulation presented various multipliers calculated for the entire linked system.

#### USE

Examination of the international transmission of economic fluctuations, and the co-ordination of EEC economic policies. In particular they sought to determine the feasibility of synchronised community economic policy.

**COMMENTS**

The structure of the Irish sub-model in DESMOS (which is the aspect of interest in this survey) was determined by the overall aims of the DESMOS project, i.e. the submodels should have the following characteristics:

- (i) equations should be specified in a single and easily understandable way,
- (ii) similar equations should be used for all sub-models,
- (iii) no special data should be required,
- (iv) each sub-model should have reasonable short- and medium-term properties,
- (v) the properties of the model should be clearly understood.

It therefore does not attempt to take into account many features specific to the Irish economy or environment.

KENNEDY/DOWLING - 1975

## PURPOSE AND APPROACH

The Kennedy and Dowling (1975) study is a comprehensive examination of economic growth in Ireland. The emphasis is on the behaviour of the components of aggregate demand, changes in the structure of the economy and the major economic forces underlying these changes, and the short-run management of the economy (K-D: xv). As the authors point out, there are various levels at which the marked rise in the longer-term growth rate of GNP, and economic progress more generally, which occurred from about 1960, might be explained. As well as describing the historical experience they seek to isolate the "key economic factors at work" to which the broader "non-economic" forces might be linked (K-D: xvi). To achieve this they "investigate certain factors which are usually postulated as causes of growth and which seem related, in the Irish case, to the acceleration of economic growth " (K-D: xvi).

The six factors which appeared to be most relevant (K-D: xvi-xvii) were:

- (1) Growth of exports
- (2) Growth of fixed investment
- (3) Behaviour of the saving ratio
- (4) Effect of structural changes on short-term fluctuations
- (5) Effect of policy measures on short-term fluctuations
- (6) Relation between short-term fluctuations and longer-term growth.

Thus the framework specified involves the impact on the longer term growth rate of the behaviour and interaction of (a) key variables (exports, fixed investment, savings), (b) economic processes (structural changes, economic policy) and (c) short-term fluctuations.

Because this is an explicitly analytical and systematic study of these factors between 1947 and 1968 it is necessary to review briefly the main aspects in order to identify a core model. (For purposes of interpretation it is worth noting that, ignoring the preliminary survey of aggregate output and expenditure growth (58 pages), the book is divided into four main sections: an analysis of exports (84 pages); savings and consumption (15 pages); investment (19 pages) and fiscal policy and demand management (63 pages). A final section (47 pages) extends the account from 1968-1972).

## 1. EXPORTS

The role of exports is considered both at a fairly general theoretical level and at a level of disaggregation. Three main categories of exports are analysed in detail.

### Manufactured Exports

- A rising domestic demand does not hold back export growth.
- Defining a rise (fall) in export competitiveness as a rise (fall) in the market share of individual commodities, then over the 1950s and 1960s there was a relatively substantial increase in exports due to improved competitiveness.
- Improvements in competitiveness may be partly explained by changes in the Irish export price relative to the UK import price and the export prices of other countries, though the evidence is not very conclusive.
- Over the 1950-1970 period, Ireland exploited its "potential" competitiveness to an increasing degree.
- Exports increased over the period as a fraction of gross output.

### Agricultural Exports

- Agricultural output, exports and stocks show large short-run fluctuations, while domestic consumption of agricultural products remains largely stable.
- Over 80% of output of cattle and beef is exported.

- Demand conditions in the UK, the main market, improved through 1950-1970 through negotiation of more satisfactory trade arrangements.
- Supply of cattle and beef increased as a result of policy measures and in response to better demand conditions.

#### Tourism Exports

- The growth rate of earnings from tourism increased greatly in the period 1958-68 over the earlier period 1949-1958, due to removal of restrictions and to incentives and development measures.
- Given its size as a fraction of export earnings (36.7% of total invisible earnings in 1968) this was an important factor in overall growth of GNP.

### 2. SAVINGS AND CONSUMPTION

The rise in the savings ratio and the components of savings (personal, company and public) are examined.

- The rise of the overall savings ratio from an average of 12.8% of GNP in 1949 to 1960, to an average of 17.6% in 1961-68 was crucial in permitting an expansion investment without excessive balance of payments difficulties.
- Improvements in the terms of trade facilitated the rise in the savings ratio in the period 1961-68 by about 2 percentage points.
- A formal econometric equation was constructed to explain the personal savings ratio as a function of real personal per capital disposable income, ratio of farm income to personal disposable income, a direct and an indirect tax effect, the employment dependency ratio, change in the population, change in private domestic credit, real interest rate.

### 3. INVESTMENT

Investment is examined at an aggregate level, and broken down by type of capital good and by sector of use. The relationship between investment, output and labour productivity is examined using gross incremental capital - output ratios (GICOR).

- The large fall in the GICOR in the 1961-68 period compared with 1949-60 was important in permitting a faster rate of growth of output without a substantial

rise in the investment ratio.

Infrastructural investment undertaken in 1949-61 was used more intensively in the 1961-68 period.

#### 4. DEMAND MANAGEMENT

The role of fiscal policy over the period 1947-68, in particular current and capital expenditure and taxation policy, is discussed. The main short-term constraint perceived by the government appeared to be the balance of payments which, in the short-term (with exogenous exports and exogenous capital flows) is simply a function of consumption, investment and import demand. The action of the public authorities in attempting to stabilise the balance of payments at zero led to large fluctuations in GNP. Only in the 1960-68 period was the constraint on the balance of payments relaxed and fiscal policy was used to stabilise aggregate demand and, hence, employment.

In summarising their treatment of the role of exports in generating growth, Kennedy and Dowling comment as follows:

"The 1960s, in contrast with the 1950s, offer us an example of the virtuous circle where growth feeds on growth - at least up to near full employment. Faster growth of exports and expansionary fiscal policy created adequate pressure of demand, rapid growth of output, a rising investment ratio, a faster growth of real income per capita, reduced emigration and a rising savings ratio. In turn, the rising savings ratio permitted an increasing investment ratio without unduly large balance of payments problems, thereby increasing capacity and the potential for further growth. A great deal of prominence has been accorded to the rise in manufactured exports, and indeed, this was very important; but equally striking, in our view, was the expansion in tourism and building." (K-D: 248-249)



On the basis of the above summary the underlying model is regarded primarily as an export-led growth model. The extensive discussion of demand management is not conducted in the context of this medium-term growth framework. Rather, a very short-term model seems to underlie the discussion of the role of fiscal policy. Thus to the extent that stylised formal models can be identified, in a manner suitable for comparison with those examined earlier, there would seem to be two such models underlying the Kennedy-Dowling analysis. For a medium-term export-led growth model we follow that in John Cornwall's Modern Capitalism (Martin Robertson, London, 1977: Chapter 9). The short-term demand management model is of a standard small scale type for such models. These are designated Model-I and Model-II, respectively and are outlined in Table 13 (the numbering in the following discussion corresponds to equation numbers in the table.)

## MAIN FEATURES

### Model-I

1. Aggregate output growth is driven by export growth and other demand.
2. Export performance is explained in terms of the competitive strength of the export sector (i.e., the domestic price inflation rate relative to the foreign price inflation rate) and other factors.
3. The growth of labour productivity is related to output growth (Verdoorn's Law). Either this relationship can be assumed to hold directly or it can arise indirectly by means of the growth of output inducing a rising investment ratio (I/Q).
- 4-7. These aspects are not examined explicitly by Kennedy-Dowling but fill in the elements necessary to determine employment and unemployment (by identities 4, 5) using labour force participation (6) and emigration (7) functions.
- 8-9. Again, while not explicitly treated, the wage-price sector is sketched. In order to perpetuate the virtuous circle and not cut off the competitiveness induced growth of exports, nominal wage increases must be related to productivity growth (8) and firms set price on the basis of a constant mark-up on average labour costs (9).

Table 13: 'Core' Models, Kennedy/Dowling - 1975

Model I: Export-led growth model

(. denotes rates of growth)

$$\begin{aligned}
 1: \quad \dot{Q} &= \alpha_0 + \alpha_1 \dot{X} + \alpha_2 \dot{OD} \\
 2: \quad \dot{X} &= \beta_0 + \beta_1 \left(1 - \frac{\dot{P}}{P_f}\right) \\
 3: \quad \dot{q} &= \gamma_0 + \gamma_1 \dot{Q} \\
 4: \quad \dot{L} &= \dot{Q} - \dot{q} \\
 5: \quad U &= LF - L \\
 6: \quad \dot{LF} &= \delta_0 + \delta_1 \dot{POP} + \delta_2 \dot{NMA} \\
 7: \quad \dot{NMA} &= \eta_0 + \eta_1 (\dot{U} - \dot{U}_{uk}) + \eta_2 (\dot{W} - \dot{W}_{uk}) \\
 8: \quad \dot{W} &= w_0 + w_1 \dot{q} \\
 9: \quad \dot{P} &= \dot{W} - \dot{q}
 \end{aligned}$$

Model II: Short-term Demand Management

(- denotes exogenous variable)

$$\begin{aligned}
 1: \quad Q &= C + I_p + \Delta S + \bar{I}_g + \bar{G} + \bar{X} - M \\
 2: \quad C &= \phi_0 + \phi_1 Q \\
 3: \quad I_p &= \theta_0 + \theta \Delta Q \\
 4: \quad \Delta S &= \varepsilon_0 + \varepsilon_1 Q + \varepsilon_2 S_{-1} \\
 5: \quad M &= \mu_0 + \mu_1 Q \\
 6: \quad BP &= \bar{P}X - P_f M - NFI \\
 7: \quad L &= \lambda_0(Q)^{\lambda_1}
 \end{aligned}$$

NOTATION:

BP -	Balance of Payments *	NFI -	Net Capital Inflows *	S -	Stocks
C -	Personal Consumption	NMA -	Net Migration Abroad	U -	Unemployment
G -	Gov. Current Expenditure	OD -	Other Domestic Demand(C+I+G)	$U_{uk}$ -	Unemployment in UK
$I_g$ -	Public Investment	P -	Domestic Price	W -	Wage Rate
$I_p$ -	Private Fixed Investment	$P_f$ -	Foreign Price	$W_{uk}$ -	Wage Rate in UK
L -	Employment	POP -	Population	X -	Exports
LF -	Labour Force	q -	Output-per-worker		
M -	Imports	Q -	GDP (Output/Expenditures)		

\* - denotes variables in nominal values; greek letters denote coefficients.

The main property of the model is its explicit identification of a driving force (exports) for growth in the economy and longer-term orientation. Since the authors state that their purpose was to "investigate certain factors which are usually postulated as causes of growth" (K-D: xvi) rather than specify a formal model of the growth process, or to apply "rigorous tests to various theoretical models" (K-D: xv), the model proposed can only be taken as representative of the type of model towards which their study leads. It can be modified to include investment induced growth. Thus, as with ED-1958 we do not, with one exception below, address the detailed structure of the model,

#### Model-II

The main features and properties are those of similar small scale short-term demand management models, such as Norton's, and have been considered in connection with previous models in the survey. From the analysis conducted and in a short-run context, the government target in the period prior to the early 1960's was the Balance of Payments and the rate of growth of demand and output fluctuated accordingly. In the later period the target became the growth rate and the Balance of Payments was treated, with varying and generally increasing leniency, as a constraint.

#### VALIDATION

Not applicable

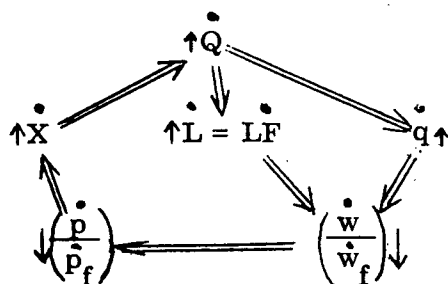
#### USE

Models underlying or emerging from detailed study of the long-run growth process and short-run fluctuations of the Irish economy.

#### COMMENTS

One unsatisfactory feature of the model concerns the role of the labour market. For example, it is assumed that conditions in the labour market (as measured by, say,

the unemployment rate) do not influence wage formation. This will be true if, whatever the growth in demand for output (and, hence, for labour), labour supply responds so as to maintain a roughly constant unemployment rate. The virtuous circle of export-led growth (outer loop) modified for this aspect becomes (Cornwall 1977: 167-170):



If the model is particularised to the manufacturing sector, given the decline in agricultural employment and flexible migration flows, the above is a fairly accurate picture of the Irish situation during the 1960's. It also provides a possible cause for the start-up of the export-led growth process. The UK, our main trading partner, experienced excess demand for labour, causing certain Irish relative wage costs to fall, thus boosting exports.

There is no explicit analysis in terms of the inter-relationship between the two models. Thus in the treatment of fiscal policy over the period 1950-1968 the relationship with the previous growth context is not explored beyond the acknowledgement that the expansionary fiscal policy in 1960-68, by providing for a high and steady growth in aggregate demand, laid the groundwork for the successful initiation of a virtuous circle growth process whose explanation lies elsewhere in the study.

SPENCER/HARRISON - 1975

## PURPOSE

The specification of a formal macromodel of the Irish and Northern Ireland economies. The examination of policy implications and external influences from Britain by means of comparative static analysis techniques.

## MAIN FEATURES

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I.	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Consumption (vol.)	Real disposable income Real government transfers
B.1	Total Investment by Domestic Concerns (vol.)	Real GNP GB real GNP Real interest rate Real transfers from government
B.1	Total Foreign Investment	GB real GNP Real interest rate Real transfers from government
D.	Total Exports (vol.)	GB real GNP Relative GB-Irish prices
E.	Total Imports (vol.)	Gross Domestic Expenditure (C+I+X) Government expenditure on goods and services Relative GB-Irish prices
II	<u>Labour Sector</u>	<u>Determinants</u>
A.	Total Labour Demand	Real GNP
III.	<u>Prices Sector</u>	<u>Determinants</u>
A.1	Aggregate Price Deflator	GB price deflator Unemployment rate
B.	Aggregate Wage Rate	GB wage rate Unemployment rate
V.	<u>Government Sector</u>	<u>Determinants</u>
A.1	Aggregate Tax on Income	GNP

---

It is a fairly conventional small open economy model.

Investment is split into investment by domestic concerns and investment by foreign concerns. In determining foreign investment, the domestic GNP term is deleted on the grounds that sales in Ireland are not particularly important compared with expected sales in Great Britain (or elsewhere).

The trade equations are demand determined, with relative price terms. The labour demand is derived from an inverted production function, where, in the short-run, it is assumed that the capital stock is fixed. The wage rate equation is a variant of the Phillips curve.

#### VALIDATION

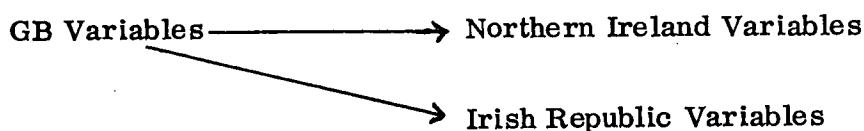
None

#### USE

Comparative static analysis of the impact of a tax rate change on unemployment and output; an increase in borrowing on unemployment; an increase in Great Britain's real GNP on unemployment; an increase in GB prices on Irish prices.

#### COMMENTS

An examination by the authors of the empirical evidence on the relationships between the three economies indicated that the chain of economic causation operates in the following way.



Hence, the comparative-static analysis of changes in GB real GNP (say) takes into account the direct impact on the Irish Republic and the indirect impact via induced changes on the Northern Ireland economy.

Furthermore, there is no feedback of changes in economic activity in the Irish model to the Northern Ireland model.

This model can yield only the direction of a policy effect. It cannot quantify the magnitude or importance of the effect.

The model, although specified formally in mathematical terms and intended as the overall framework for individual sector empirical studies, was never estimated empirically.

COMET II - 1976**PURPOSE**

The development of a set of interrelated medium-term macroeconomic models for the nine EEC countries, the structures to be similar (to enable meaningful intercountry comparisons) and the specification to enable the study of the interaction between supply and demand factors.

**MAIN FEATURES**

I.	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Per capita Private Consumption (value)	Per capita disposable income above, lagged Consumption deflator (+ lag) Ratio of short to long term interest rates Lagged consumption
A.2	Public Consumption (value)	Private consumption Capacity utilization (+ lag)
B.1	Gross Investment in fixed assets (actual, vol.)	"Desired" investment Import - cost of capital price ratio Capacity utilization
B.1	"Desired" Investment	Output (+ lag) Factor price ratio Employment Capacity utilization
C.	Stock changes	Final demand (excluding stock changes) Deflator of above Capacity utilization
D.1	Exports of commodities to rest of non-EEC world	Real imports of rest of world Relative prices





A.1	Exports of Goods Price	Average labour cost per unit of output Cost of capital Price of commodity imports "Competitive" export price Capacity utilization
B.	Wage rate	Labour productivity Unemployment rate Consumption price Employers Social Insurance contributions
IV.	<u>Output Sector</u>	<u>Determinants</u>
E.	GNP (volume) (implicit in COMET via vintage production function)	Employment Investment Time trend
E.	Capacity Utilization	Output Labour supply Investment Time trend
V.	<u>Government Sector</u>	<u>Determinants</u>
A.3	Corporate Tax Revenue	National Income net of wage bill Lagged dependent variable
VI.	<u>Income Sector</u>	<u>Determinants</u>
C.	Depreciation (nominal)	Nominal investment Investment price "Other" income
F.	Disposable Income of Households	Wage bill Social Security contributions National Income at factor cost

---

COMET II has an explicitly medium-term perspective.

Very explicit treatment of capacity utilization and productive capacity, developed by means of an aggregate vintage production function. This capacity utilization variable has an all-pervading influence on the entire structure of the model, both as an explanatory variable in expenditure and demand for factors of production and to explain part of the variation in prices. In the context of Ireland, it is difficult to accept this definition of capacity as the most meaningful, particularly in light of recent studies dealing with the calculation of the full-employment labour force in Ireland.

The determination of total investment is closely linked to the definition of capacity in COMET II and is related to that component of capacity utilization which is related to the utilization of fixed capital.

In COMET II it is assumed that the domestic production function is separable into domestic inputs and imported inputs. Hence, the decision on inputs is a two-stage process:

- (i) A decision is made on what to import and what to produce domestically. Total imports are a function of weighted final demand, relative prices and capacity utilization.
- (ii) The actual composition of local inputs and imported inputs is determined, given the total needs of each. Hence, the "fixed" imports of goods is allocated over their country of origin (seven EEC countries and the rest of the non-EEC world) by a bilateral trade flow technique.

Demand for labour is determined from an inverted production function (desired demand) and a partial adjustment of actual to desired (where the determining factors are relative wage-price and capacity utilization.) Supply of labour is by means of a fairly standard participation rate equation (with a negative real wage term.) Migration flows are ignored in the labour sector.

The actual wage rate is a distributed lag over differences between the "desired" and the actual wage rate, together with an unemployment influence. But the production function used, together with profit maximising behaviour, implies a long-run wage rate proportional to productivity. Hence, productivity features in the wage equation also.

Most of the prices in COMET II are derived using a uniform methodology. Actual prices adjust to "theoretical" prices by a partial adjustment mechanism and include a capacity utilization "pressure" effect. The determinants of "theoretical" prices vary between different deflators and the resulting equations are summarised above.

Because COMET II is a set of linked models to the EEC countries, its treatment of inter-member trade can be endogenised within the overall model.

On the export side of COMET II, given its closed nature, it is only necessary to endogenise exports of goods to the non-EEC rest of the world and exports of invisibles. The explanatory variable in the former is total rest-of-world imports from the EEC, and in the latter is total exports of goods.

#### VALIDATION

Within sample dynamic simulations for 1964- 1972 for major endogenous variables and tracking performance analysis. Detailed estimation results also published for entire model.

#### USE

Out-of-sample forecasts for 1973-1980. Model sensitivity analysis with respect to changes in isolated country models (exchange rate changes, investment changes and changes in growth of world imports.)

#### COMMENTS

The rationale for the construction of COMET II was based on the following two points:

- (i) The EEC member countries display intensive mutual economic interrelations, which are becoming stronger over time.
- (ii) Because of this interdependence, a tool of examining the inter-country effects of national policies, and of exogenous shocks from outside the EEC, is desirable.

COMET II has a rigid and uniform structure for all member states.

Consequently, since the data sample is small (1953-1972) it is unlikely that the data could be able to discriminate finely between alternative specifications.

Hence, the domestic influences which one would expect to be dominant in the larger countries (France, Germany, England) are also very much in evidence in Ireland. This is somewhat paradoxical, since conditions in Ireland are likely to deviate from those of its major trading partners. For example, in the medium term simulations for the period 1973-1980, Ireland has the lowest EEC inflation rate (jointly with Belgium) which is a full  $2\frac{1}{4}$  percentage points lower than Germany and  $6\frac{1}{2}$  percentage points lower than the UK.

The following criticisms can be made of the prices sector:

- (i) the domestic labour cost term has a very important role in the COMET II price sector. This causes behaviour in the medium-term which is at variance with the small size and openness of the Irish economy.
- (ii) Indirect taxes influence prices in a very simple and crude manner.
- (iii) The manner in which the "competitive" export price index is derived in COMET II gives rise to serious difficulties in the case of Ireland, whose trade is dominated by competition on the UK market.

Multiple period simulations for the within-sample period 1964-1972 were carried out with COMET II. The results for Ireland are very poor and hardly inspire confidence in its specification vis-a-vis Ireland. Out-of-sample simulations for the period 1973-1980 are also implausible and suggest serious mis-specification in the case of the Irish model.

Consumption expenditure by the government is endogenous, and based on the assumption that policy makers wish to maintain some equilibrium between private and public expenditure. Given the medium-term nature of COMET, and the fact that it was not intended to model the government sector in any detail this is an appropriate method of linking the government and private sectors. Nevertheless, the government sector of COMET II is simple in structure and it could not be used to carry out inter-member fiscal policy analysis in any great detail.

Diverse sectors such as Agriculture, State and Private Industry, Private Services and government are added together for output and investment purposes, although there is a distinction between private and public consumption.

FANNING - 1979**PURPOSE**

A general purpose macromodel of the economy, specifically to be used for the evaluation of aggregate employment policy during the period of economic programming 1958-1973.

**MAIN FEATURES**


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<b>I.</b>	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Real Personal Expenditures (disaggregated into non-durables, services, durables, rent and personal services) on a per capita basis	Real disposable per-capital income income Real exports of Tourism (per capita) Real per capita liquid assets (lagged) Prices of durables, non-durables and services to total consumption price.
B.1.a	Demand for Real Capital by Industry	Real industrial output Relative price of capital and labour Lagged capital stock Time trend
B.1.b	Demand for Real Capital by Services Sector	Real service sector output Employment in service sector Lagged capital stock
B.1.c	Government Investment by Housing	Real per-capita GDP Lagged investment
B.1.e	Private Residential Investment	Share of agricultural output in total GDP. Change in total population Deposits with other financial institutions (i. e. , Building Societies, etc.) Real government housing grants
D.1	Exports of Goods (SITC 0 + 1)	Rate of change of industrial output Real agricultural output Real exports of industrial countries Relative price term Lagged exports

D.1	Exports of Goods (SITC 2 + 3 + 4)	Real exports of industrial countries Relative price term Lagged exports
D.1	Exports of Goods (SITC 5+6+7+8+9)	Rate of change of industrial output Real exports of industrial countries Relative price term Lagged exports
E.1	Imports of Goods (SITC 0 + 1)	Real non-durable consumption Exports (SITC 0 + 1) real Relative price term
E.1	Imports of Goods (SITC 2 + 4)	Real industrial output Lagged import reserve cover Time trend Lagged imports
E.1	Imports of Goods (SITC 3)	Real private sector output Lagged imports
E.1	Imports of Goods (SITC 5 - 9) (less investment goods)	Output of industry and services (real) Real personal consumption of durables and non-durables Relative price term Ratio of external reserves to balance of payments (lagged) Lagged imports
E.1	Imports of Investment Goods ready for use	Real industrial investment Real services investment Ratio of external reserves to balance of trade (lagged) Lagged imports

<b>II.</b>	<u>Labour Sector</u>	<u>Determinants</u>
A.1	Employment in Industry	As for investment in industry
A.2	Employment in Services	As for investment in services
B.1	Change in Population aged 15 +	Net migration Time trend
B.2	Net migration as a fraction of population	Relative UK-Irish unemployment rates Relative UK-Irish real wages Lagged migration term
B.3	Labour Force Participation	Real wage in industry Relative ratio of employees in employment to civilian labour force in Ireland and the UK Relative real industrial wage rates in Ireland and the UK Industrial capacity utilization

III.	<u>Price Sector</u> (All rates of change of deflators for A.1)	<u>Determinants</u>
A.1	Non-Durable Consumption	WPI for agricultural materials Indirect tax rate (percentage change) Industrial output price Agricultural output price
A.1	Durable Consumption	WPI for more elaborately transformed goods Indirect tax rate (percentage change) Industrial output price
A.1	Services Consumption	Indirect tax rate (percentage change) Services output price Fuel prices
A.1	Government Consumption of Goods and Services	Services output price Government wages (percentage change)
A.1	Industrial Investment	Industrial output price Housing investment Import of other goods
A.1	Exports of Materials	Industrial output price Raw materials imports
A.2	Industrial Output	User cost of capital (industry) Wages in industry Output in industry Time trend Lagged price term
A.2	Services Output	Capacity utilization Wages in services User cost of capital (services) Output of services Lagged price term
B.1	Industrial Wage Rate	Rate of change of consumption deflator Rate of change of social insurance contribution rate Time trend
IV.	<u>Output Sector</u>	<u>Determinants</u>
A.	Industry	Real domestic credit (lagged) Real consumption of goods Total fixed investment Net exports of SITC 5 - 9

- |    |             |   |
|----|-------------|---|
| B. | Services    | Real per capita personal disposable income<br>Tourism exports |
| D. | Agriculture | Profitability Index (output prices/input prices)<br>Weather   |

- |     |                                     |  |
|-----|-------------------------------------|--|
| V.  | <u>Government Sector</u>            | <u>Determinants</u>  |
| A.1 | Tax Revenue from<br>Personal Income | Personal income<br>Personal income lagged<br>Time trend                                      |
| A.2 | Excise Duty Revenue                 | Non-durable and services consumption<br>Imports, (SITC 5 - 9)<br>Imports of fuel. (SITC 3)   |
| A.2 | Value-Added Tax<br>Revenue          | Nominal consumption of durables<br>and services<br>Lagged consumption of above<br>Time trend |
| B.2 | Unemployment Transfer<br>Payments   | Real private income<br>Unemployment numbers  |

- |      |   |   |
|------|---|---|
| VII. | <u>Monetary Sector</u>                      | <u>Determinants</u>   |
| A.   | Wide Money Supply                           | Gross Domestic Product at<br>market prices                        |
| A.   | Deposits in Other<br>Financial Institutions | Personal savings<br>Central Bank Discount Rate<br>Lagged Deposits |

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Output for the four major sectors - Agriculture, Industry, Services and Government is modelled explicitly. Service and Industry output is primarily demand determined. Agriculture output is determined by a profitability measure and the weather.

The Hickman-Coen joint factor demand system is estimated for the industrial sector. Hence, the demand for the two factor inputs, labour and capital, have a single underlying Cobb-Douglas production function. These factor demand equations are a disequilibrium model and allow substitution of labour and capital (putty-putty). The consistent treatment of factor demands (and output price) is an important feature for medium-term analysis.



The heterogenous nature of the services sector prevented the full implementations of the Hickman-Coen approach. This sector is modelled on the basis of a labour requirements approach, with consistency imposed on investment and price equations by sequential estimation.

Factor demands are not modelled for Agriculture or Government.

Capacity utilization is defined in Industry, Services and Agriculture; in the case of services and agriculture by a four and three year moving average, respectively.

The key explanatory variables in the prices sector are the industrial and services output prices, which are modelled in the business sector as a mark-up on average costs via the cost minimization criterion. These, combined with domestic price variables (such as raw materials, indirect tax rates and government wage rates) and import prices determine the mechanism of price formation.

The wage model used is that developed by Sargan and based on achieving a desired increase in real wages by a target rate of increase in money wages, taking expected price changes into account.

The aggregate labour supply is endogenised by means of a participation rate equation which embodies an "encouraged worker" effect, a negative real wage effect, and a push-pull effect from conditions in the UK labour market.

The Irish and UK labour markets are linked explicitly by a migration equation which relates migration flows to the relative attractiveness of the labour market, as measured by relative wages and relative unemployment rates.

Personal consumption expenditures are disaggregated into non-durables, durables, services, tourism and travel and rent. The estimation is by means of an additively consistent method due to Bodkin where personal savings are also estimated within the system. The explanatory variables are real personal disposable income, lagged real liquid assets and a range of relative price terms. Again this consistency is important for medium-term analysis.

In the three exports of goods equations, the demand activity variable was industrial countries total exports. Hence, Ireland is seen as competing for a fixed share of world exports. Domestic industrial output is also an important supply factor.

Price competitiveness measures are also included.

The imports equations are mainly demand driven by domestic activity variables such as industrial output, consumption, investment etc. Government expenditures are disaggregated and extensively endogenised. They are induced or facilitated by growth in other sectors of the economy as necessary to meet needs created by the growth process. Tax revenues, likewise, rise in line with income and expenditure i.e. marginal effective tax rates are assumed to be fixed, and are estimated from the data.

Inventories are derived residually as the difference between Gross Domestic Supply (output + imports) and Gross Domestic Demand ( $C + I + G + X$ ).

The monetary sector is post-recursive to the real sector for single-period simulations. Only in dynamic simulations does the lagged liquidity variable affect consumption. Domestic credit is also one explanatory factor in industrial output.

#### VALIDATION

Prediction error analysis, for selected endogenous variables, within-sample:

single-period simulations for 1959-1971; two-period simulations for 1959-1971; three-period simulations for 1959-1971. Full dynamic simulations for 1959-1971.

Impulse multipliers and cumulative sustained multipliers with respect to government investment and government current expenditure.

#### USE

The relative effectiveness of the main aggregate as part of employment policy were quantitatively assessed by using the model to estimate dynamic elasticities with respect to government spending, public sector employment expansion, industrial exports expansion, industrial import substitution, and a wage control policy in industry. The purpose was to provide a quantitative evaluation of the main policy themes of the

Programmes for Economic Expansion (1958-1969.)

**COMMENTS**

The Hickman-Coen framework may be too rigid for a small open economy, The model and study omits an examination of the role of direct foreign investment and the impact of the capital incentives which played such a large part in the Programmes for Economy Expansion.

A simple cost-of-capital formulation is used where a fixed rate of return of 10 per cent is assumed.

The manner of specifying the government sector makes it difficult to examine the use of policy instruments, since so much of government behaviour is endogenised.

The negative real wage effect in the labour force participation equation would bear further examination. Real wages over the period were highly correlated with a time trend. Hence, the real wage effect may be simply capturing trend developments in participation.

CB AND DoF -- 1981**PURPOSE**

The construction of a model for the analysis of short-run demand management policies, budgetary, wages and exchange rate analysis.

**MAIN FEATURES**


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<b>I.</b>	<u>GNP by Expenditure</u>	<u>Determinants</u>
A.1	Personal Consumption (disaggregated into durables, non-durables and services; different options available).	Real Personal Disposable Income  Consumption prices
B.2.a	Private Investment in Machinery and Equipment	Ratio of output price to user cost of capital  Final Demand  Index of world exports of manufactured goods  Lagged capital stock
B.2.b	Private Investment in non- Residential Building	Final demand  Relative cost of capital to labour  Lagged investment
B.2.c	Private Residential Investment	Real disposable income  Nominal interest rate  Lagged investment
C.	Non- agricultural Stock Changes (disaggregated into distribution, raw materials in TGI, finished goods in TGI, other stocks)	Activity Measure (e.g. consumption final demand, output)  Interest rate  Lagged stocks
D.1	Industrial Exports	Capital stock  Exports prices  Wage costs

E.1	Imports (SITC 5-9) (different options available)	Investment in Machinery and Equipment Equipment Weighted final demand Industrial wage rate Import prices Capital stock - output ratio
II.	<u>Labour Sector</u>	<u>Determinants</u>
A.1	Employment in Transportable Goods Industries	Output in TGI Wage-Output price ratio Cost of Capital-Output price ratio Fuel Price-Output price ratio Agricultural Price-Output price ratio Lagged employment
A.2	Employment in Services	Nominal Wages Output of Services Lagged Employment
B.2	Migration	Relative Irish-UK real wages Relative Irish-UK unemployment rates Lagged migration
B.3	Participation Rates	Ratio of employment to population Time trend
III.	<u>Prices Sector</u>	<u>Determinants</u>
A.1	Consumer Price (Durables, Non-durables and services)	Output of TGI price Imports SITC 5-9 price Indirect taxes and subsidies Wage costs in services VAT rates
A.1	Investment price of machinery and equipment	Imports SITC 5-9 price Lagged imports price

A.1	Investment price of non-residential building	Industrial wage rate Merchandise imports price
A.1	Industrial Exports price	Price of imports of raw materials World price of exports of manufactured goods Lagged world price
A.2	Price of TGI output	Imports SITC 5-9 price Agricultural Output price
B.1	Wage Rate in Industry	TGI output price Consumption price Industrial productivity Lagged unemployment

## IV.

Output SectorDeterminants

A.	TGI Output	Weighted final demand
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## V.

Government SectorDeterminants

A.1	Direct Personal Income Tax Revenue	(Tax) Adjusted personal income Value of Income tax allowances
A.2	Value Added Tax Revenue	VAT Adjusted consumption base Consumption prices VAT rates
A.2	Excise Duty Revenue	Volume of aggregate consumption Consumption prices Excise duty rates
B.2	Pay-related Unemployment Benefit Expenditure	Numbers unemployed Rate of unemployment benefit Wage rate
B.3	National Debt Interest (on loans denominated in Irish pounds)	Change in total loans outstanding by an interest rate Lagged value of above Lagged national debt interest

VII.	<u>Monetary Sector</u>	<u>Determinants</u>
A.	Demand for current accounts	Nominal disposable income Ordinary deposit rate

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Personal consumption expenditures are disaggregated into durables, non-durables, and services. However, the basic consumption functions estimated are all simple, static linear functions of real disposable income. Hence, the disaggregation, while useful in the expenditure tax section, is not exploited fully at the estimation stage.

Investment is disaggregated by type of asset, i. e., machinery and equipment, non-residential construction, and residential construction. A further breakdown into public authorities direct investment (by the three categories) and private investment is made, the public components being exogenous (in nominal terms).

The Jorgenson profit maximising model underlies investment in machinery and equipment. In addition to domestic determinants (final demand, and the product price relative to the cost of capital), a direct world trade influence is included. The theoretical justification is somewhat dubious.

The Coen cost-minimising model underlies investment in non-residential construction, the determinants being relative factor prices and final demand.

The four-way disaggregations of non-agricultural stocks allows the endogenization of adjustments for stock appreciation.

Industrial exports are endogenised by a short-run supply equation. The immediate adjustment of export supply to changes in the capital stock is somewhat implausible.

Goods imports, disaggregated into three types, together with imports of services, are demand determined by means of import-content weighted final demand. The effect of supply constraints are included by means of wage rates and capacity utilisation terms.

The major employment equation is for employment in transportable goods industries. The underlying model is due to Dhrymes and the explanatory variables are output and various relative factor and other prices. The adjustment lags are rather long being over two years.

The remainder of the labour sector is fairly conventional, including population, migration and labour force participation equations.

Transportable goods industries output prices are the key price variables in the model, changes being caused by import prices and agricultural output prices. Price transmission then spreads to the other expenditure deflators both via TGI output prices, directly via import prices, via wage costs, and in the case of consumption prices, via indirect taxation.

Wages in industry are driven by output and consumption prices, by productivity changes and by lagged unemployment. Wage rates in services are similarly determined by consumption prices, services productivity and unemployment.

The Government sector is very detailed, and while many items of expenditure are still exogenous, unemployment transfers, £IR denominated national debt interest, and public authorities expenditure on wages and salaries are endogenised. On the revenue side, the main taxes on expenditure and on income are endogenised by the use of suitable tax bases and taxation rates. Capital revenue and expenditure, while disaggregated into fairly fine detail, is still totally exogenous. In particular, capital transfers to industry and households as yet have no impact on investment.

The monetary sector is post-recursive to the model and consists of demand determined demand for money functions and linked interest rate equations.

## VALIDATION

Extensive validation results are available. Detailed within-sample tracking performance by means of single-equation, single-period, and multiple-period simulations. A wide range of model multipliers are calculated. Unlike most other models, CB and DoF-1981 is part of an ongoing modelling project and is the subject of continuing testing and development.



## USE

The model has been used extensively within a number of institutions -Government, Central Bank, Economic and Social Research Institute - for budgetary analysis etc.

(For a published example of its use see, P. Bacon et al., Quarterly Economic Commentary, The Economic and Social Research Institute, Dublin, October 1981.)

## COMMENTS

A more integrated approach to modelling the demand for the factors of production, output, and productivity changes would be desirable. The existing specification leads to inconsistencies when applied to medium-term developments.

There is no linkage between government capital transfers to the private sector, industry and households, and private investment.

The labour supply mechanism is rather primitive. A disaggregating of the labour force into primary and secondary components would be desirable.

The wage equations incorporate a "Phillips curve" effect which is highly unstable.

The linkages between agricultural output, agricultural prices and agricultural incomes are not specified.

The monetary sector may have been realistic in the pre-EMS era. However, since CB and DoF - 1981 is part of an ongoing modelling project, post-EMS changes will have to be incorporated leading, perhaps, to a monetary sector with reverse linkages with the real sector through, perhaps, endogenous interest rates.

IV

CONCLUSION

For the survey we identified twenty-six macromodels of the Irish economy for extensive analysis. That so much work had been done was quite a surprise. All of the models other than ED-1958 and KENNEDY AND DOWLING - 1975 (Models I and Model II) were formal macromodels and, of these formal models, all except SMYTH - 1974 and SPENCER AND HARRISON - 1975 were implemented econometric models. Very broadly, the breakdown into large-scale and medium-to-small-scale is as follows:

(i) Large-Scale Macroeconometric Models

WALSH - 1966  
 DESMOS - 1974  
 WEFA - 1975  
 COMET II - 1976  
 CENTRAL BANK - 1977 (MAXI)  
 FANNING - 1979  
 CB AND DoF - 1981

(ii) Small-Scale Macroeconometric Models

GEARY - 1964  
 LESER - 1964  
 LESER - 1967  
 STRONGE - 1971  
 CLARKE - 1971  
 CLARKE - 1972  
 LENNAN - 1972  
 TEEHAN - 1972  
 ISS - 1972  
 NORTON - 1973  
 GEARY AND McCARTHY - 1976  
 CENTRAL BANK - 1977 (MINI)

An additional interesting classification into short-term, medium-term and long-term models can be made as follows:

(i) Short-Term Macroeconometric Models

LESER - 1964

WALSH - 1966 (but has some medium-term features)

LESER - 1967

STRONGE - 1971

CLARKE - 1971

CLARKE - 1972

LENNAN - 1972

TEEHAN - 1972

ISS - 1972

NORTON - 1973

WEFA - 1975

GEARY AND McCARTHY - 1976 (but has some medium-term features)

CENTRAL BANK - 1977 (MAXI and MINI)

CB AND DoF - 1981

(ii) Medium-Term Macroeconometric Models

DESMOS - 1974

COMET II - 1976

FANNING - 1979

(iii) Long-Term Macroeconometric Models

GEARY - 1964

In the above, we use short-, medium-, and long-term in the following sense. Short-term models deal with the demand side of the economy and assume away, or only have implicitly, the supply side responses; medium-term models usually concentrate on the interaction of supply and demand via the role of capacity utilization; long-term models concentrate on the supply side and ignore transient problems connected with deficient demand.

It is interesting to examine the development cross-references and influences of model research in Ireland. Working from the start of our sequence (ED - 1958) forward in time, the "story" evolves along the following lines:

- (i) The publication of Economic Development (1958) and the ensuing climate for research may have influenced Geary (1964) in his study of growth and consistency problems in the context of a macro-growth model. In his discussion of Geary's pioneering Statistical and Social Inquiry Society paper, T.K. Whitaker, who was involved in the preparation of Economic Development, emphasised the significance of Geary's analysis and, in particular, the interaction of the GICOR and the savings ratio.
- (ii) The next pathbreaking model was by Walsh (1966). This was basically a dualistic model with an explicit treatment of the interrelationship of the Agricultural and Industrial sectors of the economy in terms of growth and change. In a certain sense Walsh's work was the logical follow-on from Geary's and, even by modern standards, was a remarkable achievement. Its limited impact may have been partly due to "technical" constraints connected with the solution and use of the model. But the non-publication and, general lack of availability, would also contribute to this.
- (iii) The early work of Leser (1964 and 1967) was "forecast" oriented. It does not belong to the ED-Geary-Walsh line of development. Its termination seems to date from the rather pessimistic paper by Baker and Durkan (1970).
- (iv) The work of Stronge (1971), Clarke (1971, 1972), Norton (1973) and Teehan (1972), and Spencer and Harrison (1975) was concerned with small-scale macro models which were "purpose oriented", i.e. the examination of Irish-UK interrelationships, the quantification of income elasticities of a range of taxes, the role of fiscal policy, and the Irish-GB-Northern Ireland relationships. None of these papers built on or appear

to have been influenced by the earlier Geary-Walsh work.

- (v) The development of DESMOS - 1974 and COMET II - 1976 took place quite independently in Louvain and Brussels. The justification for the inclusion of Ireland in these models seems to have been the political necessity of not appearing to exclude us ! Geary and Dempsey (1977) seem to be the only people who took COMET II seriously, to the extent of examining the implications of the COMET II forecasts for the period 1973-1980.
- (vi) The comprehensive work of Kennedy and Dowling (1975) logically belongs to the ED-Geary-Walsh line of development. Fundamental issues were addressed in this work and, the very size and scope of the study may, in the eyes of its authors, have precluded a formal model-based aspect. Indeed, it is fair to say that the issues and problems raised by Kennedy and Dowling have not yet been taken up by modellers to the extent that the authors recognised as necessary.
- (vii) The two most recent models in our survey, FANNING - 1979 and CB DoF - 1981, were independently developed over roughly the same time period (1976 - 1979). To some extent FANNING - 1979 addresses the growth and development problems in the ED-Geary-Walsh-Kennedy/Dowling line of research.
- (viii) CB and DoF - 1981 was not in this line of development but rather represented the eventual breaching of the anti-model fortifications which surrounds the masters of fiscal policy ! Because of this it is interesting to examine the genesis of this model in the Central Bank of Ireland. The earliest framework for the model which eventually culminated in CB and DoF - 1981 was laid down in an internal memorandum by Robert Kelleher as "Preliminary Specification of a Macroeconomic Model for Ireland" (1975). The work of Geary, Walsh, Stronge and Norton is cited. In addition, Kelleher had been exposed to the problems of short-term judgement forecasting in the ESRI. This, and a thorough appreciation of what one can expect from a macromodel set the programme going. The provision of resources by the Central Bank of Ireland to the project and the major collaborative involvement of the Department of Finance resulted in the development and extensive use of CB and DoF - 1981 for policy research and forecasting. It is tempting to speculate on how some of the earlier models might have been developed if given such support and if equivalent computer hardware and software had been available.

In attempting to evaluate macromodel-building in Ireland one sees clearly that most of the models were "purpose-oriented". With some exceptions, most models were built in order to meet an immediate need and to examine particular problems in the economy. Hence, the "systemic" theory of the economy was relatively neglected. The major domestic exceptions to this were WALSH - 1966, FANNING - 1979, and CB and DoF - 1981. In these models an attempt to model the economy was the paramount objective and only when the model was deemed satisfactory from a systemic point of view was attention turned to its use.

From a sectoral point of view, the following points can be made about model research. With the exception of WALSH - 1966, KENNEDY/DOWLING - 1976 and (slightly) FANNING - 1979, the agricultural sector has been ignored. This may be tolerable in the short-term (and this was the justification used in CB and DoF - 1981) but for medium-term analysis the role of the agricultural sector must be tackled. In addition, only WALSH - 1966 and KENNEDY/DOWLING - 1975 deal with the evolving roles of the Agricultural, Industrial and Services sectors (only the first two in the case of Walsh) and the problems of consistency between them. Also the manner of treating the Government sector depends on whether one is taking a short-term or medium-term perspective. FANNING - 1979 attempted to examine the role of an almost fully endogenous government sector, while in CB and DoF - 1981 the role of government is treated using a target-instrument approach. Finally, changing economic circumstances have led to the growing importance of a monetary sector. Earlier models were, however, fairly correct in largely ignoring the monetary sector and regarding monetary policies as permissive.

Finally, one notes that the standard of documenting models varies widely from model to model. In the case of econometric models is a necessary amount of validation

information would consist of:

- (i) Full estimation results and data sample.
- (ii) Within-sample tracking performance.
- (iii) Extensive multiplier analysis.

The whole issue of model validation and testing is treated very comprehensively by Fitzgerald and Keegan (1981) in the context of CB and DoF - 1981. The high standard of model validation displayed in this paper should serve as a useful guideline for the validation and testing of all future models.

In summary, there has been extensive macromodelling of the Irish economy and three phases can be identified. The early studies were pathbreaking and were also done quite early on by international standards. However, this early work had limited influence and the later phases failed to capitalise on these. The second phase occurred in isolation from the early work and failed to consolidate and develop this work. Only in the third phase has model building begun to reach the potential that was implicit in the first phase, but the task is by no means near completion as yet. In preparing this survey we have made no attempt to assess what role or impact these models may have had on policy-making. It would appear that one use made of some of the models, or more accurately their results, was to support arguments and bolster previously held positions. Elsewhere, Fanning and Bradley (1982) have examined some issues concerning the appropriate use of macro-econometric models or policy research which emerge from use of such models, in general, but have not sought to assess the Irish experience.