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IMPACT is an economic and demographic research project conducted by Commonwealth Government agencies in association with the Faculty of Economics and Commerce at The University of Melbourne, the Faculty of Economics and Commerce and the Departments of Economics in the Research Schools at the Australian National University and the School of Economics at La Trobe University.

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A DECADE OF APPLIED GENERAL EQUILIBRIUM MODELLING FOR POLICY WORK

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ABSTRACT

The Impact Project was set up in 1975. The ORANI CGE model of the Australian economy, developed at the Project, has been used extensively by government and other policy analysts since 1977. These applications, and other CGE work on the Australian economy, are reviewed. Aspects of model design and project management, believed to have contributed to the success of the endeavour, are discussed in detail.

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1 INTRODUCTION

This paper is mainly retrospective. Dale Jorgenson asked David Vincent and us to cooperate in producing an account of the experience in applied general modelling of the Impact Project and its main sponsor, the (Australian) Industries Assistance Commission (IAC). Vincent's (1986) contribution to this meeting of the Task Force gives a view from within the largest public-sector user of the ORANI model (whose standard form is described by Dixon, Parmenter, Sutton and Vincent (1982)). He tells us how general equilibrium policy simulations affected the advice given by the Commission in a number of recent enquiries into tariffs and other industry assistance arrangements, and reports the light that the ORANI model has shed on Australia's currently most pressing macroeconomic problem; namely, an almost unprecedented collapse in the terms of trade.

In this paper we seek to complement his account with a discussion of the following issues:

(a) What are the distinctive elements in Impact's experience which account for the Project's success in having CGE modelling used routinely in the policy advising process?

(b) What were the strategic design choices that affected the outcome?

(c) What is the ideal composition of a team to carry out CGE research with a policy focus?

(d) How do institutional arrangements impinge on the above questions?

(Above, we use the convenient CGE abbreviation for 'computable general equilibrium', which we do not distinguish in this paper from applied general equilibrium.) Before offering our thoughts on the above issues, we give a brief survey of the uses to which Impact's CGE models (ORANI, SNAPSHOT and ORANI-MACRO) have been put, not only by Australian governments, Federal and State, but also by academic researchers. This survey is meant:

(i) to substantiate our claim that Impact's CGE models, especially ORANI, have received wide acceptance in Australia as the preferred method for policy analysis of intersectoral issues;

and

(ii) to illustrate the very wide range of issues amenable to such analysis.

We hope that this descriptive material will whet the appetite for the nostrums which we then offer in answer to questions (a) - (d) above.

The balance of this paper is organized as follows. Our brief survey of applications appears next. Then follows a short section on the historical and institutional imperatives out of which the Project grew. The fourth section deals with strategic issues in model design (some of this material repeats earlier views put by one of us -- see Powell (1981)). Aspects of project management are discussed in the fifth section, while in the sixth and final section we sum up, and prognosticate on what the future of policy modelling may hold.

2 BRIEF SURVEY OF APPLICATIONS OF GENERAL EQUILIBRIUM MODELS OF THE AUSTRALIAN ECONOMY

This section draws on and updates earlier surveys by Dixon, Parmenter, Sutton and Vincent (1982), Parmenter and Meagher (1985) and Powell (1985a). Because of the Impact Project's policy of open access to its models, we cannot be aware of all the applications which have been made, particularly in the government sector. Our coverage therefore has a bias towards model simulations which have been publicly reported. It includes not only the Impact models, but the other CGE models of Australia that are known to us.

The published studies are listed in Table 2.1, while Table 2.2 identifies unpublished applications of which we are aware. One of the unusual features of the Impact Project has been its cross-institutional affiliations and the conscious decision to encourage as wide as possible use of the models. To give some indication of this, in the discussion that follows, applications are considered in terms of six broad categories of users.

2.1 Applications by the Impact Team

The wide range of applications to which the ORANI model is amenable has been illustrated in numerous papers produced by the Impact team over the last decade. Three strands of activities can be identified:

(a) analyses of the effects of particular economic shocks, with varying emphasis on industries, occupations and the macroeconomy;

(b) examination of the robustness of these analyses to changes in the parameters, data and/or closure of the model;

and

(c) the identification of policy options which, according to the model, would achieve important macroeconomic objectives (e.g., policies to increase employment without running into further trade balance or inflation problems).

The applications chosen by the modellers also identify some of the key economic issues perceived to have influenced the direction of the Australian economy over the last 10 years; an idea of the scope of these issues is given by the subject headings of Table 2.1.

The emphasis on protection reflects not only the strong institutional links between Impact and the IAC, but also the importance that has been attached to this topic by applied economists generally in Australia (on which we comment in Section 3). It should be noted that although these studies indicate the extent to which different groups win or lose from industry assistance, at the present stage of ORANI's development, important efficiency gains from trade reform (e.g., via scale effects) are not captured. This is of practical importance since it is not easy, politically, to institute a reform if the outcome appears to be a zero-sum game.

2.2 Applications by the Industries Assistance Commission

The use of CGE models by the IAC is covered in some depth in the companion paper by David Vincent (1986). In these remarks we attempt to give some idea of the breadth of applications of the ORANI model.

Nowadays the model is used for most major IAC inquiries in which inter-industry or economy-wide effects may be important, e.g., iron and steel (IAC (1983a,b)), motor vehicles (IAC (1978, 1981a)), chemicals and plastics (IAC (1986c)), textiles, clothing and footwear (IAC (1986b)) and wood products (IAC (1981b)). In some instances partial equilibrium models with similar behavioural assumptions to the ORANI model are used;

the results of these smaller models may in turn be used as an input to the ORANI model. An example of this is provided by the inquiry into Heavy Commercial Vehicles (IAC (1984)).

Acceptance of ORANI within the IAC was gradual. Initially there was scepticism, both about the model's ability to capture the likely effects of changes in assistance to an industry on the rest of the economy, and about its ability to deal realistically with important specific features of the industry under review. The latter problem was largely overcome by the development of procedures to model such industries in greater detail while remaining within the ORANI framework (see Vincent (1986)).

The model's treatment of inter-industry and economy-wide effects was accepted more readily for agricultural-sector inquiries such as that into fertilisers (IAC (1982a, 1985a,b). This readier acceptance reflects, in part, a consensus on the applicability of competitive theory to behaviour in agriculture, as well as the relatively strong detail on multiproduct agricultural industries built into the standard version of ORANI (Dixon, Parmenter, Powell and Vincent (1983)).

The current inquiry into the taxation of petroleum products (IAC 1986a,d)) represents an interesting development of the use of ORANI in the IAC. Taxes on petroleum products are a significant source of revenue to the Australian Government and are levied on intermediate usage and final consumption. The model was used to analyse the effects of these taxes on international competitiveness and resource allocation, taking into account the implications for the Government's net budgetary position, as well as the effects of tax exemptions on intermediate usage. These simulations required the addition of a large amount of fiscal detail to the ORANI mainframe. Such major modifications will be much easier when current developments in computer packages (Pearson (1986)) come fully on stream.

Table 2.1: Selective Bibliography of Australian CGE Policy Applications[a]

Application	Policy Simulations Conducted by: Impact	IAC	Other Federal Agencies	State Governments & Regional Modellers	Academics/Graduate Students	Private Sector
A. Effects of Protection	Powell (1977) Dixon, Parmenter, Ryland, Sutton (1977) Dixon, Parmenter, Sutton (1977) Powell, Parmenter (1979) Wright, Cowan (1980) Parmenter, Sams, Vincent (1981) Dixon, Parmenter, Sutton, Vincent (1982) Powell (1982) Cooper (1983) Higgs, Parmenter, Powell (1984) Dixon, Parmenter, Powell (1984) Cooper, McLaren, Powell (1985) Dixon, Parmenter, Rimmer (1986)	IAC (1977) IAC (1982b)	Crowley, O'Mara, Campbell (1983)	Dixon, Parmenter, Sutton (1978b) IAC (1981c) Higgs, Parmenter, Rimmer, Liew (1981) Madden, Challen, Hagger (1981) Liew (1982) Dixon, Parmenter, Sutton, Vincent (1982) Parmenter (1983a) Higgs, Parmenter, Rimmer (1983) Fraser, Salerian (1986) Brown, Camilleri (1986)	Evans (1972)* Klijn (1974)* Meltzer (1980) Alalabie (1981,1983,1985) Warr, Parmenter (1984) Parmenter, Meagher (1985) Siriwardana (1985)* Horridge, Parmenter, Warr (1986)	Chai, Dixon (1985) Dixon, Parmenter, Rimmer (1985) Higgs (1986b)
B. Exchange Rates	Powell (1977) Dixon, Parmenter, Sutton (1977) Dixon, Parmenter, Powell (1982,1983)	Fallon, Thompson (1986) Vincent (1986)		Hagger, Challen Madden (1983)	Horne (1985)	Business Council of Australia (1985) Higgs (1986b)
C. International Trade (other)	Vincent (1980a)	IAC (1979)	Bateman (1984)		Warr, Lloyd (1983) Dixon, Johnson (1986)	
D. Terms of Trade	Dixon, Harrower, Powell (1977) Dixon, Parmenter, Sutton (1978)	Fallon, Thompson (1986)				Higgs (1986b)
E. Supply Shocks						
(i) - Oil	Vincent, Dixon, Parmenter, Sams (1979,1980) Vincent (1980b)				Higgs (1981)	

Table 2.1 cont'd.

Application	Policy Simulations Conducted by: Impact	IAC	Other Federal Agencies	State Governments & Regional Modellers	Academics/Graduate Students	Private Sector
(ii) - Mining (resources boom)	Dixon, Harrower, Powell (1977) Dixon, Parmenter, Sutton (1978) Powell, Parmenter (1979) Higgs, Parmenter, Powell (1984)		Stoeckel (1979)*	IAC (1981c) Madden, Challen, Hagger (1982) Fraser (1984,1986)		Cook, Porter (1984) Higgs (1986a,b)
(iii) -Technical Change	Dixon, Vincent (1980)* Rimmer (1984)		BIE (1981a)*			
(iv) - Drought		Vincent (1983)	Campbell, Crowley, Demura (1983)			
F. Macroeconomic Policy - expanding activity without inflation or trade balance problems	Dixon, Powell, Parmenter (1979) Parmenter (1983b) Dixon, Powell (1984)	IAC (1982c)		Bonnell, Parmenter, Rimmer (1985)	Norman (1981) Parmenter, Meagher (1985) Dixon, McDonald, Meagher (1984) Feltenstein (1986)*	Higgs (1986b)
G. Other Employment and Wage Issues	Dixon, Parmenter, Sutton (1978a) Higgs, Parham, Parmenter (1981) Powell (1985)			Challen, Hagger, Madden (1983,1984)	Corden, Dixon (1980) Bonnell, Chew, Dixon (1984) Bonnell, Parmenter, Rimmer, Scorgie (1985)	
H. Immigration			Norman, Meikle (1985)		Cook, Dixon (1982) Dixon, Bonnell (1982) Bonnell, Dixon (1983)	
I. Government Taxes, Charges and Expenditure	Cooper, McLaren (1983) Meagher, Agrawal (1986)	IAC (1986a,d)	BAE (1985)	Ministry of Economic Development, Vic. (1982) Madden, Challen, Hagger (1983) Burke (1983,1984) Meagher, Parmenter, Rimmer, Clements (1985)	Castle, Guest (1980) Meagher (1983,1986) Piggott (1983) Parmenter, Meagher (1985) Chapman, Vincent (1985) Liew (1985) Meagher, Parmenter (1985) Blampied (1986)	Higgs (1986b)

Table 2.1 cont'd.

Application	Policy Simulations Conducted by: Impact	IAC	Other Federal Agencies	State Governments & Regional Modellers	Academics/Graduate Students	Private Sector
J. Industry Studies						
- long run prospects	Dixon, Harrower, Powell (1977)		BIE (1981b)* Fitzpatrick, McKeon (1982)*			
- agriculture	Vincent, Ryland (1981) Dixon, Parmenter, Powell (1982,1983) Dixon, Parmenter, Powell, Vincent (1983)	IAC (1983c,d) Vincent (1986)	Crowley, Martin (1982) Quiggan, Stoeckel (1982) Campbell, Crowley, Demura (1983)		Dixon (1986) Dixon, Parmenter (1986) Dixon (1985a,b)	Parmenter (1985) Higgs (1986b)
- fertilisers		IAC (1982a) IAC (1985a,b)	BAE (1984)			
- forestry, timber		IAC (1981b)				
- mining				Madden, Hagger (1985)		Johnson (1985)
- food			PJT (1979)			
- textiles, clothing		IAC (1986b)				Higgs (1986a)
- chemicals, plastics		IAC (1986c) Vincent (1986)				
- petroleum products		IAC (1986a,d)				
- iron and steel	Rimmer (1984)	IAC (1983a,b)				
- motor vehicles		IAC (1978) IAC (1981a) IAC (1984)				
- transport			Lawson (1979)			
- tourism				Hagger, Madden, Challen (1984)		

(a) All citations except those indicated by an * refer to applications of ORANI.

ORANI has also been used for more general studies of the effects of protection and other economic factors on the Australian economy (IAC (1977, 1979, 1982b,c)).

2.3 Applications by Other Commonwealth Agencies

Much of the use of Impact CGE models by other federal agencies is unpublished or undocumented. Some agencies have used Impact training courses to develop the in-house expertise necessary to carry out their own applications. Most rely on the IAC, or occasionally the Impact Research Centre at the University of Melbourne, to do the analysis for them. (The IAC has a formal responsibility to provide such assistance to other federal agencies.) Many of the unpublished studies of which we know are listed in Table 2.2.

These applications again demonstrate the diversity of uses to which the model has been put; but more importantly, a glance at their dates indicates that this usage is growing. This reflects both increased acceptance of the CGE approach to policy analysis as well as the steady diffusion of staff with a training in CGE modelling (gained in most cases at the IAC and/or Impact).

The major public sector user (other than the IAC) has been the Bureau of Agricultural Economics (BAE), which has a long standing record in applied economic research and (until recently) a Director who built a CGE model for his doctoral thesis (Stoeckel (1978)). Several papers published by BAE officers are listed in Table 2.1. They have used ORANI to analyse the effects on agriculture of protection for manufacturers (Crowley, O'Hara and Campbell (1982), Crowley and Martin (1982), Quiggan and Stoeckel (1982)), as well as the general economic effects of a major continent- wide drought (Campbell, Crowley and Demura (1983)). They have also used results from ORANI in submissions to IAC inquiries and to the Economic Planning Advisory Council (EPAC) (BAE (1984, 1985)). Other studies are in progress.

Table 2.2

Summary of Unpublished Applications Carried Out for Australian Government Agencies

Application	Client
Farm costs of assistance to manufacturing	Bureau of Agricultural Economics (BAE) (1985)
Assistance to agricultural industries	Submission by W.A.McKinnon, Chairman, IAC to (Balderstone) Working Group on Agricultural Policy (1982)
Costs of industry assistance to farmers	IAC submission to Technical Group on Farm Costs, Treasury (1985)
Price increases resulting from the devaluation of the Australian dollar	Treasury (1985)
Expansion of mining exports	BAE (1981)
Changes in world demands for meat	BAE (1979, 1980)
Deterioration in the Balance of Trade	BAE (1986)
Disruption in oil supplies	Department of Resources and Energy (in progress)
Oil price rises	Department of National Development (1978, 1979), Treasury (National Wage Case 1980)
Effects of assistance on migrants	Submission by W.D. Carmichael, Chairman, IAC to (Jupp) Committee of Review of Migrant and Multicultural Programs and Services (1986)
Payroll tax exemptions	Ministerial Task Force on Long Term Economic Growth (1985)
Distortions inhibiting food processing	BAE (in progress)
Changes in the price of sugar	Department of Business and Consumer Affairs (1979)
Production of aircraft in Australia	Australian Government Aircraft Industry Study Group (1979), Hawker-Siddeley (1983)
Increased road and rail transport charges	National Road Freight Industry Inquiry (1984)
Various shocks on the Australian economy	IAESR for Bureau of Labour Market Research (1985)

The Bureau of Transport Economics (BTE) used ORANI to analyse the economy-wide effects of increased road and rail charges (Lawson (1979)), while the Bureau of Industry Economics (BIE) used the SNAPSHOT model to explore the long-run implications for Australian industries of foreseen technical changes (BIE (1981a,b), Fitzpatrick and McKeon (1982)).

In association with the Committee for Economic Development of Australia (CEDA), the Department of Immigration and Ethnic Affairs used the ORANI and BACHUROO models in a major study of the economics of immigration. The study included long-run simulations of the effects of immigration on industries (Norman and Meikle (1985)). The ORANI model has even been used to consider the strategic defence implications of disruptions to Australia's overseas trade (Bateman (1984))!

2.4 Applications by State Governments and by Regional Modellers

The ORANI Regional Disaggregation System (ORES) was developed very much as a by-product by the Impact team (Dixon, Parmenter and Sutton (1978)). This approach to regional disaggregation followed the 'tops-down' procedure (as developed initially by Leontief, Morgan, Polenske, Simpson and Tower (1965)). There was widespread interest in this development, presumably because nothing (other than unconstrained input-output) had previously been available to analyse the effects of national policies on the Australian States.

With State and Federal Government support, the Centre for Regional Economic Analysis (CREA) was set up at the University of Tasmania in 1980. It uses the ORANI-ORES model for much of its analysis. Topics analysed include the impact on the Tasmanian economy of reductions in protection (Madden, Challen and Hagger (1981)), the devaluation of the Australian dollar (Hagger, Challen and Madden (1983)), the mining boom (Madden, Challen and Hagger (1982)),

subsidising employment (Challen, Hagger and Madden (1983)), exports of woodchips (Madden and Hagger (1985)) and a decline in tourism (Hagger, Madden and Challen (1984)).

Regional modelling was enhanced by allowing explicitly for regional industries in the national ORANI model. These industries were located entirely in one region. This strategy provided a richer story at the regional level. The improvement in the analyses is demonstrated in papers by Higgs, Parmenter, Rimmer and Liew (1981) and Higgs, Parmenter and Rimmer (1983), which re-examined the regional effects of protection using this new method, which may be seen as a compromise between the 'tops-down' approach of ORES, and the impossibly data-hungry 'bottoms-up' approach (Liew (1982)).

Regional modelling was subsequently taken up at the University of Western Australia, illustrated in papers by Fraser (1984, 1986) on the effects of the State economy of the expansion of mining and a study by Fraser and Salerian (1986) of the regional effects of protection. More recently the Melbourne Institute of Applied Economic and Social Research (IAESR) commenced work on the economy of the Northern Territory (Bonnell, Parmenter and Rimmer (1985)).

The Victorian Government has used ORANI to study the effects on Victoria of changes in electricity pricing (Ministry of Economic Development, Victoria (1982)) and of changes to indirect taxes and to workers' compensation charges (Burke (1983, 1984)), while the South Australian Government sponsored a study (Meagher, Parmenter, Rimmer and Clements (1985)) of proposed changes to taxation of the wine industry, which is an important activity in that State.

2.5 Applications by Academics, including Graduate Students

Since its inception, the Impact Project has encouraged the involvement of Australian academic economists. Undergraduates,

graduates and teaching staff have all made contributions to the theoretical framework, to parameterising the model, and to applying it to a large range of issues.

There are 19 universities in Australia. Economists from 12 of them have contributed to or made use of the ORANI model. Although in part this reflects the mobility of academics associated with the original development of the model, it also reflects a wide recognition of the model's usefulness as a tool for applied economics, as well as the Project's policy of open access.

The first applications emanated from universities in Melbourne, where the Impact Project was being developed. Relative to the traditional effective rate concept, Meltzer (1980) demonstrated the superiority of a practical CGE approach for explaining the resource allocative effects of protection, while Norman (1981) was able to use ORANI to attach some numbers to the famous Swan diagram (1963) of internal and external balance.

In the late 'seventies and early 'eighties, Peter Dixon led a strong team of CGE modellers at La Trobe University, whose work was focused on the effects of structural change on different labour market groups (Dixon and Bonnell (1982), Cook and Dixon (1982), and Bonnell and Dixon (1983)), and on the effects of fiscal policies on industries (Meagher (1983)). This interest in fiscal issues had precedent in the work of Corden and Dixon (1980), who used ORANI to see if a cut in hourly labour costs made possible by lower direct taxes could improve employment without creating budgetary problems for the Australian economy. More recently, Chapman and Vincent (1985) used the model to see if the removal of payroll taxes could be beneficial.

The final strand of academic research which we will mention examines various protective devices. Warr and Parmenter (1984) analysed government procurement policies, while Warr and Lloyd (1983) estimated

the impact of Australia's trade policies upon less developed countries. Work is in progress on the effects of a 'Buy Australian' policy, which currently has some official support, and is the focus of direct action by some trades unions (Horridge, Parmenter and Warr (1986)).

Work at the IAESR over the last two years has focused on the use of ORANI for short-run (Dixon, McDonald and Meagher (1984)) and long-run (Dixon (1986)) forecasts, and the analysis of taxation (Dixon (1985a) and Meagher and Parmenter (1985)). Current work in association with the Impact team will extend the use of ORANI to analyse income distribution issues (Meagher and Agrawal (1986)). A steady stream of papers analysing Australia's protection policy, international trade possibilities and the agricultural sector also has been produced (Dixon (1985a,b), Dixon and Johnson (1986)).

2.6 Private Sector Applications

To date, sponsorship by the private sector of applications of the Impact models has not been great (and not all of what is done gets published). A number of reasons can be put forward for this.

A considerable initial investment in human capital is required. Often, however, potential clients in the private sector lack either the resources or the motivation to make such an investment. For those seeking more protection, direct lobbying activities may dominate as an investment opportunity.

Second, an alternative model has been available. Although inadequately documented, its reported simulation performance suggests that it has a structure, closure and parameter settings which better suit the predilections of certain customers. One outcome of this is that, on occasion, an IAC inquiry has been characterised as a 'battle of the models'. The last inquiry into the Passenger Motor Vehicle Industry is a good example of this. The debate spread to the newspapers, radio,

and meetings of the Victorian Branch of the Economic Society of Australia and New Zealand.

The first users of the ORANI model in the private sector were various business organisations such as the Australian Farmers' Federation (AFF), the Confederation of Australian Industry (CAI) and the Business Council of Australia (BCA). Use tended to be confined to the reporting of other applications, rather than initiating new work. A recent example is the BCA (1985), which looked at estimates of the price effects of the devaluation of the Australian dollar generated by different models, including ORANI. A simplified version of ORANI was used by the Monash Centre for Policy Studies for a report (sponsored by the Australian Mining Industry Council (AMIC)) on the quantitative impact of the minerals sector on the Australian economy (Cook and Porter, (1984)).

More recently, the AFF asked the IAESR at the University of Melbourne to carry out a study of the costs to farmers of protection of manufactures (Parmenter (1985)). ORANI-based analysis of the same issue was also undertaken by the IAC and the BAE, and the three studies were submitted to a Technical Group on Farm Costs established by the Australian Government in 1985 (thankfully no large divergence of opinion emerged from the three studies!). The estimated magnitudes of the effect on farm costs were significantly lower than estimates based on the simpler approach of Clements and Sjaastad (1983), which had provided the stimulus for the establishment of the Technical Group.

This is probably a portent of things to come. Increasingly we can expect a number of ORANI-based analyses of the same subject to be undertaken by different interest groups and submitted to government. The current IAC inquiry into the Pulp, Paper, Paper Products and Related Printing Industries is a good example. Apart from its own analysis, the IAC understands that up to three interested parties may be commissioning CGE analyses to assist them with their submissions. If, due to

different closures, parameters or shocks, the results differ widely, CGE policy analysis will have come of age.

The major work undertaken to date with a significant element of private sector sponsorship is the comprehensive study by Higgs (1986b) of adjustment pressures on the agricultural sector. This was supported, in part, by the Australian Wool Corporation. Subsequently Higgs (1986a) undertook a similar, but much briefer, analysis of the mining sector for the Mining Industry Council (AMIC). Other sponsored work includes analyses of protection (Chai and Dixon (1985)) and of the sensitivity of the results of tariff simulations to assumptions about Australia's export responsiveness (Dixon, Parmenter and Rimmer (1985)). However, the greatest impetus for future use of the ORANI model by the private sector is likely to come via the IAESR.

The IAESR's first CGE-based study to be sponsored by a company was an analysis of the short-term economic effects of environmental constraints on forest industries (Johnson, (1985)); the first step in a major extension of the ORANI model into medium-term forecasting was sponsored by the Royal Bank of Canada (leading, after further developments, to the work reported in Dixon (1986)).

3 HISTORICAL AND INSTITUTIONAL BACKGROUND

This record of intellectual enquiry into the general equilibrium effects of policies may be more than coincidentally related to the fact that Australia is among the most highly protectionist countries in the world when it comes to manufacturing. Gough Whitlam, Australian Prime Minister in 1974, forcefully reminded Australian manufacturers of this fact (Rattigan (1986, p. 216)). This assertion is not just polemics -- it can be verified objectively by asking: (a) 'What western country (other than New Zealand) has, for thirty years, completely failed to expand the share of international trade in its GDP?'; and (b) 'In which other

Table 3.1

Comparative Openness of the Australian Economy

to International Trade

Country	GDP(a) (1984)	Exports as a Percentage of GDP		
		Base Year (1955)	Final Year (1984)	Rate of Growth (per cent per year)
Australia	173.8	16.6	13.7	-0.7
Austria	64.3	17.0	24.5	1.3
Belgium	78.1	30.8	66.2	2.7
Canada	336.7	15.5	26.8	1.9
France	489.9	10.1	19.9	2.4
Germany	613.2	14.2	28.0	2.4
Greece	33.5	7.6	14.4	2.2
Italy	348.4	7.7	21.1	3.5
Japan	1,157.5(b)	8.4	12.7(b)	1.5
Netherlands	122.5	34.3	53.6	1.6
New Zealand	23.3(b)	26.2	23.2(b)	-0.4
Norway	54.7	18.7	34.5	2.1
Spain	161.3	7.0(c)	14.6	3.1
Sweden	94.8	17.6	31.0	2.0
United Kingdom	425.5	15.6	22.1	1.2
United States	3,619.2	3.9	6.0	1.5

Source: International Monetary Fund, International Financial Statistics Yearbook, 1985.

(a) Expressed in billions (i.e., 10^9) of U.S. dollars.

(b) Data are for 1983.

(c) Data are for 1960.

country of comparably small economic mass does international trade account for such a small share of economic activity?'. Table 3.1 offers some pertinent statistics.

Australian economists, and New Zealand and other economists resident in Australia, have contributed disproportionately to the theory of international trade. (Names springing readily to mind are Max Corden, Bob Gregory, Bharat Hazari, Murray Kemp, Peter Lloyd, Richard Manning, Ian McDougall, Albert Schweinberger, Pasquale Sgro, Richard Snape, Peter Warr and Alan Woodland.)

In other countries the IAC is being cited as an institutional model for informing government opinion, and the public, 'of the consequences of government actions for specific industries' (e.g., Rivlin (ed.) (1984), cited by Gruen in the foreword to Rattigan (1986)). Finally, the success of the ORANI team led by Peter B. Dixon has given Australian work on the use of CGE models for the analysis of international trade a standing second to none. This work itself built on Evans' (1972) CGE model of protection in Australia, which was seen internationally as a major pioneering effort.

Question: Have Australian economists become fascinated with international trade (a) because, or (b) in spite, of the fact the Australia has so little of it?

We lack the expertise necessary to answer this riddle. What we can point to is the fact that Australia had applied the Stolper-Samuelson theorem (1941) to policy more than 30 years before it was invented! Almost from the earliest days of federation it was taken as an article of faith by an impressive majority of Australia's elected legislators that tariffs were friendly to labour -- for more details, see Powell (1982). No CGE analysis of which we are aware -- including a cliometric study of the Colony of Victoria as it was in 1880 (Siriwardana (1985)) -- supports this viewpoint. Living in this topsy-turvy world, Australian economists perhaps have felt the need to do battle on the tariff front to reassure themselves that they have not

lost their grip on reality (which is exactly what they are accused of by the protectionists).

The circumstances of the reform of the Tariff Board in 1967, and the creation in 1973 of its successor, the Industries Assistance Commission, followed by the Impact Project in 1975, have been documented by the Commission's exceptionally far-sighted and courageous first Chairman (Rattigan (1986)). That so distinguished a gathering as this Task Force would be interested in what we have to say, we see as fitting testimony to the service rendered to the theory and practice of economic policy by Alf Rattigan.

Rattigan and his chief of staff Bill Carmichael (the current Chairman of the IAC) perceived that the fragmented approach to industry policy which had prevailed prior to 1967 had left a gaping hole in the principle of public accountability for government action. To a first approximation, sectoral policies in the short run are zero-sum games. Unfortunately, tariffs and other protective measures tend to be games with pay-off matrices having many dimly perceived elements -- especially those applicable to the losers. It is necessary for open, informed and honest government to make explicit the full pay-off matrix -- not just the gains to the principal winners. This much was clear to the leadership of the IAC when CGE modelling was in its infancy. Rattigan and Carmichael were aware that the economy had to be seen as a system -- obviously decisions taken in one area (manpower or immigration) could make nonsense of those taken in another (tariffs) if the interconnectedness of the economy was ignored. In 1973 Rattigan asked one of us (Powell) to set up a policy information system which would allow sensible advice to be given on industry assistance in an economy-wide framework. At the same time he was taking steps to mobilize an integrated data base (Rattigan (1986, pp. 192-193)) and to

recruit the necessary professional expertise in-house to make best use of the new facility.

4 DESIGN ASPECTS

It will be clear that we, and the Impact Project, came into CGE analysis from the 'muddy boots' arena, not the cloisters of Arrow-Debreu theory. Data and policy relevance always have been the imperative driving the work of the Project. This, and the use of a team approach, marked Impact apart from most comparable efforts other than Norway's MSG (multi-sectoral growth) modelling project pioneered by the late Leif Johansen (1960) (see Førsund et al. (eds) (1985) for an account of recent developments). Whilst not exactly a design feature, these emphases on

(a) an integrated data base spanning the areas of interest to the IAC and the other participating government agencies in areas such as labour, immigration and housing,

and on

(b) policy relevance as seen by policy makers,

had important consequences for the way in which we went about our work. So too did the attention we gave to

(c) human capital formation

-- more than 100 participants passed through intensive, 'hands-on' residential training courses on the use of Impact models run by Impact over the period 1981-84 (Powell (1985a, pp. 62-65)), while many more have benefitted from on-the-job training at the IAC and/or Impact, or from courses in the use of the ORANI model run by the IAC. Unlike Norway's MSG team, from the start it was our goal that the ORANI model

be usable by as many policy analysts as possible. The recent initiation by Pearson (1986) of a research program to develop flexible, portable, computer code for CGE analysts, already has enabled researchers at four sites other than the Impact Centre to install, and to run, ORANI on their own mainframes.

4.1 Strategic Choices

A simplified flow-chart tracing important design decisions taken early in the life of the Project is given in Figure 4.1. We have already pointed out that the IAC's management believed that a comprehensive economy-wide analytic framework was essential to the proper function of the Commission. Economy-wide models then in use were later classified by Challen and Hagger (1979) as follows:

(i) Keynes-Klein (KK) Models, of which the work of Wharton Econometric Forecasters (e.g., (1981)) is a leading example ;

(ii) Phillips-Bergstrom (PB) Models, of which the continuous-time disequilibrium model of Bergstrom and Wymer (1976) is a leading example;

(iii) Walras-Johansen (WJ) Models, which include all applied general equilibrium work -- although Challen and Hagger made finer distinctions in a later version of their taxonomy (1983). Below we simply use the CGE label to describe this class.

The KK class was ruled out because the ad hoc approach to disaggregation usually employed within it was judged to be unsuitable for the analysis

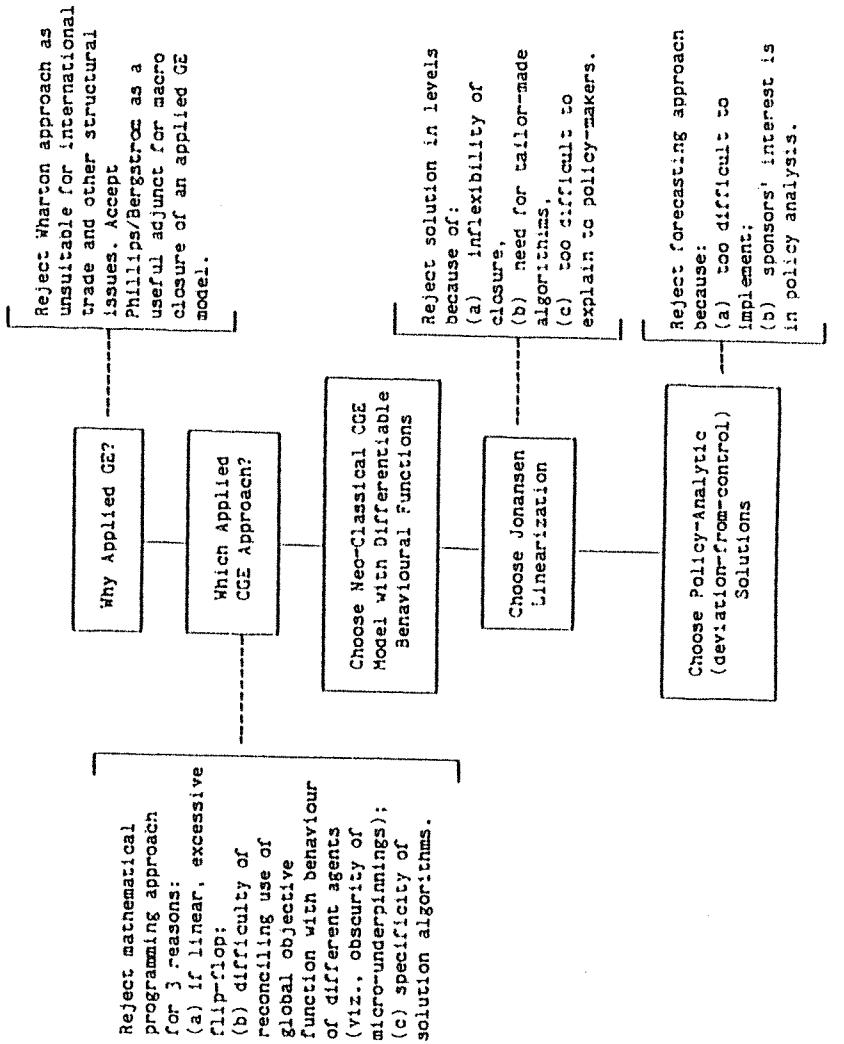

Figure 4.1 Simplified Account of Strategic Choices in Model Design Adopted by the Impact Project 1975-1985

of intersectoral interactions. Even where formal input-output methods are used within a KK model, the smorgasbord approach towards the definition of other variables and towards the specification of other relationships tends to produce a model which is poorly integrated; moreover, the price behaviour generated by the simple input-output extension may lack credibility. The kinds of simulations required for analysis of compositional changes in the economy would clearly go beyond the purpose (macroeconomic policy analysis and forecasting) for which the KK class was constructed. The inability of these models to handle major compositional events was devastatingly revealed in the wake of the OPEC oil shocks of the 1970s.

The PB class of models is formulated in continuous time. Typically, such a model consists of a set of differential equations specifying the rates of adjustment of endogenous variables as functions of the gap between the current value of the variable, and some equilibrium or target value; the latter are specified in auxiliary equations to be functions of exogenous variables (see Bergstrom and Wymer (1976)). Such an ambitious approach to dynamics seemed clearly to go beyond the data base which we could hope to mobilize; as well, it had only been feasible with relatively small systems. (We did, nevertheless, find a way of capitalizing on the strengths of the PB approach (of which more later).)

The above discussion makes it seem that we adopted the CGE approach because that was all that was left. In fact we were attracted to CGE analysis by positive factors, especially by its very strict insistence on an exhaustive treatment of the interactions among industries, both on the demand and on the cost sides.

4.2 Which CGE Approach?

As of mid-1974 it is fair to characterize the state of applied general equilibrium analysis as follows: two schools were well established, and a third was in its infancy. The first of the established schools was Johansen's Norwegian group, whose adherents, except for Taylor and Black (1974), seemed to be confined to that group; the second was the mathematical programming/development planning school, which had many adherents (for typical works see Sandee (1960), Manne (1963), Bruno (1966), Evans (1972), and Goreux and Manne (1973)). The third, fledgling, school was differentiated from Johansen's group by a somewhat narrower interpretation of the notion of equilibrium, and by the habit of solving its models in the levels rather than in log differential form. Shoven and Whalley (1972, 1973, 1974), provide early examples of the work of this third (by now dominant) school.

In the initial design phase of 1975-76, the recruitment to the project of Peter B. Dixon was the decisive element. Dixon had built a prototype CGE model of Korea while at the IMF; he joined Impact with the express purpose of continuing this type of modelling. It was clear that the major model which he had in mind would not deal with

(a) monetary or financial markets;

nor with

(b) labour supply.

To handle the latter it was decided to build an economic-demographic model BACHUROO, on which I reported at the first meeting of this Task Force (Powell (1983)). (For a description of the state of this model's development at the time when shrinking research resources caused planned refinements to be abandoned, see Sams and Williams (1983).) Dixon recommended that we build two CGE models: one for long term

analysis, SNAPSHOT; and one for shorter term work, ORANI. The first of these belonged to the mathematical programming class, and the second to the Johansen class. SNAPSHOT was used as a consistency framework for checking the implications of foreseen technological changes (Bureau of Industry Economics (1981a,b); Dixon and Vincent (1980)); for the same reasons as applied to Evans' earlier (1972) work, it did not lend itself to the analysis of international trade. In SNAPSHOT a perfectly substitutable import was available for each local product; this led to excessive 'flip-flop'.

ORANI's development proceeded in parallel with SNAPSHOT. The use of the Armington (1969, 1970) specification gave ORANI a much better chance of endogenizing imports realistically; moreover, we began to perceive that the latter model also could be used to produce 'snapshots' of the economy in a relatively distant future year (10 or more years away, say); in due course this led to the abandonment of SNAPSHOT. An additional reason for not going on with SNAPSHOT was the realization that the solution algorithm would have to be redeveloped with every non-trivial extension of the model.

The account so far is at about the level of the second box from the top in Figure 4.1. Basically, we resiled from the use of the mathematical programming approach for reasons (a) and (c) listed in the Figure. A third reason for caution, which Peter Dixon emphasized from the beginning of the Project, is listed as (b) in Figure 4.1: used incautiously, the programming approach can result in an economy-wide objective function being specified in a way which, whatever its merits from a normative economics standpoint, is not satisfactory from the viewpoint of positive economics. The problem is that the maximization of such a global function may not be consistent with plausible micro behaviour on the part of all agents. Thus SNAPSHOT was <u>not</u> initially formulated as a mathematical program with a global objective function.

Rather, each agent's behaviour was specified and this information used to define an equilibrium for the system; to develop an efficient algorithm for the solution of the model we <u>then</u> made use of mathematical programming. While this is no more than following standard practice in general equilibrium analysis, such practice was not always followed by members of the development planning school.

4.3 <u>Why Johansen?</u>

The attractions of differentiable technological and behavioural functions caused us to arrive at the third box in Figure 4.1. While discontinuities are undoubtedly present in the real-world behaviour of individual agents, they are much less common in the observed behaviour of aggregates at the level at which we were working (about 100 industries and about ten occupations). We chose Johansen-style solutions for the three reasons listed in Figure 4.1: (a) given the non-linear structural form of a typical neoclassical CGE model, moving between closures could become a major exercise -- for the policy work planned with ORANI, however, flexibility of closure was essential; (b) neo-classical CGE models solved in the levels, like their forerunners in the mathematical programming school, require tailor-made algorithms -- these would have to be redeveloped with each change of specification and/or closure of the model; and most importantly (c) Johansen-style solutions are <u>much</u> easier to explain to policy makers than are solutions in the levels; moreover, Johansen-style solutions decompose additively into effects which are specific to the individual component shocks.

To grasp point (c) it is not necessary to go beyond a comparison of the Johansen and the levels form of factor demand equations based on CES technology:

Johansen form

(4.1) percentage change in labour demand

equals percentage change in output

minus σ × (percentage change in wage rate relative to cost of primary factors in general).

Levels form

$$(4.2) \quad L = \frac{Y}{A}\left(\frac{\delta}{W}\right)^{\sigma}\left(\delta^{\sigma}W^{(1-\sigma)} + (1-\delta)^{\sigma}R^{(1-\sigma)}\right)^{\frac{\sigma}{(1-\sigma)}},$$

where Y, and L are the amounts of output, and labour; W and R, respectively, are the wage rate and the rental price of capital; and A, δ and σ are parameters. To see the advantages of the additive decomposition of a Johansen solution, one need do no more than peruse the tables of Vincent's (1986) companion paper.

4.4 What Sort of Solution?

The final issue concerned the type of solution. The meaning of an 'equilibrium' -- which for the most part seems to be used as a synonym for 'a solution to a CGE model' -- has effectively been defined by what CGE modellers actually do. Some modellers have regarded only certain types of solution as valid objectives of CGE analysis -- in particular, solutions in which supply and demand are equal for all commodities and all factors. Both Malinvaud (1973, pp. 5-8) and Hahn (1985, p. 3) regard this focus as too narrow. At Impact we have often utilized closures in which a price is exogenized and the corresponding excess demand endogenized. The leading case in point is the labour

market, where extremely rigid real wages are an undisputed short-run feature of the actual Australian economy. The standard ORANI closure (Dixon, Parmenter, Sutton and Vincent (1982, p. 143)) involves an exogenously set real wage and the endogenization of employment.

There is another aspect of solution choice. Comparative statics can be intertemporal, or contemporaneous. In each case, two solution points for the simulated economy are compared. In the intertemporal case, the points correspond to calendar dates -- 1988 and 1990, say. The difference between the values of an endogenous variable at these two dates is then interpreted to be the result of different settings of the exogenous variables in 1988 and 1990. In the contemporaneous approach, on the other hand, we consider the difference between two 1990 solutions for the endogenous variable in question; this difference is attributed to a 'shock' introduced into the values of the exogenous variables generating the initial 1990 solution. Elsewhere (Cooper, McLaren and Powell (1985, p. 417),) we have referred to such differences as contemporaneous differential comparative static (CDCS) solutions. These are the analogues of 'deviation-from-control' solutions in macrodynamics; they answer questions like: relative to the values which they would otherwise have taken, by how much would output, employment, and profitability in industries a,b,c, ... differ in about two years time as a consequence of a planned increase of z per cent in the tariff on product x? Differentials of the sort defined by questions framed in this way define the field of policy analysis. Forecasting is much more ambitious; it requires estimation not only of deviations from control, but also of a control path which depicts the future course of events as accurately as possible. The reasons for eschewing forecasting (as listed in Figure 4.1) were (a) the sheer difficulty of assembling believable scenarios on the very large number of exogenous variables driving ORANI (see Powell (1981, pp. 231-232)); and (b) the desirability of keeping the questions, and answers, focused

sharply on the policy shock. To these we would add (c): it is better to attempt to crawl before entering an Olympic marathon. (In fact, contemporary developments with the ORANI model include its extension to forecasting; the first such application is reported in Dixon (1986); Peter Dixon and Brian Parmenter's (1986) paper to this Task Force meeting touches on some of the methodological issues involved.)

4.5 Macroeconomic Closure

The account so far has abstracted from two important aspects: (i) macroeconomic closure; and (ii) long-run versus short-run closure. It has been clear at least since the work of Patinkin (1965) that it is not valid to visualize the economy as being dichotomized into two blocks, in the first of which are determined all real magnitudes and all relative prices; and in the second of which are endogenized only money demand and the price level. The problem is that the determination of all real magnitudes (at levels where excess demands are zero) by relative prices alone is sufficient to ensure equilibrium in the money market (the excess demand for money is just the excess supply of goods (by Walras' Law), while the supply of money is exogenous). Thus no scope exists for a separate role for a purely monetary market; in particular, such a market in isolation could not determine the absolute price level (for a fuller discussion, see Adams (1986)). The 'Impact' paradigm as originally formulated (Powell and Lawson (1975)) did postulate the separability of the economy into a 'macro' block, and a 'micro' block; while no monetary or financial variables appeared in the latter, real variables (in particular, aggregate consumption and investment) did appear in the former. This formulation was developed because ORANI, as originally conceived by Peter Dixon, lacked equations sufficient to endogenize aggregate consumption C, aggregate investment I, and the price level P, in most policy-relevant closures of the model. For short-run analysis, a model based on macroeconomic ideas could be

used to endogenize C and I, and thus to drive the microeconomy. Hence this approach made provisions for the possible non-neutrality of money in the short-run, while insisting that the disaggregation of the real economy was faithful to Walrasian ideas.

ORANI's lack of macroclosure meant that policy analysts routinely would have to set exogenously:

(i) 'one of the price level or the exchange rate (as numeraire),

(ii) one of the real wage or the aggregate level of employment,

(iii) one of real absorption (C+I+G) or the balance of trade surplus (X-M)' (Cooper, McLaren and Powell (1985, p. 415)).

This selection is referred to as the analyst's choice of a 'macroeconomic environment' under which to conduct his policy simulations.

Contemporaneous with our work was the development by Peter Jonson and co-workers at the Reserve Bank of Australia of a small PB model concentrating heavily on monetary and financial variables, endogenizing about a dozen of these, plus C, I and P, and not much else. We borrowed the Bank's model (Jonson and Trevor (1981)), modified it slightly, and dubbed the resulting model MACRO (Cooper (1983, p. 28)). The aim was to use MACRO to provide ORANI with a short-run macroeconomic closure. As far as we are aware, nobody had previously attempted to interface a macrodynamic model with a comparative static one. This presented a major theoretical challenge which was solved in a series of papers by Cooper and McLaren which are summarized in Cooper, McLaren and Powell (1985).

The problem was attacked as follows. ORANI contains aggregate variables which appear in MACRO.

> 'These variables are measured quarterly and track the observed real world data with reasonable precision (using this term in the context of macrodynamic modelling). The behaviour of these variables in MACRO ... sets the standard for empirical validations. A method for interfacing ORANI and MACRO is then devised which is conditional on the (as yet) unknown length of the ORANI short run. It is required that those variables which are endogenous to both models should have values, in the interfaced system, which are in agreement at the unknown lag equal to the ORANI short run. The latter is then found as the period of time elapsing between the injection of a shock in government spending and the achievement of such consistency in the double endogeneities (i.e., variables endogenous to both models; namely, output, the domestic price level, employment and imports). The period so estimated is 7.9 quarters (Cooper (1983))'. (Powell (1985b),p. 50)

Basically, this method allows equations from a dynamic continuous-time model to be transformed so as to permit them to be added to a comparative static model such as ORANI; the augmented model can be solved in the usual Johansen form.

Empirical results with the interfaced ORANI-MACRO system confirmed that ignoring possible macroeconomic feedbacks from tariff shocks introduced only second order errors; that is to say, solving ORANI in stand-alone mode with an exogenous macroeconomic environment would give a good approximation to the results obtained from ORANI-MACRO. Thus for most policy work involving sectoral shocks, macroeconomic closure is not a major issue. Nevertheless, given the macroeconomic difficulties facing the Australian Government, fiscal issues are now so

prominent that a further approach to macroeconomic closure recently has been developed at the Melbourne Institute of Applied Economic and Social Research. Although its use is much wider than just trade-related issues, this approach takes explicit account of the differences in tax revenues caused by a sectoral shock such as a change in one or more tariffs (Meagher and Parmenter (1985)). A standard closure of ORANI with this NAGA extension allows exogenization of the public-sector borrowing requirement (rather than absorption).

4.6 Long-run versus Short-run Closure

The most frequently used closure of ORANI is described in full as 'the neoclassical short-run with slack labour markets' (or more briefly just as the 'standard short-run closure'). The term 'slack labour markets' indicates the assumption, alluded to in Section 4.4 above, that real wages are rigid, labour of all types is in excess supply, and as a consequence that employment is demand-determined. Industry-specific capital stocks are taken as exogenous; the adjustment period must be short enough to ignore any new capacity coming on stream as a result of the shock, but long enough to allow firms to attain new cost-minimizing compositions of variable inputs. Investment demand responds to the shock, but the new capital created is assumed not to come into production until the period following the solution period.

With industry-specific capital stocks set exogenously , their rental prices, and rates of return, are endogenized in ORANI's short-run closure; in long-run closures, these roles are reversed. Thus Australia is seen as a 'small country' in the world capital market.

Politics being what it is (especially in a country where the electoral cycle never exceeds three years), the short-run closure was clearly the one relating most closely to the policy clients'

self-perceived needs. This is why the short-run closure was developed first (in 1975). However, as explained above in Section 4.2, there was also an interest from the beginning in the long-run consequences of tariff and other policies.

Dixon (1978) had demonstrated early in the life of the Project that the existing class of CGE models, including ORANI, was not suitable for estimating the long-term costs of protection. In particular, however convenient from the viewpoint of generating an easily interpretable economic story, the assumption of globally constant returns to scale inevitably meant that some of the most costly consequences of protectionism would be overlooked. Logically prior to our attempting to develop a CGE model allowing for scale effects was the tidying-up of some aspects of ORANI's long-run macroeconomic closure. In particular, if a simulated shock injected in (say) 1980 resulted in a much larger aggregate capital stock in 1990, it would be necessary to know how this was achieved before we could understand the implications for the domestic economy. At one extreme, the growth in capacity might have been financed entirely by domestic savings; at the other, all of this growth might have been financed by foreign capital inflow. The latter would have implications for payments to service rentals on capital -- gross national product could well diverge substantially from gross domestic product.

To handle this problem within the contemporaneous differential comparative (CDCS) static framework requires that at least some primitive dynamics be specified to link the base period (e.g., 1980) with the year (e.g., 1990) for which CDCS solutions are computed -- this much is required to allow the necessary stock-flow accounting to be done. A consistent procedure was developed on a prototype by Dixon, Parmenter and Rimmer (1984) and further explored by Horridge and Powell (1984), resulting in an operational method for use on the full ORANI model

(Horridge (1985)). This long-run closure is now a part of the standard ORANI tool kit. It does not, however, cope with scale economies. We will return to this issue in Section 6.

5 MANAGEMENT ASPECTS

We believe that Impact would have had much less chance of success if it had been attempted to run the Project:

(a) entirely within a university;
(b) entirely within a government agency;
(c) without full public documentation of data, methods, and results;
(d) entirely in the federal capital, Canberra;
(e) without detailed involvement of the policy-making clientele in the design stages;
(f) at anything less than a full arm's length from executive government.

The Project (however financed) would not have prospered in a purely academic environment for two reasons. Firstly, academic proclivities in the choice (and approach to the solution) of problems are biased towards what is intellectually novel, irrespective of the scope for application. This bias is not irrational in terms of career strategy -- papers showing an original turn of mind are much more likely to lead to academic promotion than papers whose immediate usefulness is obvious but which lack creative novelty. This emphasis on 'pure research' may be socially justified since, if universities do not take the long view, it is unlikely that any other institutions will. Nevertheless we believe that current practices in the academic economics profession discourage many talented researchers from the painstaking kind of empirical

research that is needed for policy modelling. This makes it harder to do credible CGE policy work in a purely academic setting.

Secondly, academics in the social sciences do not like to be directed. A researcher whose creative urges take him off at some interesting tangent does not respond well when it is pointed out to him that he is being paid to solve the original, not the tangential, problem. Again, there are good and bad aspects to this. On the plus side, he may have discovered something of major importance, such as a new line of attack on a difficult problem. On the negative side, a whole team may be seriously delayed while waiting for some crucial input from him.

At the other extreme, trying to run a major research effort within the strictures of a bureaucracy has problems. The first is how to ensure that the creative spark of young researchers is not killed when the many quality reports which they prepare never get beyond some official's desk. The second is bureaucrats' obsession with secrecy. This not only prevents the best young professional talent from striving for an excellence which, if achieved, would remain forever anonymous; as well it prevents the work of an agency receiving the kind of outside professional criticism and feedback which keeps its researchers on their toes. But against these drawbacks there are two enormous advantages: (a) civil servants, by and large, are willing to accept direction; and (b) the quality of data and relevance of empirical work <u>are</u> taken seriously.

To make the best of both worlds Impact had to create an environment in which public servants could work at their creative best. It was necessary, not only to ensure that the work of the Project was public, but to establish the custom of civil servants publishing under their own names. There was some bureaucratic resistance to this at

first; at least in the case of the IAC, however, a workable publications policy was established which resulted in many of the public servant members of the Project team making contributions which became widely quoted. (The most celebrated case is the 1982 ORANI volume, three of the co-authors of which were public servants at the time of the final draft.)

The academic connection was important for the following reasons:

(i) the shortage of skilled manpower precluded the assembly in-house of a complete team;

(ii) it is doubtful that careerline civil servants would have been able to insist that the quality of ideas should determine how the Project developed, rather than the bureaucratic rank of the adherents to the ideas; involving academics in a leadership role gave this a much better chance of success;

(iii) keeping a 'shop front' open in the university sector gave immediate access to new ideas under development in economic theory and econometrics; moreover, it made it easier to identify consultants (e.g., Russel J. Cooper, Keith R. McLaren) having the skills to solve analytically challenging problems;

(iv) a university affiliation enabled the Project to provide opportunities for, and to benefit from, graduate research training (the Project produced Ph.Ds and Masters graduates at the rate of about one in each category per year over the decade ending in 1985, as well as providing many less formal opportunities for research internships -- for details see Powell (1985a, pp. 42-48));

and

(v) the academic connection insisted on peer group assessment of the quality of the Project's work through attempts at refereed publication.

Quite apart from quality control through peer group assessment, full public documentation of data and methods was a precondition for acceptance (or for informed rejection!) of the Impact policy information system. Given the desire of many influential people, both inside and outside government, that such work should not continue, it would otherwise have been relatively easy to discredit the Project by commissioning secret assessments claiming that the quality of the work was inferior. (In the early days of the Project, one of us (Powell) was shown (but not allowed to copy) such a secret report which was commissioned by a very senior bureaucrat with the express aim of terminating Impact on the grounds of incompetence. Fortunately, this move had been foreseen, and the Committee of Officials investigating the Project (see Battigan (1986, p. 270)) also had in front of it the opinions of some world leaders in economic modelling.)

Canberra is a city in which the concerns seen by the Government as most pressing on a day-to-day basis dominate the ambience of the civil service. It is not a good environment for basic research by public servants on policy issues. This is well illustrated by the mistake we initially made of holding ORANI training courses in Canberra. Most of the (predominantly civil service) student participants would check their desks at 8:00 am before turning up for lectures at 9:00 am. If anything of significance had come up, their span of attention for economic analysis would have been reduced almost to zero; if they turned up at all at lectures, they would hurry back to the office at lunch time. In the evenings, when they were supposed to be doing homework, they would instead be burning the midnight oil in an attempt to complete office work. The location of the basic research and development group

outside of Canberra did involve some logistic difficulties; however, such location away from day-to-day pressures in policy advising did allow a research ambience to develop.

The detailed involvement of clients in the design stage of model building is no more than common sense. It ensured that the models when completed could, and would, be used for policy analysis.

Keeping basic research and development at arm's length from executive government is another common-sense requirement. When political imperatives are allowed to override longer term professional judgments on questions such as when a model is ready to produce credible policy simulations, the whole operation is put irreversibly at risk. Impact had two levels of insulation from the executive: firstly, the convening agency, the IAC, is an independent advisory body, not part of the executive; secondly, the Project was set up to provide tools and human capital development for policy advisers, not to provide the advice itself.

6 CONCLUSION AND PERSPECTIVE FOR FUTURE POLICY MODELLING

At the beginning of this paper we posed four questions. We are now in a position to provide an answer to them in summary form. Briefly, then, to what do we attribute Impact's success in establishing CGE modelling in Australia as a practical policy tool?

First, both the sponsors and the researchers took data and empirical relevance to be of signal importance. Second, quality control was assured by very full documentation and an open style of management which invited critical feedback, not only from clients and protagonists in the policy debate, but from other modellers. Third, a productive

team was assembled by exploiting favourable complementarities between the academic, and the civil service, approaches to research. Fourth, the emphasis on Johansen solutions of the contemporaneous differential comparative static type paid good dividends for three reasons: (i) because it focused discussion quite strongly on the policy shock under review; (ii) because it allowed great flexibility in moving between closures of the model; and (iii) because it allowed computation of solutions on a routine basis; these were relatively inexpensive, from the viewpoints both of code development and of central processor time. Fifth, keeping the basic research group of the Project at a full arm's length from executive government was an essential ingredient; it is doubtful whether this could have been achieved without University involvement. Sixth, the clients were fully involved at the design stage. Seventh, Impact writers have put much effort into explaining, as non-technically as possible, the principal mechanisms responsible for the results obtained in particular policy simulations. The Australian Prime Minister recently issued this challenge to economists:

> 'Effective communication is not merely informing people of the outcome of your analysis. It involves communicating an intuitive understanding of the reasons why such judgments should be supported. Success in this regard will ensure that modelling efforts, and the associated commitment of resources, are adequately rewarded in terms of their influence on policy development'. (Address of welcome by the Rt. Hon. R.J. Hawke to the visiting Chinese members of the Bilateral Australia-China Working Party on the Role of Economic Modelling in National Economic Management, 2 December 1985).

Eighth, acceptance of the ORANI model was aided enormously by formal and informal training courses enabling policy analysts to make independent

hands-on use of the model. Finally, the Project was fortunate in the extreme to attract Peter B. Dixon to design and supervise the building of the ORANI model.

What do we expect the next decade of CGE modelling in Australia to hold? First, let us state that we are optimistic that the ORANI model and its derivatives will survive as a policy instrument, however uncomfortable that may be for some influential Australian figures of the political left and of the right. This is because the CGE approach is the only plausible calculus available for determining the consequences for different agents in the economy of the myriad of policy decisions which governments routinely take. As for methodological developments and the extension of Australian CGE work into new applications, we foresee:

(a) a much more detailed disaggregation of taxes and of the fiscal system (along lines in ORANI pioneered by Meagher (1986), and Meagher and Parmenter (1985)),

(b) many more special-purpose models being erected, at the IAC and elsewhere, around the core of the ORANI model,

(c) the development (mainly at the Melbourne Institute of Applied Economic and Social Research -- the IAESR) of a CGE model for forecasting (see Dixon and Parmenter (1986),

(d) the development of a monetized CGE model (probably mainly at the Impact Research Centre) drawing on the work of Feltenstein (1986) and others (e.g., Vincent (1985), Dee (1986)),

(e) following Harris (1984a, 1984b), the development of a CGE model allowing for oligopolistic pricing and scale economies in some

import-competing industries, perhaps along the lines of the Australian prototype developed by Cory and Horridge (1985),

(f) the progressive relaxation of many of the technological assumptions of standard ORANI to incorporate accumulating econometric knowledge on matters such as materials-materials substitution (see, e.g., Truong (1986)),

(g) the extension (mainly at the IAESR and the Impact Research Centre) of the ORANI framework in order to map from the functional to the personal distribution of income, and to allow a start to be made on the welfare analysis of a wide variety of policies (see Meagher and Agrawal (1986) for a progress report),

(h) increasing attention to the labour supply side of CGE modelling, with emphasis on incentives affecting labour market attachment (see Piggott and Whalley's (1986) novel development, within a CGE model, of the consumption and labour/leisure decisions of a household with two working partners),

(i) the development (at the IAESR, with New Zealand cooperation) of an Australia-New Zealand CGE model, which focusses on trade relations between the two countries,

and finally

(j) the diffusion of flexible and portable computer code, currently under development at the Impact Research Centre (Pearson (1986)), for the solution of CGE models.

The institutional environment in which these developments take place will alter, partly as a consequence of (j) above, which will make it much easier for new applied CGE analysts to enter the field. This may not, in the beginning, be all that advantageous, as relatively few Australian economists have an adequate training in CGE analysis. To the extent that they can do so within an educational system which is badly equipped to supply a high level of professionalism in economics, we would hope to see Australian universities attempting to rectify this.

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The Impact Project Information Officer
Mr Mike Kenderes
Industries Assistance Commission
P.O. Box 80
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who will supply a catalogue on request.

(Note: AGPS - Australian Government Publishing Service.)

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