IMPACT PROJECT REPORT

A brief account of activities over the period 1st January 1988 to 31st December 1990, with a prospectus for further developments

by

ALAN A. POWELL

Director

Impact Project Report No. R-08

University of Melbourne, February 1991

ISSN 1031 9034
ISBN 0 642 10089 6

IMPACT PROJECT REPORT

A brief account of activities over the period 1st January 1988 to 31st December 1990, with a prospectus for further developments

by

ALAN A. POWELL

Director

Impact Project Report No. R-08

University of Melbourne, February 1991

The views expressed in this report do not necessarily reflect the opinions of the participating agencies, nor of the Commonwealth Government.

ISSN 1031 9034
ISBN 0 642 10089 6

The Impact Project is a cooperative venture researching the structure of the Australian economy and building a policy information system to assist others to carry out independent analysis. The project is convened by the Industry Commission and is supported by:

- INDUSTRY COMMISSION
- UNIVERSITY of MELBOURNE
- AUSTRALIAN NATIONAL UNIVERSITY
- AUSTRALIAN BUREAU of AGRICULTURAL and RESOURCE ECONOMICS
- DEPARTMENT of the ARTS, SPORT, the ENVIRONMENT, TOURISM and TERRITORIES
- DEPARTMENT of EMPLOYMENT, EDUCATION and TRAINING
- BUREAU of IMMIGRATION RESEARCH
- BUREAU of INDUSTRY ECONOMICS
- LA TROBE UNIVERSITY

Since March 1979 the University of Melbourne has dedicated the Ritchie Chair of Research in Economics, held during this period by Alan A. Powell, to the Impact Project.

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 11 Oct	Dr Ken Pearson La Trobe University and University of Melbourne	New GEMPACK Facilities for Multi-Step (Euler) Solutions and Database Updates
Thurs 18 Oct	Dr Chris Ellis and Dr Mark Thomas University of Oregon	Credibility and Political Business Cycles
Thurs 25 Oct	Professor Cedric Sandford University of Bath and University of Melbourne	The Compliance Costs of Taxation – Why They Matter
Thurs 1 Nov	Dr Leong-Hoe Liew University of Melbourne	Rent Seeking and the 2-Track Price System in China
Weds 14 Nov	Professor Robert Flanagan Stanford University	Union Labour Adjusts to a Change in Climate
Thurs 15 Nov	Dr Philip Adams and Mr Brian Parmenter IAESR	Economic Effects of Tourism in Australia
Thurs 22 Nov	Dr Ethan Weisman National Centre for Development Studies ANU	Aid as a Booming Sector in the South Pacific: Evidence from a CGE model of Papua New Guinea
Thurs 29 Nov	Dr John Madden, Centre for Regional Analysis University of Tasmania Professor Peter Dixon and Mr Matthew Peter IAESR	Changing the Distribution between States of Commonwealth Grants
Tues 4 Dec	Dr Kit Baum Boston College	Monthly Term Structure of US Interest Rates 1919-30
Thurs 13 Dec	Dr Jim Breece Impact Project and University of Maine	An Overview of the FAIRMODEL

CONTENTS

LIST OF TABLES

Appendix 2 (continued)

Date	Speaker	Topic
Convenor: Mark Horridge		
Thurs 26 July	Professor Peter Dixon IAESR	Analysing the Economic Effects of a Multi-function Polis
Thurs 2 August	Dr David Turner ESRC Macroeconomic Modelling Bureau, University of Warwick	Should Macro-economic Models have Simple Long-run Properties?
Thurs 9 August	Ms Daina McDonald IAESR	The Accumulation of Foreign Dept in Canada, 1950 to 1986
Thurs 16 August	Mr Heling Shi and Dr Xiaokai Yang Monash University	The Evolution of Industrial Structure
Thurs 23 August	Dr Tony Meagher IAESR	Calculating Fiscal Incidence in Australia
Thurs 30 August	Professor Ian Harper University of Melbourne	Financial Deregulation: Boon or Bane?
Thurs 6 Sept	Mr David Johnson IAESR	Construction and Use of an ORANI-based Model (ORANI-F MILK) of Special Interest to the Dairy Industry
Thurs 20 Sep	Mr Micheal Malakellis and Mr Matthew Peter IAESR	How do Expan-sionary Demand Policies Stimulate Employment in ORANI?
Thurs 4 Oct	Assoc Prof Tom Hertel Purdue University & University of Melbourne and Dr Matt Rendleman USDA	Modelling the U.S. Sugar Program

... continued

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 10 May	Professor Carl Miller University of Guelph and University of Queensland	Regional Fiscal Policy and the Great Canadian Recession of 1982-83
Thurs 17 May	Dr Jeff Borland University of Melbourne	Real Wages Over the Business Cycle in Australia
Thurs 24 May	Professor Atsushi Maki Keio University and ANU	Savings and Assets Accumulation Patterns of Japanese Households: Twin-humped Wealth and Portfolio Behavior of the Elderly
Thurs 31 May	Brian Parmenter IAESR Matthew Peter Deakin University	The Economics of Immigration
Thurs 7 June	Dr Peter Higgs Graduate School of Management, University of Melbourne	Australia's Foreign Trade Strategy
Thurs 28 June	Professor Yew-Kwang Ng Monash University and La Trobe University	The Value of Your Life as You Age
Thurs 5 July	Professor George Bitros Athens School of Economics	Demand for Product Attributes: The Case of Automobiles in Greece
Wed 11 July	Professor L. Fraser Jackson Victoria University of Wellington	The Commodity Choice Approach to Demand Modelling: Non-negativity, New Commodities and Engle Curves in Some Additive Demand Systems
Thurs 19 July	Dr Tony Meagher Mr Brian Parmenter IAESR	Historical Simulations with ORANI

IMPACT PROJECT REPORT

A brief account of activities over the period

1st January 1988 to 31st December 1990,

with a prospectus for further developments

by

ALAN A. POWELL[1]

1. Introduction

A report of this type was last issued in February 1988[2]. The purpose of the current document is to brief the participating universities and Commonwealth agencies, and other interested parties, on developments in the Project since then.

This report is organized as follows. A brief recapitulation of the aims of the Project is given in Section 2. In Section 3 institutional arrangements (including staffing) are briefly outlined. Section 4 contains a review of the Project's achievements in the field of model development during the triennium 1988-1990. In Section 5 a case is made for the development of a new suite of models, better suited than *ORANI* for studying environmental and other intertemporal issues. Since such issues will dominate policy debate in the 'nineties, it is now urgent that appropriate models are developed. Section 7 details a proposal to combine the resources of the Impact Project and the Centre of Policy Studies at Monash University over the fiscal triennium beginning 1st July 1991 in order to assemble a team with the critical mass necessary to develop the new generation of models. This proposal is consequent to the imminent establishment of a research team at Monash under the newly appointed Director of the Centre of Policy Studies, Professor Peter B. Dixon, charged with the development of a new economy-wide model.[3]

1 The author is grateful to Micheal Malakellis and Maureen Rimmer for assistance in the preparation of this report, and for helpful comments to the following: Philip Adams, Peter Dixon, Tom Hertel, David Johnson, Mike Kenderes, Tony Lawson and Ken Pearson.

2 Alan A. Powell, "A Brief Account of Activities over the Period 1st March 1985 to 31st December 1987 with a Prospectus for Further Developments", *IMPACT Project Report* No. R-07 (Melbourne: University of Melbourne, 1988), pp. iv + 103.

3 Reported in the Melbourne *Age*, 1st January 1990, p. 3.

2. Aims of the Project

At the time of the project's inception the Chairman of the Industries Assistance Commission (IAC), as convenor of the participating Commonwealth agencies, issued a paper describing the aims of the Project in detail.[4] There have been some changes in emphasis, but no changes in the basic aims as set out by Rattigan in 1976.[5] In this section I draw freely also on earlier reports and reviews.[6]

The main goal of the Impact Project has been to upgrade the information system available to policy advisers. The Project has only incidentally become involved in actual policy debates since too much activity of this type would hardly be consistent with widespread adoption of the tools developed at the Project. The main areas in which the Project has striven to upgrade the policy information system are the following:

1. data conventions, data gathering and data editing,
2. development of computable economic models,
3. development of computer systems for the solution of economic models, and
4. training of personnel.

One major development in contemporary labour statistics, namely the design principles underlying the Australian Standard Occupational Classification (ASCO), in part reflects the response of the Australian Bureau of Statistics (ABS) to an early request from the Project for occupational statistics based on the skills of workers. Before the adoption of ASCO, occupations were classified largely by the industry affiliation of the worker, rather than by type and level of training. With labour mobility between different activities now an important feature of most labour markets, the United Nations is using ASCO as the template for a new global system of labour statistics.

---

4 G.A. (Alf) Rattigan, "The IMPACT Project", *Impact Project General Paper* No. G-01, Industries Assistance Commission, May 1976.

5 *Ibid.*

6 See especially Powell *op. cit.* and Alan Powell and Tony Lawson "A Decade of Applied General Equilibrium Modelling for Policy Work", Ch. 8 in Lars Bergman, Dale W. Jorgenson and Ernö Zalai (eds), *General Equilibrium Modeling and Economic Policy Analysis* (Cambridge, Mass: Blackwell, 1990), pp. 241-290. Other published material is listed in Powell *op.cit.* p.2.

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 7 Dec	Mr Kevin Hanslow Industries Assistance Commission Ken Pearson La Trobe University	Sensitivity Analysis Within GEMPACK
Thurs 14 Dec	Mr Robert McDougall and Mr John Zeitsch Industries Assistance Commission	Domestic Trade Distortions and Australian Agriculture in the Long Run
	1990	
Thurs 8 Mar	Prof Barbara Spencer University of British Columbia and ANU	Vertical Foreclosure and International Trade Policy
Thurs 15 Mar	Professor James Brander University of British Columbia and ANU	Election Polls, Free Trade and the Stockmarket: Evidence from the 1988 Canadian General Election
Thurs 22 Mar	Professor Peter Dixon IAESR	The Pricing of Urban Water
Thurs 29 Mar	Mr Paul Gretton Industries Assistance Commission	Basis of Valuation of the Import Substitution Elasticities used in the ORANI Model
Thurs 12 Apr	Mr Stuart James Industries Assistance Commission	The Economic Benefits of Increasing Graduate Numbers: How Long Can We Wait?"
Thurs 19 Apr	Dr Russel Cooper University of Western Sydney	A Pricey but Profitable Approach to Consumer Demand Analysis
Thurs 3 May	Kazuo Nishimura Kyoto Institute of Economic Research and ANU	Endogenous Fertility and Growth

... continued

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 7 Sept	Dr Maureen Rimmer IMPACT Research Centre	Factor Substitution in Manufacturing
Thurs 14 Sept	Dr Will Martin National Centre for Development Studies ANU	A General Equilibrium Model of the Chinese Economy with Particular Emphasis on the Fibre and Textile Markets
Wed 20 Sept	Professor Ken Clements University of Western Australia	University of Western Australia Studies in Applied Demand Analysis
Thurs 28 Sept	Mr Brian Parmenter and Prof Peter Dixon IAESR	Dynamics in ORANI, a Large-Scale General Equilibrium Model
Thurs 5 Oct	Dr Philip Adams IAESR	The Impact of Overseas Tourism Expenditures on the Australian Economy
Thurs 19 Oct	Mr Andrew Dilnot University of Melbourne and Institute for Fiscal Studies, London	Taxation and Savings
Thurs 26 Oct	Assoc Prof Ronald Bewley University of Sydney and University of N.S.W.	Nonstationarity in Demand Analysis
Thurs 16 Nov	Mr George Codsi, Dr Peter Wilcoxen, and Dr Ken Pearson IMPACT Research Centre	Dynamic Models in GEMPACK
Thurs 23 Nov	Mr Brian Parmenter IAESR	Validation Simulations with the ORANI Model
Thurs 30 Nov	Dr Tony Meagher IAESR	Taxation Policy, Consumer Demand and the Distribution of Income

Since the Project's resources have never permitted the gathering of primary data, the support of the ABS and the Industry Commission (IC) have been critical for the Project's work.[7] The data files developed in the areas of industry structure, the labour market and international trade were designed to provide a summary of the available factual information pertinent to policy analysis in the various fields covered by the participating Commonwealth agencies.

The economic models (briefly described below) were to be *policy-analytic* in nature, designed to estimate how much difference the application of a particular policy would make *relative to the situation in the absence of the application of that policy*. Thus questions to be addressed to an economic model would typically take the form: if such-and-such a policy change were to be implemented in 1991, how different would the economy look in 1993 by comparison with what 1993 would be like without the policy change? More specifically, the economic models were designed to shed light on questions such as:

1. How would employment change in about 100 industry groups spanning the economy as a consequence of a planned reduction in the level of protection provided to the motor vehicles industry?
2. What is the significance for employment, and for different industries, of a successfully implemented wage-tax bargain?
3. Which Australian industries, occupations and regions would gain (and by how much) as the result of successful negotiation of a lowering of agricultural protectionism in Europe?

Credible answers to these and to many other policy questions can be worked out only within an economy-wide perspective that recognizes the interconnected nature of markets for commodities and factors of production. The models built at the Impact Project, therefore, have focused on these interrelations.

The main models developed at Impact (other than prototypes, which are discussed in Section 4 below) are listed in Table 1, where a brief description of their scope is given. During the triennium under review, the focus of research has been exclusively on the *ORANI* suite of models (including *ORANI-MACRO*).

7 A major primary data base on international trade flows was mobilized for the Project by the predecessor to the IC, the Industries Assistance Commission, in 1977. See J. S. Marsden and L. F. Milkovits, "The construction of Price and Quantity Indexes for Australian Trade Flows", *Impact Project Preliminary Working Paper* No. IP-03, IAC, Canberra, October 1977 and C. M. Alaouze, "The IMPACT Trade Flow Data Base", *Impact Project Working Paper* No. I-24, IAC, Canberra, August 1985.

Table 1
*The Main Models Developed at Impact**

Name of Model [Major Focus]	Scope	Remarks
BACHUROO [Labour Supply]	Highly disaggregated demographic/economic projections of the labour market.	Following the disbanding of the Bureau of Labour Market Research in 1986, this model was lost.
ORANI [Industry Structure, International Trade, Labour Demand]	The industrial composition of the economy, relative prices, the demand for labour. Routinely disaggregated to about 100 industries, 8 occupations, and the six States. Available in a large number of special-purpose versions.	Implemented on mini-, personal and mainframe computers using the *GEMPACK* software suite developed at Impact.
ORANI-MACRO	As for *ORANI*, but with feedback to, and from, the macroeconomic environment in the short run.	A second-generation version, based on the *Murphy* (macro) *Model*, is under development.
SNAPSHOT [Industry Structure, Technological Change]	A consistency framework for synthesizing a picture of the future economy on the basis of detailed technological scenarios.	No longer used, long-run versions of *ORANI* providing a superior alternative.

* Entry points to the literature of these models are: for *BACHUROO*, D. Sams and P. Williams, "An Economic-Demographic Model of Australian Population, Labour Force and Households", *Impact Project Working Paper* No. B-18, August 1983; for *ORANI*, P. B. Dixon, B. R. Parmenter, J. Sutton and D. P. Vincent, *ORANI: A Multisectoral Model of the Australian Economy* (Amsterdam: North-Holland, 1982); for *ORANI-MACRO*, R. J. Cooper and K. R. McLaren, "The ORANI-MACRO Interface: An Illustrative Exposition", *Economic Record*, Vol.59, No.165 (June 1983), pp.166-179; and for *SNAPSHOT*, P. B. Dixon and D. P. Vincent, "Some Economic Implications of Technical Change in Australia to 1990-91: An Illustrative Application to the SNAPSHOT Model", *Economic Record*, Vol. 56, No. 155 (December 1980), pp. 347-361.

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 15 June	Dr Nisha Agrawal IMPACT Research Centre	Tariff Reform, Income Distribution and Consumer Welfare
Thurs 22 June	Dr Glen Harrison University of New Mexico	GE Modelling of the EEC
Thurs 29 June	Mr Robert McDougall Industries Assistance Commission	A Finite Transformation between Domestic and International Goods: Does the Trick Stick?
Thurs 6 July	Professor T.J. Kneisner University of Indiana	Numerical Simulation of Hedonic Equilibrium
Thurs 20 July	Mr David Pearce Industries Assistance Commission	Landing Rights: How Much Does QANTAS Cost Us?
Thurs 27 July	Professor Ken Wallis University of Warwick	Econometric Evaluation of the Exchange Rate in Models of the UK Economy
Thurs 3 Aug	Mr Paul Gretton Industries Assistance Commission	Assistance as a Tax and its Effects on Households: An Evaluation Using ORANI
Mon 7 Aug	Dr Alberto Alesina Harvard University	Working on the Budget Deficit
Thurs 10 Aug	Mr Bruce Parsell IAESR, Professor Alan Powell and Dr Peter Wilcoxen IMPACT Research Centre	The Walrasian Take-over Bid for Policy Economics: The Macroeconomists Strike Back
Convenor: Peter Wilcoxen		
Thurs 17 Aug	Professor Ian Walker Keele University and Institute of Fiscal Studies	Indirect Taxation and Welfare

... continued

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 16 Mar	Dr Tony Meagher IAESR	Modelling the Distribution of Income in Australia: An Extension to the ORANI Model
Thurs 23 Mar	Professor A.F. Shorrocks University of Essex and ANU	Poverty Indices
Thurs 6 April	Dr Mark Horridge and Mr David Johnson IAESR	The Economic Effects of Energy-Conserving Technology in the Heavy Road Transport Fleet
Thurs 13 April	Dr Denis Lawrence Industries Assistance Commission	Productivity Change and Price Responsiveness in Australian Agriculture
Thurs 27 April	Dr David Luskin Industries Assistance Commission	Labour Supply Modelling in Fiscal-ORANI
Thurs 4 May	Mr Robert McDougall Industries Assistance Commission	Reforming Trans-Tasman Shipping: An International General Equilibrium Analysis
Thurs 11 May	Dr Peter Wilcoxen IMPACT Research Centre	Optimal Investment in Two Capital Stocks: Did Pollution Control Equipment Crowd Out Ordinary Capital?
Thurs 18 May	Mr John Madden CREA (University of Tasmania) and IAESR	Tariff and Tax Change Simulations with the FEDERAL (TAS-MAIN) Model
Thurs 1 June	Dr Peter Higgs Graduate School of Management, University of Melbourne	A CGE Model of the Australian Corporate Sector

Discussion of the role of computer systems in the work of the Project is deferred to Section 4.

Personnel training takes two forms. First, Public Service personnel outposted to the Project receive the opportunity for a rigorous research training under senior academic supervision. In several cases it has been possible to combine a period of outposting to the Project with candidature for a higher (research) degree.[8] In many cases topics related to the work program of the Project have provided suitable vehicles for supervised research at the Masters or Doctoral level, while the graduate level courses in Applied General Equilibrium Economics at the University of Melbourne have been open to such candidates. Whether enrolled for a higher degree or not, outposted researchers participate in the weekly meetings of the Workshop in Computable General Equilibrium Economics.[9]

Second, occasional formal training courses and workshops are held. During the 1988-90 triennium the basic research and development unit of the Project has, in view of its current small size, vacated the training field in favour of the Industry Commission, which regularly holds courses on the *ORANI* model, and the Institute of Applied Economic and Social Research (IAESR) at the University of Melbourne, which held two *ORANI* training courses in 1988.[10] The Project did, however, run one-day workshops on the *GEMPACK* software suite in 1989 and 1990. The Project will sponsor a two-day Applied General

8 Since its inception in 1975, 4 Ph.D.s and 3 Master's degrees (plus one Master's preliminary qualification) have been awarded to public servants outposted to the Impact Project. In the triennium under review, Dr Philip Adams (then of ABARE) earned his doctorate (1988), while Dr Maureen Rimmer (an outposted officer of the Industry Commission who holds a Ph.D. in Mathematics) earned a Master's degree in Commerce for applied work in Econometrics (1990).

9 The program of talks by members of the Workshop and visitors over the triennium under review is listed as Appendix 2.

10 The number of graduates of the seven formal training courses in the use of ORANI held by the Project up till the end of 1984, of the annual training courses held by the Industry Commission (and its predecessor) in recent years, and by the IAESR, must now exceed 300 persons, and may possibly be as high as 450. These courses, which may run as long as two weeks fulltime, give intensive hands-on training in the use of the ORANI suite of models, so that graduates are able to make independent use of policy models in their own professional work environment.

Equilibrium Modelling Conference to be held at the University of Melbourne in May 1991. International guest speakers at this conference will include Associate Professors Ballard (Michigan State University), Breece (University of Maine) and Hertel (Purdue University).

3. *Current Staff and Institutional Arrangements*

3.1 Participating Institutions

The nine institutions participating in the Impact Project during the triennium under review are listed above on page iii. The Industry Commission[11], whose Chairman acts as Convenor, provides the secretariat for the Project. The Project's work program is overseen by a Management Committee which is chaired by a senior representative of the IC. The Committee's membership consists of one representative of each of the participating institutions. Meetings are held twice (formerly four times) annually.

3.2 Personnel

At the date of writing, the research staff of the Impact basic research and development unit is as follows:

University of Melbourne	*Industry Commission*
Professor Alan A. Powell (DIRECTOR)	Mr George Codsi
Dr James H. Breece[12]	Mr Micheal Malakellis
	Dr Maureen Rimmer

La Trobe University

Dr Kenneth R. Pearson (ASSOCIATE DIRECTOR)

Visiting Senior Fulbright Fellow (Purdue University)

Associate Professor Thomas W. Hertel

Current active Associates of the Project include Associate Professor Keith R. McLaren (Monash University), Mr Chris W.

11 The Industry Commission was known as the Industries Assistance Commission prior to March 1990.

12 Dr Breece is Associate Professor of Economics at the University of Maine, which is partially supporting him during his sabbatical year August 1990 – July 1991 at the Impact Project.

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 3 Nov	Dr Peter Smith London Business School and ANU	The London Business School Econometric Model of the U.K. Economy
Thurs 10 Nov	Mr Brian Parmenter IAESR	Medium-Run Employment Projections
Thurs 17 Nov	Mr Bruce Parsell IAESR	Fiscal Policy Simulations Using the MSG2 Model
Thurs 24 Nov	Mr Steve Bakalis La Trobe University and University of Melbourne	Modelling Harris-Todaro Type Unemployment in a CGE Framework
Mon 5 Dec	Professor David Batten University of Umea (Sweden)	Modelling Trade Between Places: A Review of Applied Spatial Equilibrium Approaches
Thurs 8 Dec	Mr Andrew Welsh Industries Assistance Commission	Estimation of Input-Demand Elasticities in the Australian Wheat-Sheep Zone
Thurs 15 Dec	Dr Viv Hall University of Sydney Dr Truong Truong University of N.S.W.	The Use of ORANI for Energy Modelling
	1989	
Thurs 2 Mar	Mr Jayatilleke S. Bandara La Trobe University	The Effects of a Terms of Trade Deterioration and of Capital Flows on the Sri Lankan Economy
Thurs 9 Mar	Dr Peter Wilcoxen IMPACT Research Centre	Environmental Regulation and Growth in the United States

... continued

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 8 Sept	Professor Graham Pyatt University of Warwick	The SAM Approach in Retrospect and Prospect: (i) Social Accounting Foundations
Thurs 15 Sept	Professor Graham Pyatt University of Warwick	The SAM Approach in Retrospect and Prospect: (ii) Modelling in a SAM Context
Thurs 22 Sept	Dr Otto Hellwig Darmstadt Technical University (West Germany)	Micro Simulations: Some Developments and a Micro Model for the Australian Household Sector
Thurs 29 Sept	Professor Peter Dixon and Mr Philip Norman IAESR	Pricing in an Urban Water Authority
Thurs 6 Oct	Professor John Creedy and Dr Ian McDonald University of Melbourne	Union Wage Responses to a Shift from Direct to Indirect Taxation
Thurs 13 Oct	Professor Peter Dixon and Ms Daina McDonald IAESR	A Short-Run Macroeconomic Forecasting Framework
Thurs 20 Oct	Mr Robert McDougall Industries Assistance Commission	Linking CGE Country Models: An Example Using the OECD Walrasian Models
Thurs 27 Oct	Mr Paul Gretton Industries Assistance Commission	Exports Supplies and Industry Transformation Prospects: An ORANI Extension

Murphy (Australian National University) and Dr Philip D. Adams (IAESR, University of Melbourne). Three La Trobe University Scholars worked with the Project on *GEMPACK* development during the triennium.[13] This research staff is supported by Ms Louise Pinchen (outposted from the IC) and Mrs Frances Peckham (University of Melbourne).

Other research staff working at the Project during the triennium under review were:

Dr Philip D. Adams	(July 1985 - December 1988)
Dr Nisha Agrawal	(January 1986 - August 1989)
Dr Peter J. Higgs	(July 1986 - December 1988)
Dr J. Mark Horridge	(February 1983 - May 1988)
Dr Peter J. Wilcoxen	(January 1989 - June 1990)

Drs Adams and Horridge left the Project to take up positions with the IAESR at the University of Melbourne; Dr Higgs went to a position in the Graduate School of Management at the same University. Dr Agrawal left the Project to take up a post in the Young Professionals Program of the World Bank in Washington D.C., while Dr Wilcoxen returned to the U.S. to a research post at the Kennedy School of Government, Harvard University.

The triennium as a whole has been a difficult one for staffing. The vacancy left by Dr Agrawal's departure took more than a year to fill. The current presence of a distinguished overseas scholar financed by Fulbright funds is a windfall unlikely to be repeated in the short term. Continuation of funding of the Project at the current level would imply that no more than five fulltime equivalent researchers could be supported. The implications of this dearth of funds for research strategy is taken up below in Section 7.

3.3 Promotions and Honours

As noted above, Dr Agrawal left Impact for an appointment in the Young Professionals Program at the World Bank. Competition among younger Ph.D.s for entry into this program is world-wide and extremely stiff.

13 Mr Jamie Mustard, Mr Richard Walker and Mr Jamie Ebery, Mathematics students from Deakin University, the University of Adelaide and Monash University respectively, were employed by the Mathematics Department at La Trobe University to work under Dr Pearson's supervision for about two months in the summers of 1988-89, 1989-90 and 1990-91 respectively.

Early in 1990 Dr Pearson was promoted to Reader at La Trobe University. Professor Powell learnt of his election to a Fellowship of the Econometric Society early in 1989.

4. Developments in Modelling

Developments during the triennium fall principally under the following headings:

- SOFTWARE DEVELOPMENT
- THE INCOME DISTRIBUTION PROJECT
- PROTOTYPE MODEL DEVELOPMENT
- ECONOMETRIC ESTIMATION OF PARAMETERS
- INTEGRATION OF MACRO AND CGE MODELLING
- ISSUES IN THE REFORM OF INTERNATIONAL TRADING RELATIONS

4.1 Software Development

As in the previous triennium, the further development of the *GEMPACK* computer environment for economic modelling has been a major activity of the Project. The *GEMPACK* software suite is highly portable and user-friendly. It has been built in order:

(a) to reduce the cost of building new policy models, and of altering existing ones, by freeing the economic modeller from many of the erstwhile time-consuming tasks involved in translating an algebraically and numerically specified model into a computer implementation;

(b) to make the *ORANI* suite of models, and other models, readily portable between computer installations;

(c) to make it routinely possible to compute the solutions of large economic models (such as *ORANI*) on mainframe, mini and personal computers, without the support of specialist computing staff.

GEMPACK has been outstandingly successful in these aims.

Aim (a) above is achieved by automating as many steps as possible in the design, construction and solution of a model.

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 7 July	Mr David Johnson IAESR	The Measurement of Poverty in Australia 1981-2 and 1985-6
Thurs 14 July	Mr Ron Arnold Industries Assistance Commission	Taxing Employer Superannuation Contributions: What Company Tax Reduction Will it Buy?
Thurs 21 July	Dr Christine Smith Griffith University	Construction of an Inter-Regional Input-Output Table for the States of Australia
Fri 29 July	Dr S.P. Jenkins University of Bath	Income Risk and Income Maintence: Implications for Incentives to Work
Thurs 4 August	Mr Craig Sugden Industries Assistance Commission	Modelling the Broad-Based Consumption Tax Properly
Wed 10 August	Professor T.J. Kneisner Indiana University	How Fragile are Male Labour Supply Function Estimates?
Thurs 11 August	Dr Peter Higgs IMPACT Research Centre	Forecasting the Two-Year Prospects for Portfolios of Australian Stocks
Thurs 18 August	Dr Guay Lim Dept of Economics University of Melbourne Dr Tony Meagher IAESR	Portfolio Behaviour, Asset Market Equilibrium and Macro Modelling
Tues 23 August	Professor Jefferey Williamson Harvard University	General Equilibrium Modelling and Economic History

... continued

Appendix 2 (continued)

Date	Speaker	Topic
Thurs 14 April	Dr Mark Horridge IMPACT Research Centre	An Extension of Tyers' World Food Trade Model
Thurs 21 April	Dr Nisha Agrawal IMPACT Research Centre	Who Will Get the Jobs? Labour Market Effects of a 25 per cent Across-the-Board Tarriff Reduction
Thurs 28 April	Mr Steve Bakalis La Trobe University	A CGE Analysis of the Idle Capacity of Capital in the Greek Economy
Thurs 5 May	Dr David Gruen Australian National University	Doing a Hatchet Job on the Richardian Equivalence Theorem
Thurs 19 May	Dr Russel Cooper Macquarie University Dr Keith McLaren Monash University	Regular Alternatives to AIDS
Thurs 9 June	Dr Warwick McKibbin Reserve Bank of Australia	The Australian Economy from a Global Perspective
Convenor: Nisha Agrawal		
Thurs 16 June	Mr Giulio Cerasani Industries Assistance Commission	Labour On-Costs: Who Bears the Burden?
Thurs 23 June	Mr Chris Murphy Australian National University	Rational Expectations in Financial Markets and the Murphy Model
Thurs 30 June	Professor Katsuhiko Ikeda Kwansei Gakuin University and IAESR	Industrial Organization and International Trade – Textile Industries in the East & South-East Asia

Pearson[14] has identified fifteen steps in this process, of which eight (in principle) are amenable to automation. At the date of writing, only two of these remain to be automated; namely, the *algebraic* linearization of the model by the computer, and the elimination of *numerical* linearization errors. A prototype version of *GEMPACK* which deals with the latter is currently available. Work on the former is planned for the new triennium.[15]

An indication of *GEMPACK's* success can be gleaned by inspection of Table 2 which indicates its widespread use by the midpoint of the fiscal triennium centred in mid-1989.

4.2 The Income Distribution Project

The mapping from the factor distribution of income into the income distribution of households within *ORANI* and the provision for feedbacks from household behaviour into industry activity and employment was the focus of this joint IAESR/ Impact research project.

The principal investigators were Dr G.A. Meagher (IAESR) and Dr Nisha Agrawal (Impact). Papers produced by this project are listed in Table 3. Illustrative applications deal with topics as disparate as the impacts of tariff reform and of flattening of the tax rate scale on the distribution of household income.[16]

The joint project was wound up when Dr Agrawal left Impact (August 1989); Dr Meagher will continue with further work in this area.

Tables 2 and 3 follow. Text resumes on page 15.

14 K.R. Pearson, "Automating the Computation of Solutions of Large Economic Models", *Economic Modelling*, Vol. 5 (October 1988), pp. 385-395.

15 A recent grant by the Australian Research Council will substantially assist this work.

16 Nisha Agrawal, G.A. Meagher and Bruce F. Parsell, "Analysing Options for Fiscal Reform in the Presence of Involuntary Unemployment", in J.G. Head and R. Krever (eds), *Flattening the Tax Rate: Alternative Scenarios and Methodologies* (Melbourne: Longman Professional for the Public Sector Management Institute of Monash University, 1990), pp. 295-320.

Table 2

Research Units Using the GEMPACK Modelling Environment
June 1989

Research Unit	Model/Current Application	Principal Investigator
(i) Government		
Industries Assistance Commission (Canberra)	A fiscally oriented applied general equilibrium model of Australia; current focus is microeconomic reform	Dr P. Dee
	Extension of the multi-country World Food Trade Model to analyse bi- and multilateral changes in agricultural trade policy	D. Pearce
	Extension of the multi-country *Walras* model to analyse policies affecting Australian food-processing sectors	R. McDougall C. Sugden
	Use of *MTM Inputs* model to analyse agricultural trade policy changes	J. Zeitsch D. Quirke
Department of Employment, Education and Training (Canberra)	Prospects for employment in various occupations using the ORANI-F forecasting model	L. Dearden
Australian Bureau of Agricultural and Resource Economics	Initial work on development of a new suite of models for policy analysis in the agricultural and minerals sectors	Several staff economists
Northern Territory Government Treasury	Use of a customised ORANI-NT model to explore economic interactions between the economy of the Territory and the rest of Australia	Several staff economists
W.A. State Planning Commission	ORANI-F with WA-specific extensions is being used as an aid to developing a strategic plan for the states	R. Biswas
(ii) Australian Universities		
La Trobe University	Three Ph.D. dissertations on various topics	
University of Melbourne		
(a) Institute of Applied Economic and Social Research	Economic Forecasting Project (a subscription service providing regular meetings for business and government)	Prof P.B. Dixon B. Parmenter D. McDonald
	A special-purpose version of ORANI to assess the potential benefits of an innovation in the trucking industry (supported by NERDC)	Dr M. Horridge Mr D. T. Johnson

* Only those sites and applications known to Impact staff in June 1989 are included in this table. The application descriptions are only approximate and should be checked with individual researchers.

APPENDIX 2

PROGRAMME OF THE WORKSHOP IN COMPUTABLE GENERAL EQUILIBRIUM MODELLING

March 1988 - December 1990

Date	Speaker	Topic
	1988	
Convenor: Peter J. Higgs		
Thurs 11 Feb	Professor Peter Dixon IAESR and Ms Daina McDonald	Movements in Australian Productivity 1970-1987
Thurs 25 Feb	Dr Nisha Agrawal IMPACT Research Centre and Dr Tony Meagher IAESR	The Distributional Implications of Alternative Policy Responses to a Deterioration in the Terms of Trade
	Dr Guay Lim Dept of Economics University of Melbourne Dr Tony Meagher IAESR	Modelling Taxation and Financial Flows in a General Equilibrium Framework
Thurs 3 March	Mr George Codsi, Dr M. Horridge and Dr K. Pearson IMPACT Research Centre	The Implementation of the ORANI Model Using Tablo
Thurs 24 March	Mr Philip Adams IMPACT Research Centre	A First Attempt to Estimate ELESA
Thurs 31 March	Professor Jaleel Ahmed Concordia University	Trade Barriers and Direct Subsidies as Alternative Adjustment Devices with Reference to Canada
Thurs 7 April	Dr Nisha Agrawal and Professor Alan Powell IMPACT Research Centre	An Attempt to Estimate Cooper and McLaren's MAIDS Model Under Additive Preferences

... continued

Appendix 1 (continued)

Document Number (Issue Date)	Author/s	Title/Publication Details
GED-24 (June 1988)	G. Codsi and K.R. Pearson	A User's Guide to TABLO Input Files, pp. 12.
GED-25 (Mar 1989)	G. Codsi and K.R. Pearson	Installing and Using GEMPACK on IBM and Compatible PCs, pp. 19+2.

Table 2 continued

	Research Unit	Model/Current Application	Principal Investigator
a)	Institute of Applied Economic and Social Research *(continued)*	A detailed elaboration of the ORANI-NAGA model to assess the income-distributional consequences of a wide range of policy options at the macro and micro levels	Dr A. Meagher Dr N. Agrawal
(b)	Impact Project basic research unit	Forecasts for incomes in southwestern Victoria using an extension of ORANI-F	Prof A. Powell Dr P. Higgs
(c)	Economics Department	A model of Australia portfolio composition	Dr G. Lim Dr A. Meagher
		Graduate-level courses in economic modelling	Prof A. Powell Dr P. Wilcoxen
(d)	Graduate School of Management	A financial model of the Australian corporate sector	Dr P. Higgs
University of Tasmania – Centre for Regional Economic Analysis		A model of the interaction of the Tasmanian and mainland economies, with particular emphasis on State/ Commonwealth fiscal relations	J. Madden
Curtin University – School of Economics and Finance		Undergraduate teaching programme *208 economic modelling*	Various staff
University of New South Wales – Department of Economics / Centre for Applied Economic Research		Special version of ORANI tailored to focus policy energy	Dr T. Truong (in association with Assoc. Prof. V. Hall of the University of Sydney)
University of Technology Sydney – School of Economics & Finance		Undergraduate/graduate teaching	Dr O. Stanley
Macquarie University – School of Economics & Finance		Honours courses in economic modelling	Dr R. Cooper
University of Adelaide – Dept of Economics		Ph.D. project on energy modelling	M. Jaforullah
Griffith University – School of Administration		Regional modelling with focus on Queensland/Federal government issues	Dr C. Smith
University of New England – Department of Econometrics		GEMPACK has been used to install the ORANI model in a collection of economy-wide models whose comparative performance is to be researched by a new 'models bureau'	C. Hargreaves

... continued

Table 2 continued

Research Unit	Model/Current Application	Principal Investigator
Australian National University		
(a) Dept of Economics, Research School of Pacific Studies	An applied general equilibrium model of technology, factor demands and income distribution in the Philippines	I. Coxhead
(b) National Centre for Development Studies	A model of the trade relations of the Chinese economy (with emphasis on Australian wool)	Dr W. Martin
	A macroeconomic model of Papua and New Guinea focused on mineral exports and international aid	Dr E. Weisman
	Ph.D. dissertation	S. Suphat
(iii) Private Sector		
Centre for International Economics (Canberra)	General-purpose model for analysing economics of selected SE Asian countries	D. Vincent
	Immigration and economic management: short-term economic consequences of minor variations in immigration	D. Vincent
	Policy analysis of wool production and processing in Australia	D. Vincent
(iv) Overseas		
University of Michigan, USA – Institute of Policy Studies	Multi-country, multi-sectoral trade model	Prof A. Deardorff Dr J. O'Reilly
Purdue University, USA – Department of Agricultural Economics	Analysis of issues relating to international trade in agriculture	Prof T. Hertel
University of Alberta, Canada – Departments of Economics and of Rural Economics	Analysis of regional issues in Canada and policies affecting forestry in SE Asia	Prof M. Percy Prof L. Constantino
National Technical University of Athens, Greece – Department of Electrical Engineering	Modelling using microcomputers	Prof P. Capros

Appendix 1 (continued)

Document Number (Issue Date)	Author/s	Title/Publication Details
OP-69 (Nov 1989)	Maureen Rimmer	Primary Factor Substitution in Manufacturing and Real Wage Explosions, pp. 35.
O-69 (Oct 1990)	Maureen Rimmer	Primary Factor Substitution and the Real Wage Explosions, pp. 28.
OP-70 (May 1990)	Mark Horridge, Alan A. Powell and Peter J. Wilcoxen	Constraining Output Responses in Long-Run Closures of ORANI: Some Suggestions, pp. 29.
Computer Manuals (other than GEMPACK)		
C8-01 (Sept 1988)	G. Codsi, M. Horridge and K.R. Pearson	An Implementation of ORANI Using the GEMPACK Program TABLO *IMPACT Computing Document*, pp. 76.
GEMPACK Documentation		
GED-20a (Feb 1988)	G. Codsi and K.R. Pearson	Update of "Implementing Economic Models Using TABLO", pp. 10+28.
GED-21 (Feb 1988)	K.R. Pearson	Installing TABLO on Different Computers, pp. 15.
GED-22 (June 1988)	G. Codsi and K.R. Pearson	An Overview of GEMPACK: A Software System for Implementing and Solving Economic Models, pp.27+3.
GED-23 (June 1988)	G. Codsi and K.R. Pearson	Stylized Johansen: An Illustrative CGE Model, pp. 23+13.

... continued

Appendix 1 (continued)

Document Number (Issue Date)	Author/s	Title/Publication Details
ORANI Development Papers		
OP-47 (May 1984)	Russell J. Rimmer	Employment Implications of Improved Labour Productivity in the Australian Iron and Steel Industry, *Economic Record*, Vol. 65, No. 189, June 1989, pp. 114-125.
O-61 (Aug 1988)	Philip D. Adams, Ching-Fan Chung and Alan A. Powell	Australian Estimates of Working's Model under Additive Preferences: Revised Estimates of a Consumer Demand System for Use by CGE Modellers and Other Applied Economists, pp. 89.
OP-65 (Oct 1988)	Mark Horridge and David Pearce	Modelling the Effects on Australia of Interventions in World Agricultural Trade, pp. 49.
OP-66 (Mar 1989)	Philippa S. Dee	FH-ORANI: A Fiscal ORANI with Horridge Extension, pp. 367.
OP-67 (Mar 1989)	Nisha Agrawal and Alan A. Powell	MAIDS under Additive Preferences: Some Early Estimates, pp. 32, forthcoming in R. Bewley and Tran Van Hoa (eds), *Consumer Demand Analysis* (London: Macmillan).
OP-68 (Sept 1988)	Peter J. Higgs, B.R. Parmenter and Russell J. Rimmer	A Hybrid Top-Down, Bottom-Up Regional Computable General Equilibrium Model, *International Regional Science Review*, Vol. 11, No. 3, pp. 317-328.

Table 3

Output of the Income Distribution Project

Working Papers and Published Articles

Agrawal, Nisha (1989) "Protection as a Tax on Consumers: Who Bears the Burden?", IMPACT Project *Preliminary Working Paper* No. IP-43, August, pp. iii + 58.

Agrawal, Nisha (1989) "Tariff Reform, and the Distribution of Household Incomes", IMPACT Project *Preliminary Working Paper* No. IP-42, August, pp. iii + 52.

Agrawal, Nisha and G.A. Meagher (1988) "Structural Reform, Macro Policies and Income Distribution", *The Australian Economic Review*, 3rd Quarter, pp. 42-52.

Agrawal, Nisha and G.A. Meagher (1988) "Tariff Reform and the Distribution of Employment", Institute of Applied Economic and Social Research, University of Melbourne *Working Paper* No. 6/1988, August, pp. 38.

Agrawal, Nisha (1988) "Sources of Inequality between Male and Female Incomes in Australia", *Australian Economic Review*, 4th Quarter, December, pp. 26-36.

Agrawal, Nisha (1988) "Who Will Get the Jobs? Labour Market Effects of a 25 per cent Across-the-Board Tariff Reduction", IMPACT Project *Preliminary Working Paper* No. IP-36, April, pp. iii + 46.

Agrawal, Nisha (1987) "Analysing Distributional Issues Using Equivalent-Adult Disposable Incomes", IMPACT Project *Preliminary Working Paper* No. IP-32, July, pp. ii + 30.

Agrawal, Nisha and G.A. Meagher (1987) "Distributional Effects of Alternative Policy Responses to Australia's Terms of Trade Deterioration", IMPACT Project *Preliminary Working Paper* No. IP-31, June, pp. iii + 74.

Agrawal, Nisha (1986) "The ORANI-Income Distribution Model: Labour Market Issues", IMPACT Project *Preliminary Working Paper* No. IP-29, December, pp. ii + 32.

Meagher, G.A. (with N. Agrawal and B. Parsell), "Analysing Options for Fiscal Reform in the Presence of Involuntary Unemployment", in J.G. Head and R. Krever (eds), *Flattening the Tax Rate: Alternative Scenarios and Methodologies*, (Melbourne: Longman Professional for the Public Sector Management Institute of Monash University, 1990), pp. 295-320.

... continued

Table 3 continued

Meagher, G.A. (1990) "A General Equilibrium Analysis of Fiscal Incidence in Australia", Paper presented to a conference on Computable General Equilibrium Modelling — Methodology, Data and Applications, University of Waterloo, Ontario, October.

Meagher, G.A. (1989) "Modelling the Distribution of Income in Australia", Institute of Applied Economic and Social Research, University of Melbourne, *Research Paper* No.2/1989.

Meagher, G.A. and P.B. Dixon (1986) "Analyzing Income Distribution in Australia", *Economic Record* Vol.62, No.179, December, pp. 427-441.

Meagher, G.A. and Nisha Agrawal (1986) "Taxation Reform and Income Distribution in Australia", *Australian Economic Review* (Special Issue), 3rd Quarter, 1986, pp. 33-56.

Meagher, G.A. (with S. M. Bonnell and P.B. Dixon) (1985) "A Description of Income Distribution in Australia: 1973/74 to 1981/82", Office of the Economic Planning Advisory Council, *Discussion Paper* No.85/04, Canberra.

Research Memoranda

Agrawal, Nisha and G.A. Meagher (1988) "Updating the 1981-82 Income and Housing Survey Database to 1984-85", *Research Memorandum* No. OA-396, Industries Assistance Commission, Canberra, January, pp. ii + 29.

Agrawal, Nisha (1988) "An Aid to Interpreting the Employment Results from ORANI-IDM", *Research Memorandum* No. OA-395, Industries Assistance Commission, Canberra, January, pp. ii + 115.

Agrawal, Nisha (1987) "Calculating Disposable Incomes for the 1984-85 Version of the IHS Database", *Research Memorandum* No. OA-394, Industries Assistance Commission, Canberra, December, pp. 16.

Agrawal, Nisha (1987) "Adjustments to the 1981-82 Income and Housing Survey Database to Attain Conceptual Consistency with the ORANI78 Database", *Research Memorandum* No. OA-391, Industries Assistance Commission, Canberra, 1987, pp. 18.

Agrawal, Nisha and G.A. Meagher (1987) "How to Compute Solutions with the NAGA Add-on to the ORANI Model", *Research Memorandum* No. CA-129, Industries Assistance Commission, Canberra, September, pp. iii + 101.

Agrawal, Nisha (1986) "Labour Market and Distributional Issues in General Equilibrium Modelling", *Research Memorandum* No. OA-352, Industries Assistance Commission, Canberra, November, pp. iii + 56.

Appendix 1 (continued)

Document Number (Issue Date)	Author/s	Title/Publication Details
G-90 (Dec 1988)	Ian A. Bruce	Forestry and Wood-based Industries in the Australian Economy: A Computable General Equilibrium Analysis, *Australian Forestry*. Vol. 51, No. 4, 1988, pp. 238-245.
G-91 (Mar 1989)	Philippa Dee	The Effects of Government Size on Economic Performance: A Quantitative Assessment of a Budget Reduction, *Australian Economic Review*, 1st Qtr, 1989, pp. 24-38.
G-92 (Sept 1989)	Philippa Dee	Economic Effects of Public Expenditure Reduction: A Strategic Role for Labour Market Flexibility, pp. 24.
G-93 (May 1990)	Marco Bini and Peter J. Wilcoxen	Characteristics of Mining in Australia, pp. 48.
G-94 (Dec 1990)	David Johnson, Alan A. Powell and Peter B. Dixon	"Changes in Supply of Agricultural Products, in D.B. Williams, ed., *Agriculture in the Australian Economy*, 3rd edition (Sydney University Press, 1990), pp. 187-200.
G-95 (Sept. 1989)	G. Codsi and K.R. Pearson	General Purpose Software for Applied General Equilibrium and Other Economic Modeling, in *Social Science Computer Review*, Vol. 7, 1989, pp. 77-78.

... continued

Appendix 1 (continued)

Document Number (Issue Date)	Author/s	Title/Publication Details
G-84 (June 1988)	Peter J. Higgs and Alan A. Powell	Forecasts of Agricultural Incomes for the South-Western Region of Victoria 1988-1990, pp. 40. A revised version under the title "Forecasting Small-Area Agricultural Incomes Using a CGE Model of the Australian Economy" is in *The Annals of Regional Science* (Springer-Verlag, 1990), pp. 43-59.
G-85 (Aug 1988)	Nisha Agrawal and G.A. Meagher	Tariff Reform and the Distribution of Employment. IAESR *Working Paper* No. 6/1988.
G-86 (Aug 1988)	Nisha Agrawal and G.A. Meagher	Structural Reform, Macro Policies and Income Distribution, *The Australian Economic Review*, 3rd Qtr, 1988, pp. 42-52.
G-87 (Oct 1988)	Nisha Agrawal	The Macroeconomic Effects of Alternative Employment-Generating Policies, pp. 40.
G-88 (Nov 1988)	Nisha Agrawal	The Effects of Structural Change on Employment, Unemployment and Labour Force Participation, pp. 35. Also in *Labour Economics and Productivity*, Vol. 1, 1989, pp. 91-110.
G-89 (April 1989)	Nisha Agrawal	Interregional Variations in the Benefits and Costs of Public Housing, pp. 39.

4.3 Prototype Model Development

In the early months of the triennium under review Dr Philip Adams completed his work on a prototype CGE model with money and assets (*MMO—Monetized Miniature ORANI*). Full intertemporal optimizing behaviour on the part of a consumer/portfolio holder was modelled using the *ELESA* system[17] (which was a seminal contribution in Dr Adams' thesis). Treatment of investment was more *ad hoc*, being based on Tobin's q-theoretic ideas but without full intertemporal optimization on the part of capital creators. This limits the use of the model to applications in which anticipated future events (such as a preannounced change in next year's tax arrangements) play no role in determining current behaviour.

Dr Wilcoxen's work on investment with foresight brought both full theoretical rigour and operational tools to bear upon capital creation.[18] His collaboration with Dr Pearson and Mr Codsi led to the development of an intertemporal version of the *TABLO* facility of *GEMPACK* with which the prototype investment models have been solved.[19] This facility is currently undergoing further development with a view to its use as the computational platform on which the new generation models will be built.

In long-run closures of *ORANI* export industries not dependent on agricultural land tend to exhibit volatile (sometimes implausibly volatile) behaviour in the face of projected changes in their price/cost situation. Various approaches to respecification of *ORANI* to deal with this problem have been canvassed by Horridge, Powell and Wilcoxen;[20] the most

17 Philip D. Adams, "From ELES to ELESA: A Linear Expenditure System with Assets", *Economic Record* (forthcoming 1991).

18 Dr Wilcoxen's work on prototype models of investment within a general equilibrium setting is summarized in Chapter 5 of Peter B. Dixon, B.R. Parmenter, Alan A. Powell and Peter J. Wilcoxen, *Notes and Problems in Applied General Equilibrium Economics* (Amsterdam: North-Holland, forthcoming 1991). A slightly earlier version is available as P.J. Wilcoxen "Intertemporal Optimization in General Equilibrium: A Practical Introduction", *Impact Project Preliminary Working Paper* No. IP-45, IAC, Canberra, December 1989.

19 The North-Holland text cited in the previous footnote comes with floppy disks devised by Dr Pearson which enable readers to solve the intertemporal problems posed in Ch. 5 by Dr Wilcoxen. The disks carry their own documentation.

20 Mark Horridge, Alan A. Powell and P.J. Wilcoxen, "Constraining Output Responses in Long-run Closures of ORANI: Some Suggestions", *Impact*

promising seems to be the incorporation of adjustment costs in capital creation.[21] The effects of introducing the latter on supply behaviour were examined by Wilcoxen,[22] whose work provides a framework which allows the behaviour of the *ORANI* model to be modified in the desired way at very little expense in terms of the number of equations which must be added or modified.[23] The full implementation of the resultant new version of ORANI, however, requires adjustment parameters about the values of which econometric evidence is scant.

4.4 Econometric Estimation of Parameters

Elasticities of substitution between labour and capital could not be estimated satisfactorily from the available time-series data during the initial development of *ORANI* during the 1970's. On the basis of an extensive survey by Caddy[24] covering applied econometric evidence to the mid 'seventies, a single value (0.5) was chosen for the elasticity of substitution between primary factors in all industries. Some increase in precision and in ability to assign different values to different industry groups seemed promised by Phipps' 1983 analysis of data becoming available in the 'eighties.[25] The virtual doubling of the length of the time series since the publication of Phipps' paper and developments in time-series econometrics during the 'eighties, however, offered the opportunity of testing the robustness of his estimates to the accretion of new experience and more stringent inferential procedures. Such a reevaluation and reestimation was the subject

Project Preliminary Working Paper No. OP-70, Industry Commission, Canberra, May 1990.

21 Another approach, suitable in the case of some mining industries, involves recognizing that costs may increase as a function of cumulative extractions. See Chris W. Blampied, Mark Horridge and Alan A. Powell, "The Behaviour of the Major Extractive Industries in Long-Run Closures of ORANI: A Proposal", *Impact Project Preliminary Working Paper* No. OP-55, Industries Assistance Commission, Canberra, April 1986.

22 Peter J. Wilcoxen, "Supply Elasticities in the Presence of Adjustment Costs", *Impact Project Preliminary Working Paper*, No. IP-46, Industry Commission, Canberra, March 1990.

23 The details of the necessary modification are given in Horridge, Powell and Wilcoxen, *op. cit.*

24 Vern Caddy, "Empirical Estimation of the Elasticity of Substitution: A Review", *Impact Project Preliminary Working Paper* No. OP-09, Industries Assistance Commission, Canberra, November 1976.

25 A.J. Phipps, "Australian Unemployment: Some Evidence from Industry Labour Demand Functions", *Australian Economic Papers*, Vol. 22, No. 41 (December 1983), pp. 333-344.

Appendix 1 (continued)

Document Number (Issue Date)	Author/s	Title/Publication Details
G-80 (Aug/Dec 1989)	Peter J. Higgs and Andy Stoeckel	"The Significance of a Range of Economic Policies for Improving Australia's Balance of Trade", in *Australian Journal of Agricultural Economics*, Vol. 32, Nos 2 & 3, (August/December 1989), pp. 69-87.
G-81 (Dec 1987)	Nisha Agrawal, G.A. Meagher and Bruce F. Parsell	Analysing Options for Fiscal Reform in the Presence of Involuntary Unemployment, in J.G. Head and R. Krever (eds) *Flattening the Tax Rate: Alternative Scenarios and Methodologies*, Longman Professional for the Public Sector Management Institute of Monash University, Melbourne, pp. 295-320 (1990).
G-83 (April 1988)	Peter J. Higgs	Domestic Trade Distortions and Australian Agriculture, pp. 48. A revised version entitled "The Taxation of Australian Agriculture through Assistance to Australian Manufacturing" appears as Ch. 10 in Andrew Stoeckel, David Vincent and Sandy Cuthbertson (eds.) *Macroeconomic Consequences of Farm Support Policies*, Duke Press Policy Studies, Duke University Press (Durham and London, 1989), pp. 293-329.

... continued

Appendix 1 (continued)

Document Number (Issue Date)	Author/s	Title/Publication Details
IP-45 (Dec 1989)	Peter J. Wilcoxen	Intertemporal Optimization in General Equilibrium: A Practical Introduction, pp. 170.
IP-46 (Mar 1990)	Peter J. Wilcoxen	Supply Elasticities in the Presence of Adjustment Costs, pp. 27.
IP-47 (April 1990)	Peter J. Wilcoxen	A Fast Algorithm for Solving Rational Expectations Models, pp. 8.
General Papers - G Series		
G-69 (Nov1987)	Alan A. Powell and Tony Lawson	A Decade of Applied General Equilibrium Modelling for Policy Work, in Lars Bergman, Dale W. Jorgenson and Erno Zalai (eds), *General Equilibrium Modeling and Economic Policy Analysis*, (Oxford and Cambridge, Mass: Basil Blackwell 1990), pp. 241-290.
G-73 (Dec 1988)	Nisha Agrawal	Sources of Inequality between Male and Female Incomes in Australia, *Australian Economic Review*, 4th Qtr, December 1988, pp. 26-36.
G-77 (Aug 1988)	Nisha Agrawal	The Economic Effects of Public Housing in Australia, *Economic Record*, Vol. 64, No. 187, December 1988, pp. 254-267.

matter of Dr Maureen Rimmer's M. Com. thesis.[26] Dr Rimmer's work makes explicit allowance for the two real wage explosions in her time-series data (1973-74 and 1981-82). Such an allowance is crucial since it is not reasonable to expect full adjustment within one year to shocks of these magnitudes.[27]

Dr Rimmer's main results are given in Table 4. Apart from the features mentioned above, her study is novel also in the treatment of technology which is allowed to respond endogenously to the real wage explosions.

Other econometric work during the triennium focused on household demand parameters. Adams, Chung and Powell[28] estimated household demand equations from time series data. Unlike the linear expenditure system and the Rotterdam models, these estimates allow for marginal budget shares that change as a function of income. Unfortunately, the system underlying these estimates does not guarantee that marginal budget shares lie strictly within the [0,1] interval when income changes by a large proportion. Since the focus of planned work for the next triennium is the solution of dynamic models possibly involving large changes, this is potentially a serious liability which is removed in later work by Agrawal and Powell[29] utilizing the greatly improved demand system devised by Cooper and McLaren.[30]

---

26 Maureen T. Rimmer, "Empirical Estimation of Primary Factor Substitution Elasticities for Broad Industry Groups in the Australian Economy", Department of Economics, University of Melbourne, July 1990. The main results are summarized in "Primary Factor Substitution and the Real Wage Explosions" *Impact Project Working Paper* No. O-69, IC, Canberra, October 1990.

27 Between 1973-74 and 1974-75 the real wage jumped by about 10 per cent.

28 Philip D. Adams, Ching-Fan Chung and Alan A. Powell, "Australian Estimates of Working's Model under Additive Preferences: Revised Estimates of a Consumer Demand System for Use by CGE Modellers and Other Applied Economists", *Impact Project Working Paper* No. O-61, Industries Assistance Commission, Canberra, August 1988.

29 Nisha Agrawal and Alan A. Powell, "MAIDS under Additive Preferences: Some Early Estimates", forthcoming in R. Bewley and Tran Van Hoa (eds), *Consumer Demand Analysis* (London: Macmillan).

30 Russel J. Cooper and Keith R.McLaren, "Regular Alternatives to the Almost Ideal Demand System", Monash University, *Department of Econometrics Working Paper* No. 12/88, September 1988.

Table 4

*Rimmer's Estimates of the Elasticity of Substitution between Labour and Capital**

	Industry Group	Primary Factor Elasticity of Substitution σ[(a)]
A	Agriculture (Forestry, Fishing and Hunting)	0.357 , 0.268
B	Mining	0.776 , 0.786
C	Manufacturing	0.67 → 0.58 → 0.53
D	Electricity, Gas and Water	0.53 → 0.64 → 0.93
E	Construction	0.996
F	Wholesale and Retail Trade	0.876 , 0.950
GH	Transport, Storage and Communication	0.73 → 1.09 → 1.17
L	Recreation, Personal and Other Services	0.80 → 0.90 → 0.94

(a) Where three values are given, these are respectively for the period 1963-64 through 1973-74, for the period 1979-80 through 1981-82, and for the year 1985-86; where two values ares shown, σ is in principle constant throughout the estimation period, but there is an ambiguity introduced by poorly determined estimates of an error-correction parameter, α — in these cases the two estimates shown for σ are conditional on α taking on its lower and upper boundary values (0 and 1) respectively; a single value for σ indicates that this elasticity is specified to be constant throughout the estimation period and that the estimated value of α is relatively well determined.

Source: Maureen Rimmer, "Primary Factor Substitution and the Real Wage Explosions", *Impact Project Working Paper* No. O-69, Industry Commission, Canberra, October 1990, p.26.

Appendix 1 (continued)

Document Number (Issue Date)	Author/s	Title/Publication Details
IP-39 (July 1988)	G. Codsi and K.R. Pearson	Developing and Implementing Large Economic Models Using GEMPACK, A General Purpose Software Suite, pp. 31. Revised version published under the title "GEMPACK: General-Purpose Software for Applied General Equilibrium and Other Economic Modellers" is in *Computer Science in Economics and Management*, Vol. 1, 1988, pp. 189-207.
IP-40 (Dec 1988)	Peter J. Higgs	A Mapping of Selected Australian Corporations Across Input-Output Industries, pp. 302.
IP-41 (July 1989)	Bruce F. Parsell, Alan A. Powell and Peter J. Wilcoxen	The Effects of Fiscal Restraint on the Australian Economy as Projected by the Murphy and MSG Models: A Comparison, pp. 55. Forthcoming in the *Economic Record (1991).*
IP-42 (Aug 1989)	Nisha Agrawal	Tariff Reform and the Distribution of Household Incomes, pp. 52.
IP-43 (Aug 1989)	Nisha Agrawal	Protection as a Tax on Consumers: Who Bears the Burden?, pp. 58.
IP-44 (Dec 1989)	Bruce F. Parsell, Alan A. Powell and Peter J. Wilcoxen	The Reconciliation of Computable General Equilibrium and Macroeconomic Modelling: Grounds for Hope?, pp. 39.

... continued

APPENDIX 1
IMPACT PROJECT PAPERS

January 1988 - December 1990*

Document Number (Issue Date)	Author/s	Title/Publication Details
Reports		
R-07 (Feb1988)	Alan A. Powell	IMPACT Project Report - A brief account of activities over the period 1st March 1985 to 31st December 1987 with a Prospectus for Further Developments (University of Melbourne), pp. 103.
Book forthcoming 1991	Alan A. Powell, Peter B. Dixon, Brian R. Parmenter, and Peter J. Wilcoxen	*Notes and Problems in Applied General Equilibrium Economics* (Amsterdam: North-Holland).
(Feb 1990)	Mike Kenderes	IMPACT Project Documentation: The First Fifteen Years, 1975-89 A Listing of Papers with Abstracts
General Papers - I Series		
IP-27 (Mar 1986)	K. R. Pearson	Automating the Computation of Large Economic Models, *Economic Modelling*, Vol.5 (October 1988),pp.385-395.
IP-36 (April 1988)	Nisha Agrawal	Who Will Get the Jobs? Labour Market Effects of a 25 Per Cent Across-the-Board Tariff Reduction, pp. 46.
IP-37 (June 1988)	Peter J. Higgs	A Forward Looking Approach to Portfolio Analysis Using a Computable General Equilibrium Model, pp. 146.
IP-38 (May 1988)	Philip D. Adams	Estimation of the Extended Linear Expenditure System with Assets, pp. 74.

* Some items independently published within the triennium were issued as working documents at an earlier date. In these cases 1987 or earlier will appear in the first (but not the third) column.

4.5 Integration of Macro and CGE Modelling

The Impact Project pioneered work on the integration of computable (or applied) general equilibrium (CGE) and macroeconomic modelling.[31] During the 1980s theoretical work in open-economy macroeconomics tended to be based on explicit microeconomic foundations respecting intertemporal budget constraints. This line of thinking influenced some applied macromodellers, among them Warwick McKibbin and Chris Murphy. Dr Wilcoxen, Dr Parsell (then a graduate student at the IAESR) and Professor Powell investigated the behaviour of the MSG2 (McKibbin-Sachs Global, Version 2) and Murphy models from the viewpoints both of their relationship to CGE modelling,[32] and their performance in analysing the twin deficits issue.[33] They concluded that the new developments in applied macroeconomics make it likely that CGE and applied macromodels of the 'nineties will be much more easily reconciled than was the case with the corresponding models of earlier generations.

One approach to such a reconciliation involves using a separate macro model to close a CGE model in the short run – this was the method pioneered by Cooper and McLaren.[34] Associate Professor Breece is applying this approach in current work which uses a new generation macro model (the Murphy Model) to provide short-run macro closure for the ORANI model.

4.6 Issues in the Reform of International Trading Relations

Associate Professor Tom Hertel has a multi-country trade model at an advanced stage of development. While at Impact he is exploring the scope for trading off reforms in different sectors of different economies, especially those on the Pacific rim. He also has papers in draft or forthcoming on the following methodological issues:

31 See Russel J. Cooper and Keith R. McLaren, "The ORANI-MACRO Interface: An Illustrative Exposition", *Economic Record*, Vol. 59, No. 165 (June 1983), pp. 166-179; and Russel J. Cooper, Keith R. McLaren and Alan A. Powell, "Short-Run Macroeconomic Closure in Applied General Equilibrium Modelling", in John Piggott and John Whalley (eds), *New Developments in Applied General Equilibrium Analysis* (New York: Cambridge University Press, 1985), pp. 411-440.

32 Alan A. Powell, Bruce F. Parsell and Peter J. Wilcoxen, "The Reconciliation of Computable General Equilibrium and Macroeconomic Modelling: Grounds for Hope?", *Impact Project Preliminary Working Paper* No. IP-44, Industries Assistance Commission, Canberra, December 1989.

33 Alan A. Powell, Bruce F. Parsell and Peter J. Wilcoxen, "The Effects of Fiscal Restraint on the Australian Economy as Projected by the Murphy and MSG2 Models: A Comparison", *Economic Record* (forthcoming).

34 Cooper and McLaren, *op. cit.*

(a) why different approaches to modelling imperfect competition are crucial for the qualitative behaviour of trade models;[35] and in particular, how such specification issues determine whether or not agriculture will expand under an across-the-board trade liberalization as simulated by a CGE model;

(b) the relative advantages and disadvantages of solving CGE models using the Johansen approach versus direct non-linear solution in the levels (jointly with J.M. Horridge and K. R. Pearson);

(c) the incidence of trade liberalization on the rewards received by primary factors of production;[36]

(d) implicit additivity as a device for achieving a parsimonious parameterization of CGE models;[37] and

(e) how the performance of existing partial equilibrium international trade models can be enhanced by their conversion to a general-equilibrium basis.[38]

Aspects of (a) and (c) are covered in an invited forthcoming address;[39] other topics on the list are likely to be the subject of papers to be presented either at the (University of Melbourne's) CGE Workshop or at the May 1991 Conference in Applied General Equilibrium Modelling (see Section 2 above).

35 Thomas W. Hertel, "Why Different Approaches to Modelling Imperfect Competition are Critical for the Qualitative Effects of Trade Policy", draft *Impact Project Preliminary Working Paper.*

36 Thomas W. Hertel, "Factor Market Incidence of Agricultural Trade Liberalization: Some Additional Results", draft *Impact Project Preliminary Working Paper.*

37 See T.W. Hertel, E.B. Peterson, P. V. Preckel, Y. Surry and M.E. Tsigas, "Implicit Additivity as a Strategy for Restricting the Parameter Space in CGE Models", *Economic and Financial Modelling*, Vol. 1 (March 1991) (forthcoming).

38 T.W. Hertel, E.B. Peterson and M.E. Tsigas, "Adding Value to Existing Models of International Agricultural Trade", paper contributed to the Conference of the Australian Agricultural Economics Society, University of New England, Armidale N.S.W. Australia, February 1991.

39 Thomas W. Hertel, "The Fate of Agriculture under Trade Liberalization: Challenging Conventional Conclusions", invited address to the Conference detailed in the preceding footnote.

Peter Dixon's attempts during 1989 and 1990 to obtain sponsorship for a Centre for Economic Modelling at the University of Melbourne were aimed at endowing his group with sufficient support to become heavily involved once more in new model development (along the lines briefly sketched above). The move of the Impact Project in November 1989 into accommodation adjacent to the IAESR greatly increased the scope for interaction between the two groups, and this opportunity has been exploited to effect. Had Dixon been successful in his funding attempts, the combination of the two groups in close proximity would have made the new round of model development feasible at the University of Melbourne.

In the event, funds were not obtainable, either from the Australian Research Council (ARC) or from a proposed consortium of federal agencies. The breach was partially filled by an initiative of Monash University, which proposed that Peter Dixon lead a research team (to be funded by Monash) at its Centre of Policy Studies (COPS). This team will be about one half the size of that envisaged in Dixon's application to the ARC[63] or about one third the size of the combined Impact and IAESR groups under a scenario in which that application had been successful. Under the assumption that Impact receives funding for the July 1991–June 1994 triennium at about the current level, combining the resources of COPS and Impact would yield a team of the critical mass envisaged in Dixon's ARC proposal.

At the present juncture it is too early to be able to make definite proposals for institutional arrangements which would optimally facilitate the pooling of the resources of the two groups. It is clear that Impact has a comparative advantage in the production of flexible, portable and user-friendly software systems for the solution of the models. Since this activity is *somewhat* separable from the development of the economic models themselves, it would be possible (though not desirable) to mount the software and model development operations in separate locales. It would be much more difficult to split the personnel involved in model development between campuses. The resolution of these issues will be determined by negotiation among the various institutions involved.

63 See the first document cited in footnote 42.

However, in view of the Institute's heavy reliance on client-sponsored research projects, applications inevitably dominated its work program. The main innovations at the IAESR in this period were the development of fiscal[57] and forecasting[58] versions of ORANI, the income distribution project (joint with Impact),[59] the elaboration of a macro closure of *ORANI* focussing on external debt,[60] and the development of a model to guide the pricing policies of urban water authorities.[61] The last-mentioned model is along intertemporal general equilibrium lines, although at a highly aggregated level with respect to the general economy.[62]

From the foregoing it is clear that the Impact Project and the IAESR possess superior skills in the development of applied economic models. It is also clear, however, that under the funding arrangements that have prevailed in recent years, neither has been able to assemble the critical mass necessary to carry new methodological developments through to the stage of full-scale, well documented and easily accessible policy models.

---

57 G.A. Meagher, "An Empirical Analysis of the Effects of a Change in the Mix of Direct and Indirect Taxation on the Australian Economy', *Australian Economic Papers*, Vol. 25, No.46 (1986), pp.47-56. Philippa Dee's group (Dee, *op. cit.*) also produced a fiscal *ORANI*; because the latter is now available for running under the most recent *GEMPACK* software, it is more readily accessed.

58 See Peter B. Dixon, B.R. Parmenter and Mark Horridge, "Forecasting versus Policy Analysis with the ORANI Model", *IAESR Working Paper* No. 4/1986, University of Melbourne, June 1986; Peter B. Dixon and B.R. Parmenter, "Recent Developments in Forecasting with the ORANI Model", *Australian Economic Papers*, Vol. 27, Supplement (June 1988), pp.92-104; and B.R. Parmenter, "ORANI-F: User's Manual", *IAESR Working Paper* No. 7/1988, University of Melbourne, August 1988. This forecasting model should be seen as a step in the direction of a full intertemporal model, rather than as an intertemporal model itself. In particular, it lacks the following two features of a full intertemporal model: (i) an explicit time path for all the variables of interest (*ORANI-F* is a single-period model which generates forecasts of average growth rates over a specified time interval; explicit time paths for variables are not identified); and (ii) the satisfaction of explicit intertemporal optimality conditions linking the variables of interest at one point of time in the projection period with their values in the anteceding and succeeding periods.

59 See Table 3 above.

60 See the citation in footnote 44 above.

61 Peter B. Dixon, "A General Equilibrium Approach to Public Utility Pricing: Determining Prices for an Urban Water Authority", *Journal of Policy Modeling*, forthcoming 1991.

62 Unlike the planned new generation models, Dixon's water-pricing model uses a highly model-specific, rather than a generic, solution method.

5. *The Need for a Major New Model Development Phase*

The *ORANI* model had gone through two complete development cycles by the early 'eighties. Since then the most significant events from an applied policy perspective have been:

(i) the extensive adoption and use of the *ORANI* model, and its derivatives, by the Australian policy-advising community;

(ii) the quantum leap in the ease with which CGE models can be constructed, modified, and solved, due largely to the development of the *GEMPACK* computer modelling environment; and

(iii) the acquisition within policy agencies of skills allowing them, more or less on a routine basis, to undertake highly sophisticated special-purpose modelling exercises.

The use of the *ORANI* suite of models has grown so rapidly in the last three years as to make exhaustive documentation of this use impossible. At the end of 1987 we were able to document about 200 applications of *ORANI*.[40] A casual review of the literature leads us to suspect that there has been at least a doubling of the cumulative total since then. In part this reflects the extensive use of *ORANI* and related models at the Industry Commission, where formal modelling work now supports virtually all major inquiries. In part it reflects the ease of access to *ORANI* and its derivatives made possible by the widespread installation of *GEMPACK* (see Section 4.1 above). And finally, it reflects the flexible use of *ORANI* now possible in view of the possession by the Industry Commission and other groups of an in-house capability to modify the basic model to accommodate the special features relevant to particular investigations.[41] All of this looks like a highly satisfactory situation. Why do we need another major investment in basic model development?

---

40 Alan A. Powell and Tony Lawson, "A Decade of Applied General Equilibrium Modelling for Policy Work", cited above in footnote 6.

41 For a practising policy economist's perspective on the use of *ORANI* within an institutional setting, see David P. Vincent, "Applied General Equilibrium Modelling in the Australian Industries Assistance Commission: Perspectives of A Policy Analyst", Ch. 9 in Lars Bergman, Dale W. Jorgenson and Ernő Zalai (eds), *General Equilibrium Modeling and Economic Policy Analysis* (Cambridge, Mass: Blackwell, 1990), pp. 291-347.

Although the *ORANI* suite of models copes well with issues involving the composition of the economy at a given date, it is not set up to deal with questions involving allocation over time. Examples of such issues are:

(a) virtually all environmental questions,

(b) the economics of renewable resources (forestry and fishing) and non-renewable resources (minerals and energy),

(c) external debt stabilization,

(d) technological planning (both at the national and at the corporate level).[42]

A leading recent example which demonstrates the power of an explicitly intertemporal model in evaluating the costs of environmental policy is provided by Jorgenson and Wilcoxen.[43] They note that during the period between the end of World War II and the early 'seventies, real output in the U.S. grew at about 3.7 per cent per annum; in the period 1973 to 1985, however, the rate averaged only 2.5 per cent. This slow-down had been blamed, in some quarters, on pollution control laws introduced in the mid 'sixties and later. To investigate this claim, they simulated the U.S. economy over the period 1974-85, with and without the pollution controls. The first of these simulations is designed merely to calibrate the model; i.e., to check that the model can indeed replicate history. The second, counterfactual, simulation is designed to see how much faster the U.S. economy would have grown if there had been no pollution abatement

42 The case for a new modelling effort to deal with these questions has been made by Peter B. Dixon and associates in two separate funding proposals – unfortunately, neither was successful. See Peter B. Dixon, "Proposal to establish a Centre for Economic Modelling in the Institute of Applied Economic and Social Research at the University of Melbourne", January 1990; John Sutton, "Proposal to Develop a Techno-Economic and Environmental Model (TEEM) for Australia", prepared by John Sutton, February 1990, Corporate Planning Office, CSIRO, Dickson ACT 2603; and Peter B. Dixon, "Multi-period disaggregated economic modelling: Do we need it? Can we do it?", Paper prepared for the workshop on techno-economic assessment held at the CSIRO Conference Centre, Canberra, June 28, 1989. I have drawn liberally on these sources in this section.

43 Dale W. Jorgenson and Peter J. Wilcoxen, "Environmental Regulation and U.S. Economic Growth", *Rand Journal of Economics*, Vol. 21, No. 2 (Summer 1990), pp. 314-340.

7. *A Proposal to Pool the Resources of the Impact Project and the Monash Centre of Policy Studies*

During the nineteen-eighties the Impact Project's basic research and development unit has extended applied general equilibrium analysis in many directions: long-run closure,[48] imperfect competition,[49] short-run macroeconomic closure,[50] the introduction of money and other assets,[51] elaboration of the links between the distribution of factor rewards and the personal income distribution,[52] the extension of applied GE modelling to the level of individual corporations,[53] its use in portfolio management[54] and the development of a routine procedure for solving intertemporal GE models in a Johansen setting.[55] All of this work has been at the prototype level, and most of it was done by doctoral candidates or by post-doctoral fellows under the supervision of the Director of the Impact Project. None of it could be converted into full-scale routinely accessible policy models without further resource injections. In fact, the Industries Assistance Commission made such an injection in the case of the long-run closure, but this was done at the Commission in Canberra by a team led by Dr Philippa Dee.[56]

Under Peter Dixon's direction the Melbourne Institute of Applied Economic and Social Research also undertook some development of the *ORANI* suite of models during the 'eighties.

48 J. Mark Horridge, "The Long-Term Costs of Protection: Experimental Analysis with Different Closures of An Australian Computable General Equilibrium Model", A Thesis submitted to the Department of Economics of the University of Melbourne for the Degree of Doctor of Philosophy, April 1987.

49 *Ibid.*

50 See the references cited in footnote 31.

51 Philip D. Adams, "Incorporating Financial Assets into ORANI — The Extended Walrasian Paradigm", A Thesis submitted to the Department of Economics of the University of Melbourne for the Degree of Doctor of Philosophy, December 1988.

52 See the references cited in Table 3 above.

53 Peter J. Higgs, "A General Equilibrium Model of the Australian Corporate Sector", University of Melbourne, Graduate School of Management, 1990 (mimeo).

54 Peter J. Higgs, "A Forward Looking Approach to Portfolio Analysis Using a Computable General Equilibrium Model", *Impact Project Preliminary Working Paper* No. IP-37, IAC, Canberra, June 1988.

55 See reference cited in footnote 46.

56 For a report documenting this and related work, see Philippa Dee, "FH-ORANI: A Fiscal ORANI with Horridge Extension", *Impact Project Preliminary Working Paper* No. OP-66, Industries Assistance Commission, Canberra, March 1989.

- a strategy for ***econometric estimation*** of intertemporal parameters has been devised.[47]

6.2 *Refurbishment of Parameter Files*

Work will continue on the progessive updating and improvement of the parameter file of the *ORANI* suite of models because:

- this is ***necessary to preserve credibility*** of policy analyses, particularly in the light of:
- the ***newer and improved methods of estimation*** developed in time-series econometrics during the nineteen-eighties, which offer scope to improve the reliability of policy analyses, and
- the much ***longer time-series now available*** as a basis for estimation.

6.3 *Software Development*

GEMPACK development will continue to be a high priority because:

- The new software will allow Australian policy agencies to model ***intertemporal issues*** on a ***routine basis***. They will be able to use the COPS/Impact models and/or to develop their own models for analysis.
- ***Linearization errors*** inherent in the Johansen solution procedure will be ***eliminated*** by the new code.
- The development of ***post-solution software*** which will ***facilitate report writing*** and visual presentation.
- PC and other desktop computer ***versions*** will continue to be ***maintained and enhanced.***

47 Keith R. McLaren, "The Use of Adjustment Cost Models in Intertemporal Computable General Equilibrium Models", draft Impact Preliminary Working Paper (December 1990).

controls. Notice that in both simulations the role of forward-looking investors is critical. Jorgenson and Wilcoxen conclude that of the 1.2 percentage point drop in the U.S. growth rate, only 0.19 percentage points could be ascribed to compliance with environmental regulations. Whilst this work was *ex post*, the same set of techniques is applicable to *ex ante* assessment of proposed changes in environmental legislation. The new generation of models to be developed for Australia will have this capacity.

The economics of forests and of fisheries is intertemporal in two respects: first, the biological laws governing rates of resource renewal are a set of differential equations in time; second, the economically optimal rates of harvesting are determined as the solution to a dynamic programming, control-theoretic or calculus-of-variations problem. Constraints on environmental degradation, or the payment of rewards for environmental improvement, can readily be accommodated within such formulations. Finally, non-renewable resource problems share all of the above intertemporal characteristics except the biological ones.

In the mid-1980s Dixon and Parmenter used the *ORANI* model to propose the lines along which Australia's external debt crisis might be resolved.[44] Part of the scenario writing for this exercise involved imposing the assumption that in the successive years 1989 and 1990 the ratios of debt to GDP would be identical; that is, they assumed that debt as a proportion of GDP would stabilize at the turn of the decade. This assumption is arbitrary; if there had been an intertemporal version of *ORANI* available, in which foreign lenders and domestic investors had detailed and explicit plans for the future, the date at which the debt/GDP ratio stabilized could have been generated as a prediction of the model, rather than as an imposition of the modeller.[45]

44 Peter B. Dixon and B.R. Parmenter, "Foreign Debt Stabilization and the Terms of Trade: Implications for Australia, end-1984 to end-1990", Appendix 1 in Rob Fraser (ed.), *Paying the Banker: Facing Australia's Foreign Debt Problems* (Canberra: Australian Mining Industry Council, 1987), pp. 79-138.

45 In the event, the ratio of debt to GDP continued to climb at the end of the decade, from 0.31 in 1988-89 to 0.35 in 1989-90 (source: Philip D. Adams, Peter B. Dixon and Daina McDonald, "Macroeconomic Forecasts for the Australian Economy, *Australian Economic Review*, 4th Qtr 1990, p.17).

Using formal models to explore technological options also involves intertemporal issues. First, knowledge now of technological options for the future may affect the quantities, and types, of investment goods which a firm will plan to invest in. For example, a pre-announced schedule of availabilities for forthcoming models of producer durables (e.g., computer hardware) may have major effects on the timing, and types of investment undertaken by a firm. Similarly, a pre-announced phasing in of emission standards for processes which produce pollutants as by-products will affect the time path of investment both qualitatively and quantitatively. The responses to scenarios of this type cannot be modelled reliably except in an intertemporal framework. Second, the exploration of theories of endogenous technological change requires an intertemporal modelling framework. For example, if we believe that the production of new technologies depends on the stocks of existing techniques and on complementary investment in trained personnel, then an optimal R&D policy requires intertemporal decision making.

It is not proposed to build an omnibus model which will, without further detailed work, allow the automatic solution of an arbitrary problem. In particular, it will still be necessary to build satellites or sub-models focussing on particular issues (as is the case with *ORANI* at the moment). The core model of the proposed new suite of models will, however, be capable of elaboration to solve particular problems belonging to the categories (a) — (d) above *on a routine basis*. This will be possible because

- all of the variables in the core model will be subscripted for future time periods, enabling them to be interfaced directly with similarly subscripted variables in the satellite models;
- the *finite difference* solution method, already available on a prototype basis in *GEMPACK*, will be used to solve both the core and the satellite models simultaneously.[46]

Note also that the pre-existing effort invested in *ORANI* will be used to good effect, since

- the nature of the new class of models is such that an *ORANI*-type model describes the economy in each of the periods simulated; i.e., the existing stock of modelling capital is fully used in the new developments.

---

46 For details of the finite difference method, see Peter J. Wilcoxen, "Intertemporal Optimization in General Equilibrium", *Impact Project Preliminary Working Paper* No. IP-45, Industries Assistance Commission, December 1989, Section 4.4.

6. Prospectus, 1991-1994

Given a renewal of funding for a further three years, Impact will continue with model development, refurbishment of parameter files, and software development.

6.1 Development of Full Intertemporal Modelling Capability

In view of the matters raised above in Section 5, the main thrust in model development will be a fully intertemporal economy-wide model. We believe:

- that this is the best way to address many pressing issues facing policy makers in the 'nineties, especially those which touch on the ***environment***, the management of renewable and non-renewable ***natural resources***, ***technology*** policy and the management of Australia's ***external debt;***
- that the new model will shed light on the optimal ***timing*** of policy initiatives in ***microeconomic reform*** (e.g., should a tariff reduction be phased in or implemented as a 'cold shower'?);
- that such a modelling capability will assist in the design of ***efficient operating policies*** for government business enterprises (***GBEs***) in areas subject to natural monopolies (e.g., distribution of electricity or gas to households; provision of water and sewage), and will help in the assessment of the size of benefits obtainable from improved performance in these areas;
- that the new suite of models will keep Australian policy agencies at the ***state of the art*** in policy modelling.

The above is feasible because:

- the work will be done cooperatively by a ***team of critical mass*** obtained by combining the resources of Impact with the staff of the Monash Centre of Policy Studies under the direction of Professor ***Peter B. Dixon***;
- extensive ***prototype development*** is now ***complete;***
- the ***GEMPACK*** software suite has been ***extended*** to allow full intertemporal modelling;