

# AUSTRALIAN RESOURCES AND ENVIRONMENTAL ASSESSMENT (AREA) MODEL

A study by the Department of Science and the Environment in consultation with Commonwealth departments and agencies

## GLOBAL ECONOMIC MODELLING: SOME AUSTRALIAN AND NEW ZEALAND PERSPECTIVES

by

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*The views expressed in this paper do not necessarily reflect the opinions of the Department of Science and the Environment, nor of the Australian Government.*

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Paper presented to the  
Australia and New Zealand  
4th Regional Science Association Conference,  
Albury-Wodonga, December 2 to December 5, 1979

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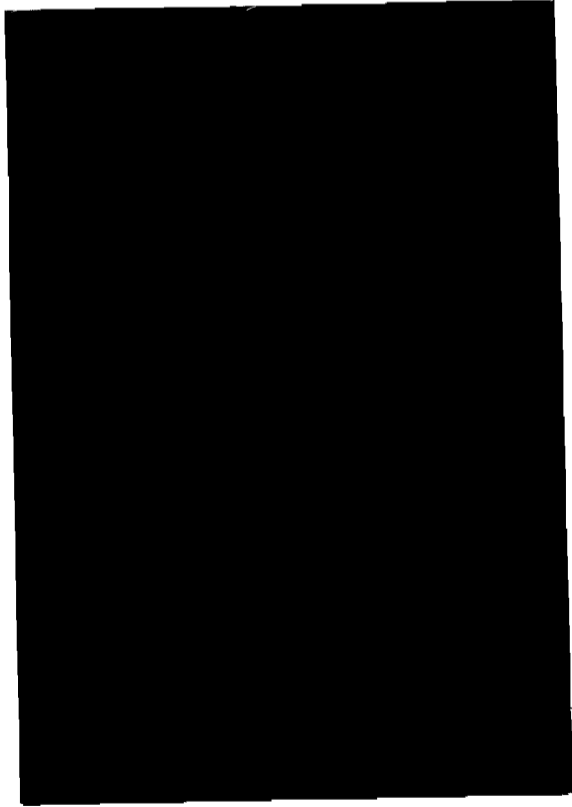
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SARUM is a world econometric model developed by the System Analysis Research Unit of the UK's Department of the Environment, in which prices do not adjust to equilibrate supply and demand in each period, but rather recognise the many factors that inhibit instantaneous clearing of markets. The world can be regionalised into twelve regions and a number of industrial and agricultural activities.



AREAM is the Australian version of SARUM for the analysis of Australian Resources and Environmental Assessment. The project was formulated in the light of a need to assess the impact of world change on the development of the Australian environment and its natural resources. In order to be able to look at environmental factors, SARUM is extended by the addition of an environment sector and the demographic sector is endogenised.

## ABSTRACT

The economic basis of global models has undergone considerable improvement in the last five years. Case studies considered in this paper have been derived from the use of an existing model of the world economy. These case studies consider some of the economic implications for Australia and New Zealand of the alternative patterns of trade in food, minerals and energy resulting from different trade liberalisation strategies between Australia and New Zealand. These strategies are considered within the context of a particular global scenario evaluated by the OECD using the same model. Two main cases are considered. The first, dealing with a gradual liberalisation of trade between Australia and New Zealand, shows that free trade between these countries could be mutually beneficial. In the second case we see that if New Zealand isolates itself through trade from the rest of the world, while continuing to trade with Australia as in the past, it may lead to a reduced standard of living as measured in consumption per capita terms. Repeated emphasis is made throughout the paper that both the modelling work described here and the results it has produced are of a highly exploratory nature.

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1. INTRODUCTION

The economic basis of global models has undergone considerable improvement in the last five years. Case studies considered in this paper have been derived from the use of an existing model of the world economy.<sup>1</sup> These case studies consider some of the economic implications for Australia and New Zealand of the alternative patterns of trade in food, minerals and energy resulting from different trade liberalisation strategies between Australia and New Zealand. These strategies are considered within the context of a particular global scenario evaluated by the OECD using the same model.<sup>2</sup> A description of how the model has been used to assess the level of stress imposed on the environment by the economic activities considered in the model is provided elsewhere.<sup>3</sup> Comparisons of economic and some environmental effects of trade liberalisation among different groupings of countries on the rim of the Pacific are also considered elsewhere.<sup>4</sup> A comprehensive exposition on the mathematical structure of the model, an outline of this structure and extensions for use in Australia, and a detailed description of the model and its uses can be found elsewhere.<sup>5</sup>

1. The model known as the Australian Resources and Environmental Assessment Model (AREAM) is an extension of an existing model developed by the Systems Analysis Research Unit (SARU) of the UK Department of the Environment.
2. The OECD's INTERFUTURES Project recently completed a wide range of global modelling studies and analyses, and reported its main findings in the final report (OECD, 1979).
3. See for example papers 3 and 11 in the AREA series by Mula (1978) and Mula and Parker (1979) respectively.
4. See for example papers 12 and 13 in the AREA series by Mula and MacRae (1979a) and Mula and MacRae (1979b) respectively.
5. See Departments of the Environment and Transport (1978), Mula and MacRae (1979) and Departments of the Environment and Transport (1977) respectively.

As a word of caution, the authors view the results presented here and in earlier papers as purely illustrative. On the one hand, further detailed econometric estimation and demographic modelling is required. More significantly, there is a need to examine comprehensively, and refine as necessary, the structural basis and assumptions underlying the subsystem of equations describing the Australian economy.

## 2. OUTLINE OF MODEL AND REFERENCE SCENARIO

The model is a dynamic simulation model of the global economy based on neo-classical economic principles. It is comprised of a variable number of world regions and economic sectors within each region. Current work is dealing with the following regions: North America, Japan, Australia, New Zealand, European and Asian COMECON, other Europe and Asia Minor, Latin America and the Caribbean, South Asia, East and South East Asia and Oceania, China, West Asia and North Africa, and other Africa. Economic sectors currently within each region deal with energy, minerals, manufactures, machinery, construction, fertilizers, water, land development, land pool, food, services, natural products. A sector recently added to this configuration provides a means of assessing the level of stress imposed on the environment by the activities of the other sectors. The development of a further sector is drawing on existing behavioural modelling studies to describe the dynamics of demographic change in Australia internal to the Australian region of the model. By modelling the trade between the sectors of the various world regions the model can be used to address problems relating to the way regions interact with each other. In trade transactions the model accounts explicitly for factors which inhibit the functioning of a free market. This is achieved by applying a matrix of trade biases (Parker, 1977) to each commodity traded in order to modify the prices perceived by the importer depending on the source. The bias includes the factors of economic barriers (controls and tariffs), distance, political, strategic and cultural barriers. In developing a population sector internal to Australia a mechanism similar to that for applying trade biases is being examined as a means of describing the underlying flow of migration. Aid can also flow from one region to another. However, there is no attempt made to model the international money markets.

In selecting a reference or baseline to assess the effects of policy changes it was considered that the scenario of low economic growth postulated and evaluated using the same model by the INTERFUTURES Project of the OECD would be suitable. Major assumptions underlying this scenario include:

- . zero recovery with respect to the productivity losses incurred during the early years of this decade
- . an annual rate of 1.5 per cent in long term productivity in the USA

- a gradual convergence in the long term productivity of the other OECD countries to the USA levels
- a rate of population growth equivalent to the UN medium level projections and relative to these projections a constant rate of labour force participation

Over the 25 years to the year 2000 this yields an average rate of growth in GDP of 3.4 per cent for all OECD countries with Australia and New Zealand registering 3.3 per cent and 2.7 per cent respectively.

In constructing the reference scenario a number of changes to the conditions set in the INTERFUTURES scenario were made as follows:

- through the trade bias matrices, trading behaviour was set according to the historical experiences of the early 1970s, such as the OPEC cartel action of 1973
- removal of conditions set to liberalise trade between North and South
- removal of conditions set to create a flow of official aid from developed to developing countries

### 3. AUSTRALIA AND NEW ZEALAND IN THE CONTEXT OF THE REFERENCE SCENARIO

In relation to the reference scenario, Figure 1 shows the surrogate measure for the standard or level of living used here, the gross consumption per capita, for the twelve regions. Dollar values are in standard 1970 US dollars unless otherwise stated. The two major growth regions over the whole run are Japan and the Soviet Block with comparatively rapid increases during the next century for China and East and South East Asia. Figure 2 shows for each region the gross production, or total production of all goods and services in the economy. The major producers here are China, Latin America and the Caribbean and the Soviet Block. The OPEC countries in West Asia and North Africa rapidly increase their production early in the next century.

Agriculture and in particular the production of food for consumption has been one of the most difficult problems to overcome on a global scale. The ability of the world to produce sufficient food for the world's population has been examined a number of times (Buringh, 1975 and Wagstaff, 1979). It is the maldistribution of that production which is the core of the problem. In Figure 3 we can see the sales of food for all regions expressed in petajoules of cereal equivalents per year. These are sales of food at the farm gate, where livestock products are equated in cereal equivalent terms and added to vegetable products. China's ability to produce food is the most pronounced curve in this figure. The levelling-off of the

Soviet Block and East and South East Asia is brought about by the lack of arable land which is less costly to develop. The reverse is true for Latin America which increases its production after 2000 by further opening up its arable lands. Japan is not able to produce food economically because of its lack of land and its high costs of production. This cost of production is reflected in Figure 4 which shows the local price of food in each region. Marked cost increases are generated in the Soviet Block, East and South East Asia and China, particularly after 2005. Significantly, Australia and New Zealand have the lowest cost of production during this period. Expressed on a per capita basis, food consumption as shown in Figure 5 illustrates this problem of maldistribution. Australia in particular reaches what we term a 'glut' limit in the model very early in the run, some four times the consumption rate of the people of the developing countries of South Asia and Africa. East and South East Asia is able to increase its rate of consumption by trading manufactured goods for food.

Expressed in 1970 US dollars, gross consumption per capita for Australia and New Zealand is shown in Figure 6 to increase from \$3420 to \$7680 for Australia and from \$2780 to \$5660 for New Zealand in the fifty years from 1970. This results in Australia being fourth in the list of twelve regions referred to in Figure 1.

Turning now to the level of trading by Australia and New Zealand, we see from Figure 7 increases and decreases in the net trade (exports minus imports) across all the major commodities for Australia plotted. Measured in 1970 standard dollars, energy and food are Australia's major net export earners, closely followed by minerals. By 2020 the standard dollars levels for these commodities have reached 14 billion 11 billion and 5 billion respectively. The largest net import by 2020 is manufactured goods, taking over from machinery about 2007. Obviously this heavy importing of manufactured goods has effects on the numbers employed in the associated industries. While the wage rate increases by 260 per cent, one hundred thousand jobs (calculated in man-years) are foregone over the period 1970 to 2020. Thus, in the context of this scenario it is considered likely that Australia would become a producer of primary commodities, particularly coal with food still playing a major role. In New Zealand's case net trade flows are dominated by primary commodities, particularly from agriculture, grazing and timber. Figure 8 shows net trade from food and natural products reaching \$2.5 billion and \$1.3 billion by 2020 respectively. Importing of machinery and manufactured goods reach \$2.2 billion and \$0.6 billion. On the minerals and energy side the story is different. Mineral requirements are virtually being supplied from home, while the net trade fluctuates from an importing situation to one of exporting by the end of the period. Net trade in energy fluctuates more markedly with an importing situation existing until the gas fields come on stream after 1980. Exporting peaks in the 1990's followed by a dropping off to net importing of around the



FIGURE 1  
GROSS CONSUMPTION/CAPITA BY REGION-STD

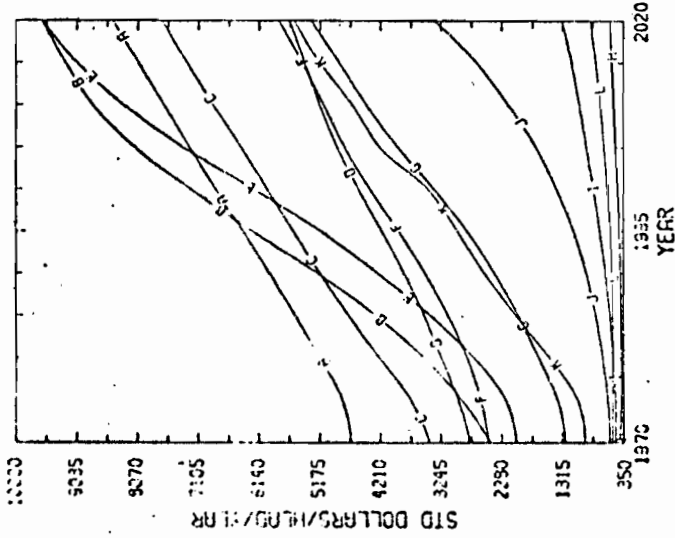
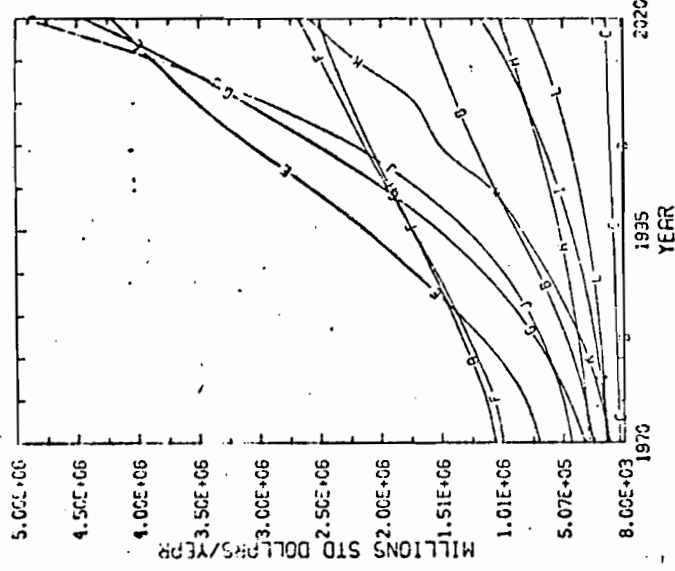


FIGURE 2  
GROSS PRODUCTION BY REGION - STD RUN



A North America  
B Japan  
C Australia  
D New Zealand

E European and Asian COMECON  
F Other Europe and Asia Minor  
G Latin America and the Caribbean  
H South Asia

I East & SE Asia  
J China  
K West Asia & North Africa  
L Other Africa

FIGURE 3  
SALES OF FOOD BY REGION - STD RUN

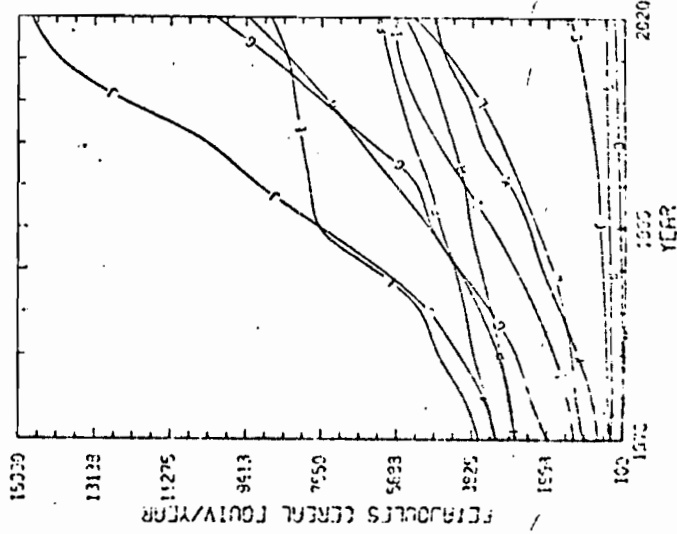


FIGURE 4  
LOCAL PRICE OF FOOD BY REGION - STD RUN

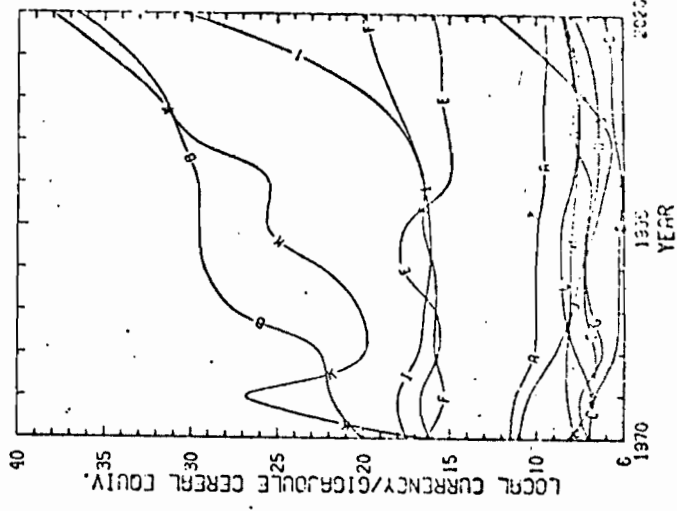
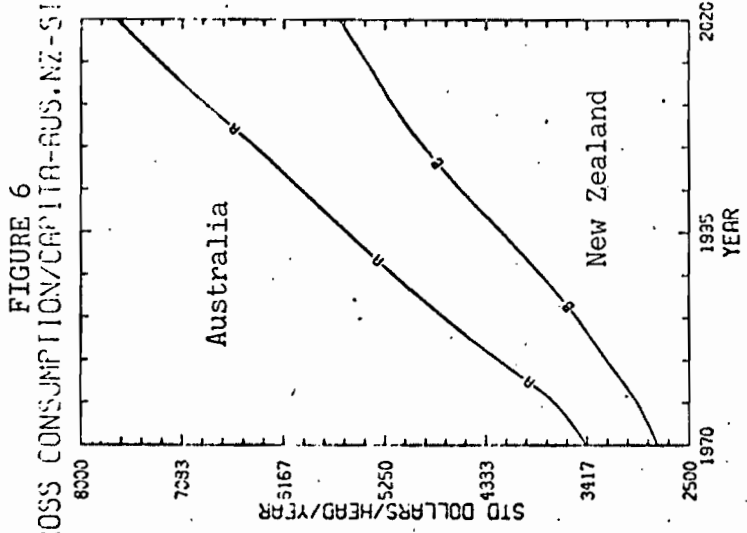
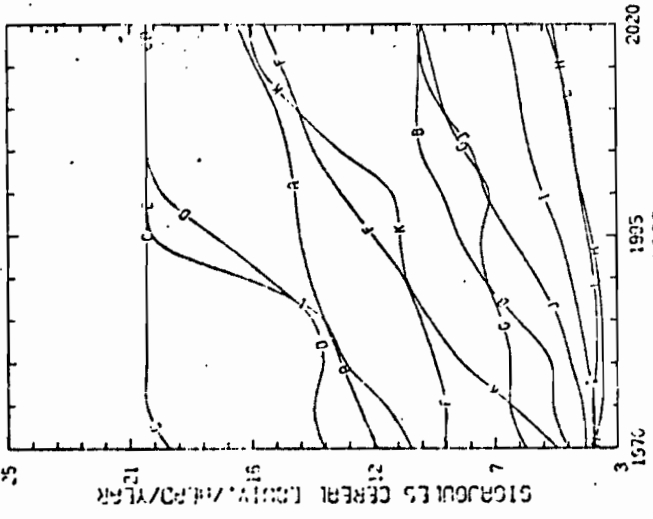
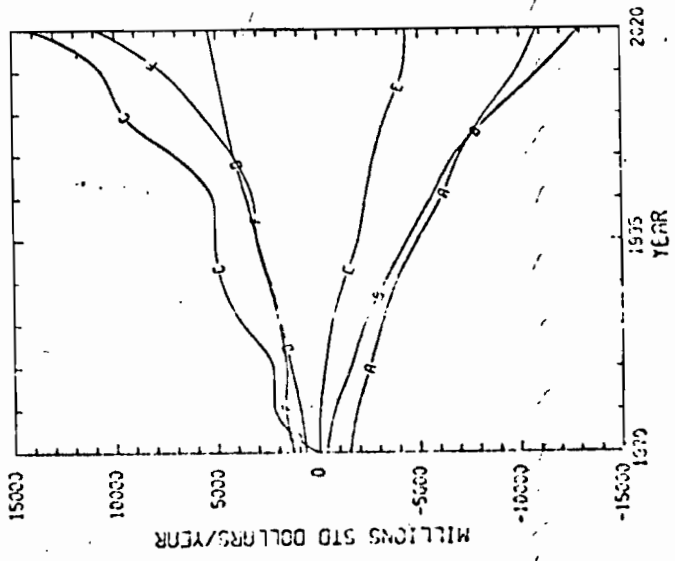


FIGURE 5 REGION-STD RUN GROSS CONSUMPTION/CAPITA BY REGION-STD RUN GROSS CONSUMPTION/CAPITA-RUS.NZ-STD RUN



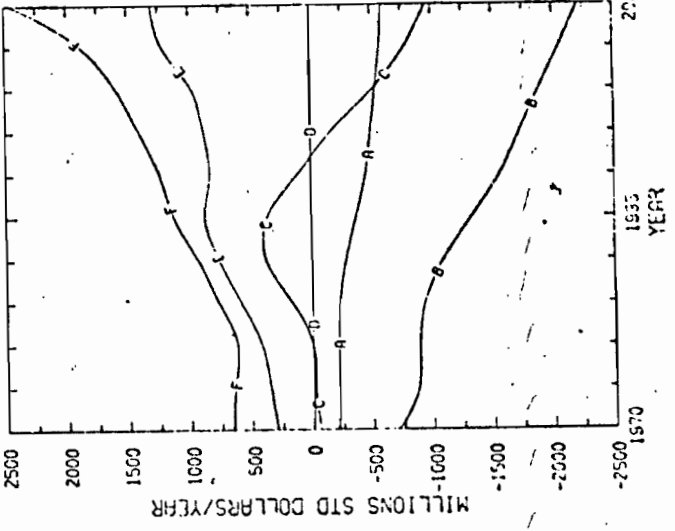
Legend as per Figures 1 to 4

FIGURE 7 NET TRADE BY AUSTRALIA, STD RUN



- A Machinery
- B Manufactures
- C Energy

FIGURE 8 NET TRADE BY NEW ZEALAND, STD RUN



- D Minerals
- E Natural Products
- F Food

FIGURE 9

EXPORTS OF MANUFACTURES FROM AUS-STD RUN

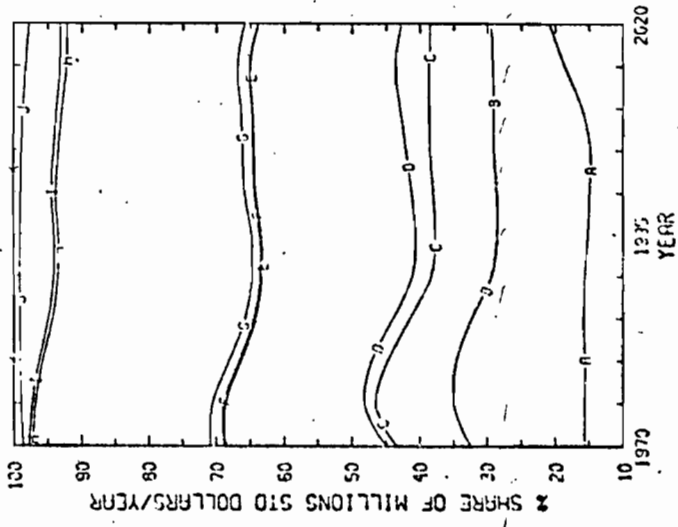
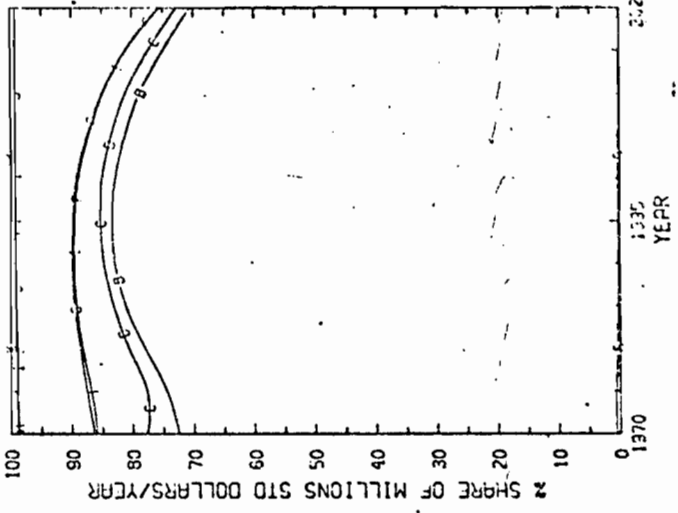


FIGURE 10

EXPORTS OF ENERGY FROM AUS - STD RUN



A North America  
 B Japan  
 C New Zealand  
 D European & Asian COMECON

E Other Europe & Asia Minor  
 F Latin America & Caribbean  
 G South Asia  
 H East & SE Asia

I China  
 J West Asia & North Africa  
 K Other Africa

FIGURE 11

EXPORTS OF MINERALS FROM AUS - STD RUN

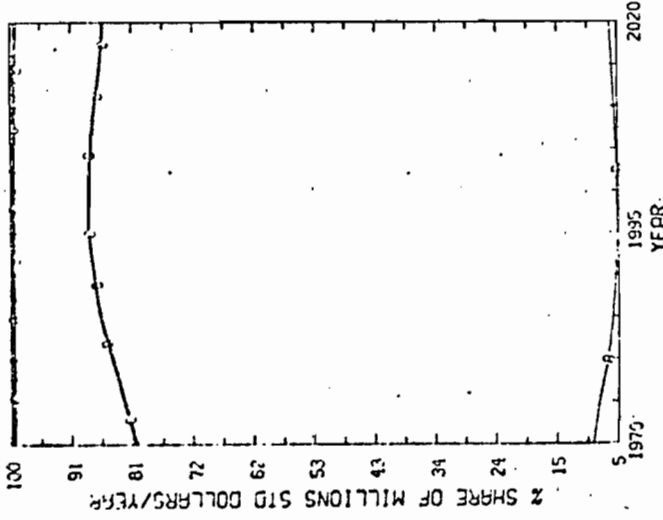


FIGURE 12

EXPORTS OF FOOD FROM AUS - STD RUN

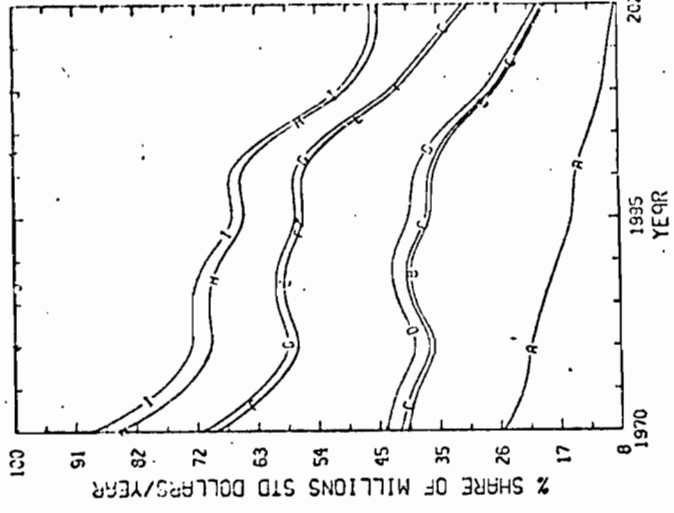
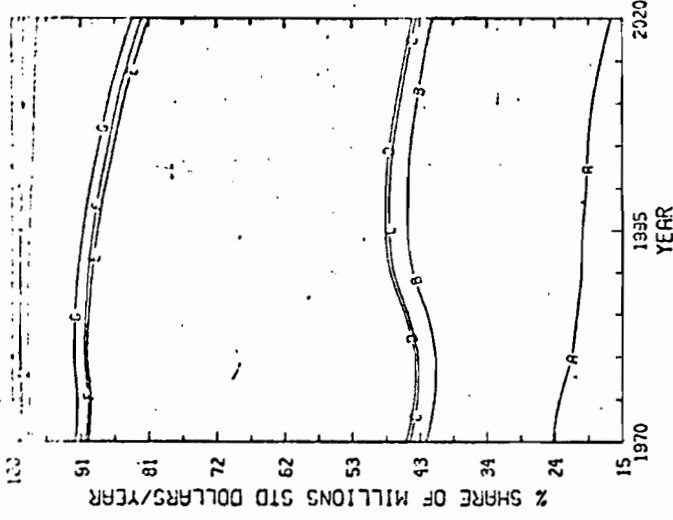
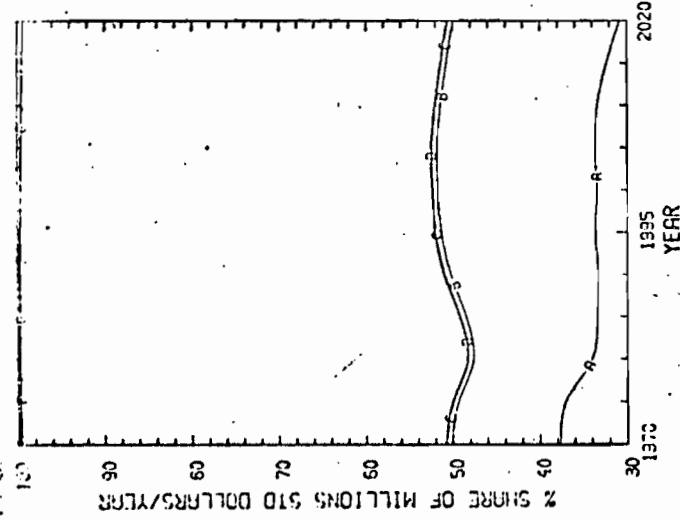


FIGURE 13

IMPORTS OF MACHINERY BY AUS - STD RUN IMPORTS OF MANUFACTURES BY AUS - STD RUN



A North America  
 B Japan  
 C New Zealand  
 D European & Asian COMECON

E Other Europe & Asia Minor  
 F Latin America & Caribbean  
 G South Asia  
 H East & SE Asia

I China  
 J West Asia & North Africa  
 K Other Africa

FIGURE 15

IMPORTS OF ENERGY BY AUS - STD RUN

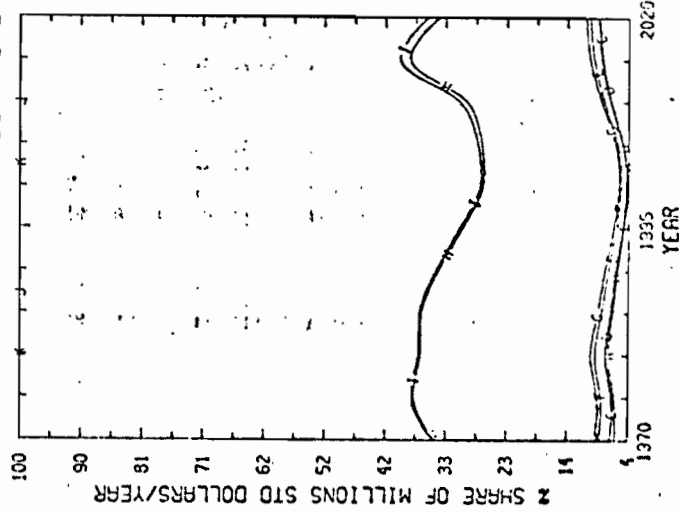


FIGURE 16

IMPORTS OF NATURAL PRCT. BY AUS-STD RUN

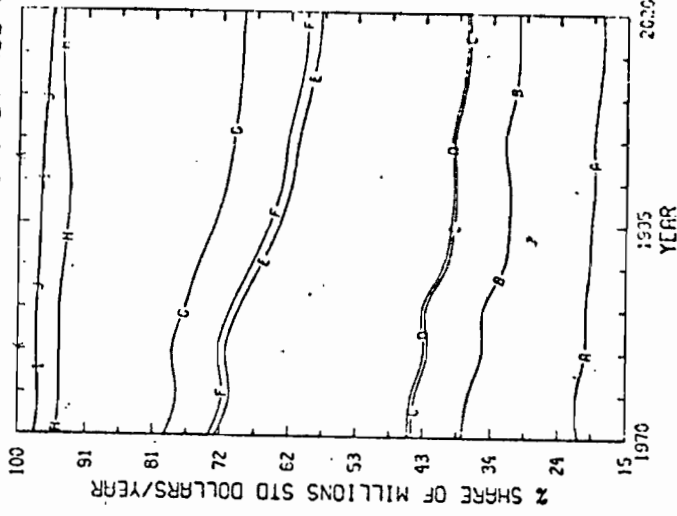
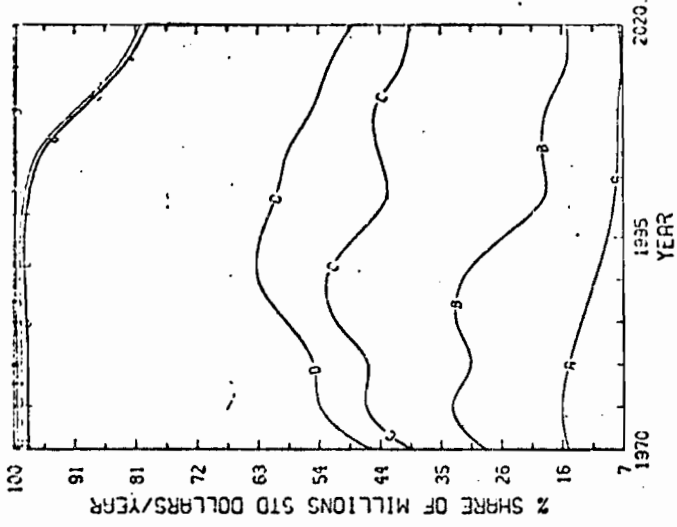
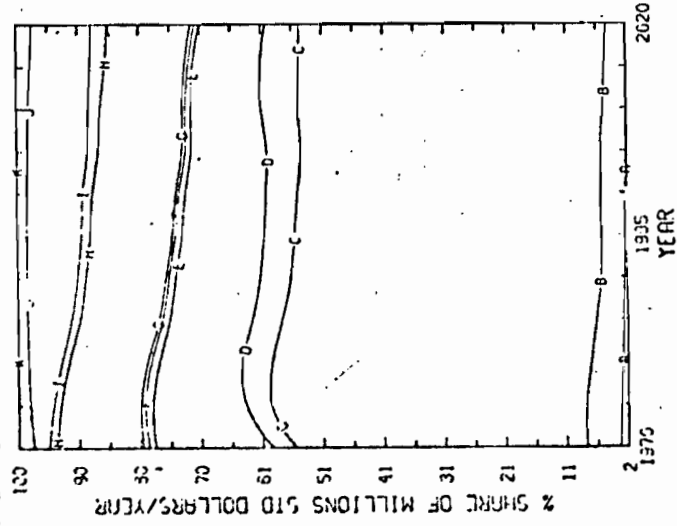


FIGURE 17

EXPORTS OF MANUFACTURES FROM NZ-STD RUN EXPORTS OF NATURAL PROD. FROM NZ-STD RUN



- A North America
- B Japan
- C Australia
- D European & Asian COMECON

- E Other Europe & Asia Minor
- F Latin America & Caribbean
- G South Asia
- H East & SE Asia
- I China
- J West Asia & North Africa
- K Other Africa

FIGURE 19

EXPORTS OF FOOD FROM NZ - STD RUN

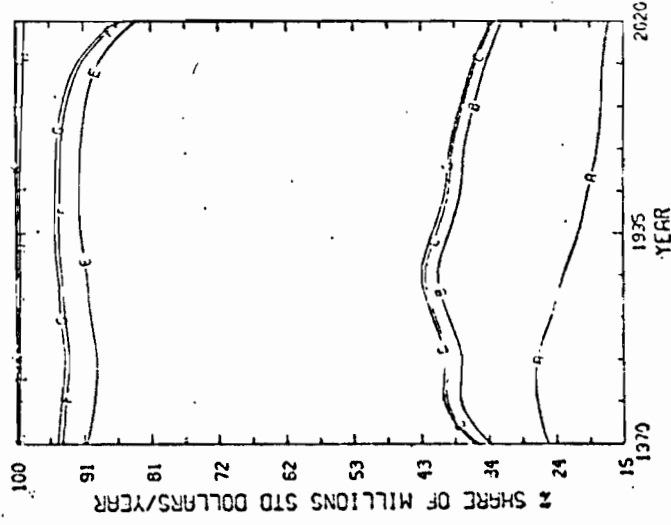


FIGURE 20

IMPORTS OF MACHINERY BY NZ - STD RUN

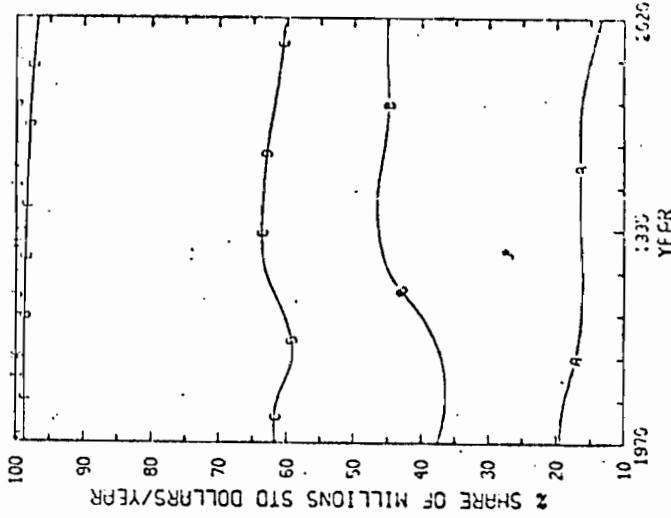


FIGURE 21

IMPORTS OF MANUFACTURES BY NZ - STD RUN

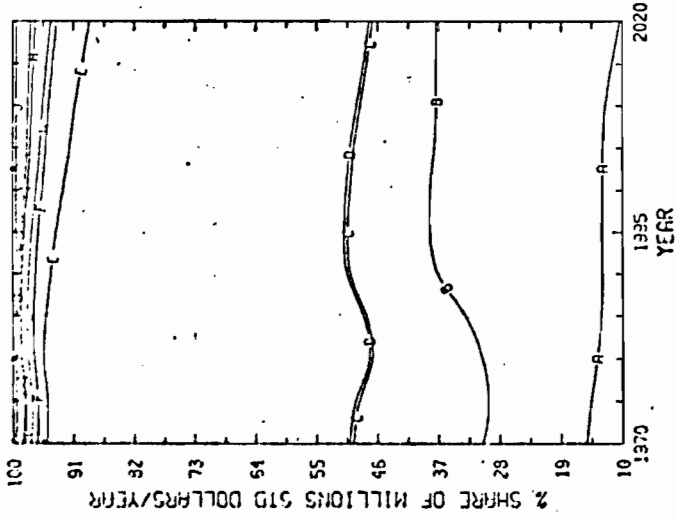
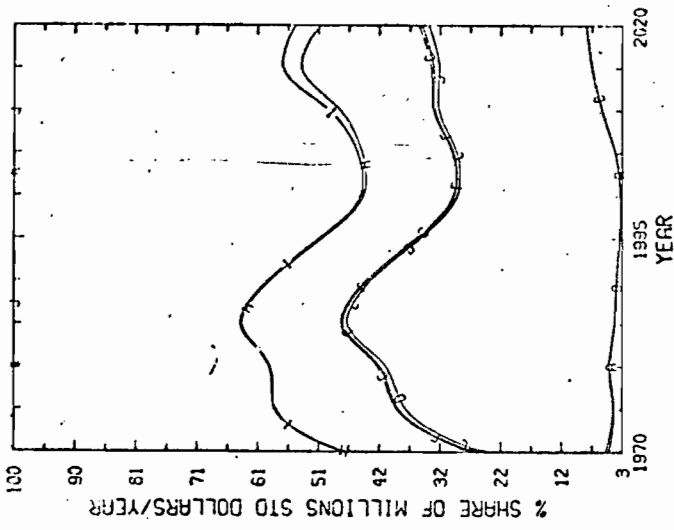


FIGURE 22

IMPORTS OF ENERGY BY NZ - STD RUN



Legend as for Figures 17 to 20

FIGURE 23

GROSS PRODUCTION - AUS & NZ

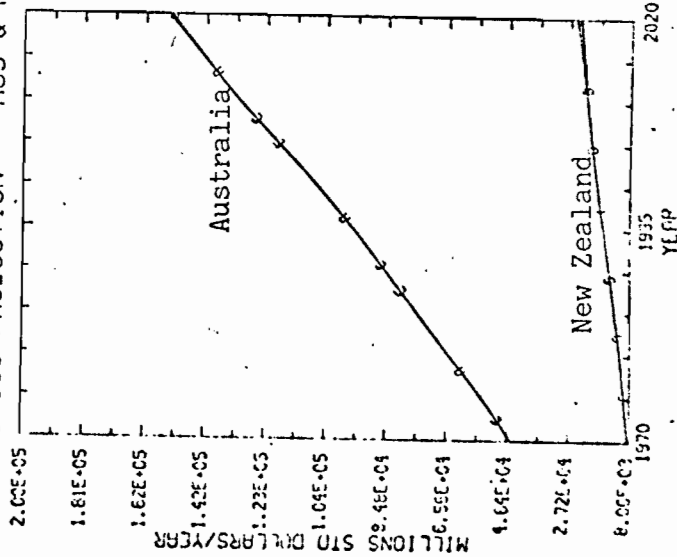
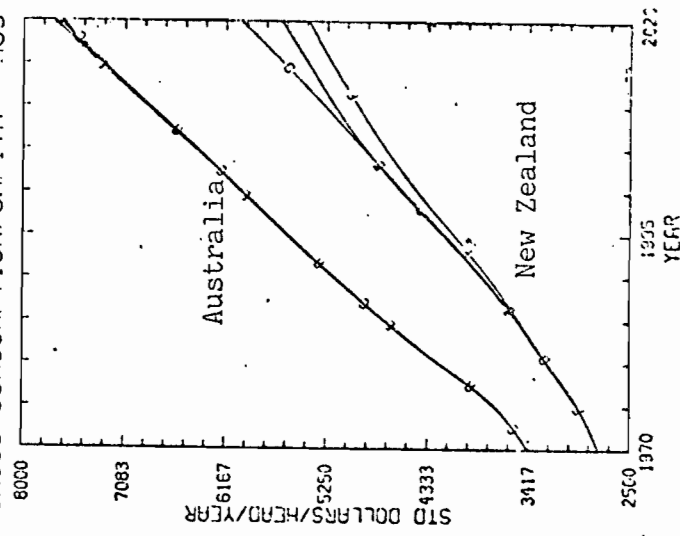


FIGURE 24

GROSS CONSUMPTION/CAPITA - AUS & NZ



\$1 billion level by the end of the period. Looking at trade in total for both regions, it appears that Australia will have a surplus in the balance of trade up until about 1995 and will then go into a deficit until about 2015 with a surplus arising again towards the end of the period. New Zealand on the other hand starts to show a surplus from 1982 until the turn of the century followed by a deficit situation for the remainder of the period.

It is necessary to know the direction of trade in order to determine possible future markets and to anticipate trends against existing markets brought on by various factors such as changes in physically constrained production; for example, food production constrained by lack of available arable land. In the figures that follow the levels of the exports and imports for a number of commodities for Australia and New Zealand are shown. These indicate the share of total exports of a particular commodity, in standard dollar values, received by the other regions. The share, expressed as a percentage, for a region is measured by the space between two lines as given by the area under the labelled line.

The Australian exports show some movement from the traditional markets towards the newer industrialising economies of East and South East Asia. Exports of manufactures (Figure 9) to Japan, and Western Europe fall, while those to North America, China and East and South East Asia increase. From Figures 10 and 11 it can be seen that Japan is Australia's biggest export market for energy and minerals with an increasing demand for energy from East and South East Asia. Food exports (Figure 12) indicate a demand by West Asia and North African countries with their share increasing from 12 per cent to 54 per cent over the period. Europe remains a large supplier of Australia's machinery (Figure 13) and manufactured goods (Figure 14) even though an increase in imports from Japan and East and South East Asia is generated. Energy imports (Figure 15) are mainly supplied by West Asia and North Africa with an increase once again in imports from East and South East Asia. A similar run out is generated for natural products (Figure 16).

Australia absorbs a much higher fraction of New Zealand's manufactured exports (Figure 17) than exports of natural products (Figure 18) and food (Figure 19). Again there is this movement away from the traditional markets of Europe where there is a fall from 49 per cent of natural product exporting to about 30 per cent by the end of the period. The bulk of New Zealand's food still goes to Europe but again the shares change. Imports of machinery (Figure 20) and manufactured goods (Figure 21) also show movements and in both cases this results in a reduction of imports from Australia in preference to those from Japan and East and South East Asia. While changes in the level of energy supplies to New Zealand (Figure 22) from Australia, East and South East Asia and West Asia and North Africa are generated, the bulk of the imports come from the latter region.

#### 4. ANZ FREE TRADE AND NZ ISOLATION SCENARIOS

By adjusting elements of the trade bias matrix for each of the commodities considered here we are able then to use the model to evaluate trade policies relating to the levels of liberalisation and protectionism over time which a region might wish to pursue in the context of a specific economic scenario. For example, we might wish to determine the broad economic consequences of free trade between Australia and New Zealand. Taking this example further the term 'free trade' is used here in its broadest sense to imply a reduction of tariff barriers on all commodities traded between Australia and New Zealand. A perfect free trade agreement would mean that trade biases would have a value of unity. This would imply that imported commodities can compete perfectly with home produced goods. In this case biases approach the lowest observed value in 1970 for each commodity at a rate of 10 per cent per annum commencing in 1980. This is the rate at which barriers fell among the countries of the Economic Community. Thus by the year 2000 the bias would have dropped to about 11 per cent of its original value. At the same time biases in the trade between Australia and New Zealand and the rest of the world were held constant. In the case of Australia and New Zealand the lowest observed values ranged from 2 to 4. By and large this means that home produced goods in Australia and New Zealand will be consumed more readily than those traded across the Tasman.

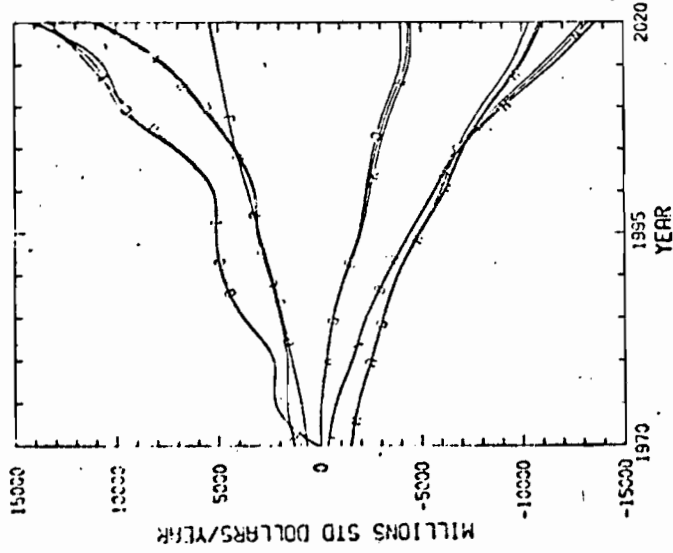
Considering now the case, of some topicality, where New Zealand effectively isolates itself from trade with the rest of the world, except Australia with which it seeks to maintain its prevailing trading relationships, we see that for a 10 per cent per annum increase in barriers to trade with all other regions except Australia that the effects on Australian gross production (Figure 23) compared with the free trade set up and the reference scenario are minimal. Although it is not completely clear from the figure, New Zealand's production under 'free trade' with Australia is 5 per cent greater than for the reference scenario by the end of the period, while trading according to the 'isolation' policy generates a 1 per cent fall compared with the reference. On a per capita basis we see from Figure 24 that while Australians fare better in the case of the New Zealand's 'isolation' policy considered here, there is a falling off of about four per cent in the standard of living in New Zealand. The 'free trade' case on the other hand generates a seven per cent increase in New Zealand, mostly over the twenty years at the end of the simulation period.

Turning now to net trade for the two countries, Figure 25 shows Australia's net trade to all regions for six commodities for each of the three trading cases. These cases only generate small variations. However, in New Zealand's case (Figure 26) the story is quite different. In the case of free trade and opening up of Australian markets manufactured goods, natural products and food generate greater export earnings than those realised as a consequence of the reference scenario. Machinery and energy are more heavily imported due to the readier and/or cheaper supply of these commodities. However, in the trade isolation case when



FIGURE 25

NET TRADE OF COMMODITIES BY AUSTRALIA

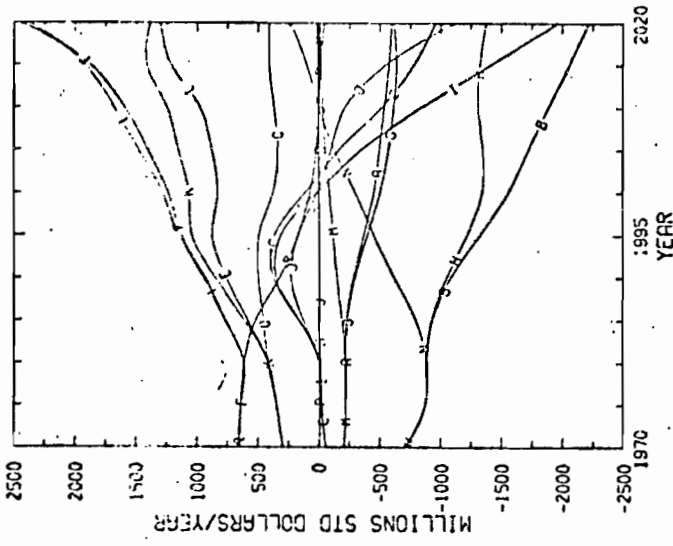


REF FT ISOL

A G M Machinery  
B H N Manufactures  
C I O Energy

FIGURE 26

NET TRADE OF COMMODITIES BY NEW ZEALAND

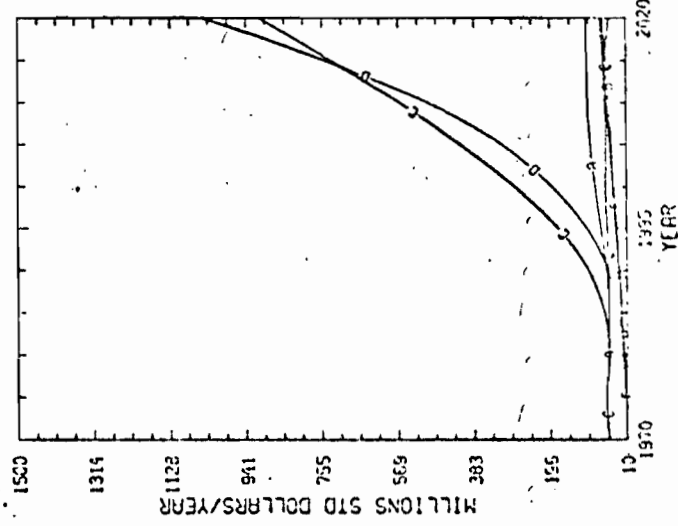


REF FT ISOL

D J P Minerals  
E K Q Natural Products  
F L R Food

FIGURE 27

TRADE FLOWS IN MACHINERY AUS<->NZ



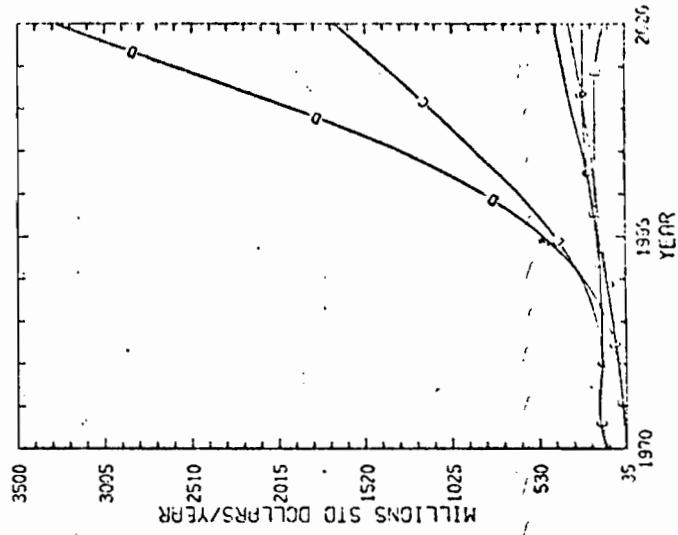
TRADE FLOWS

From AUS to NZ from NZ to AUS

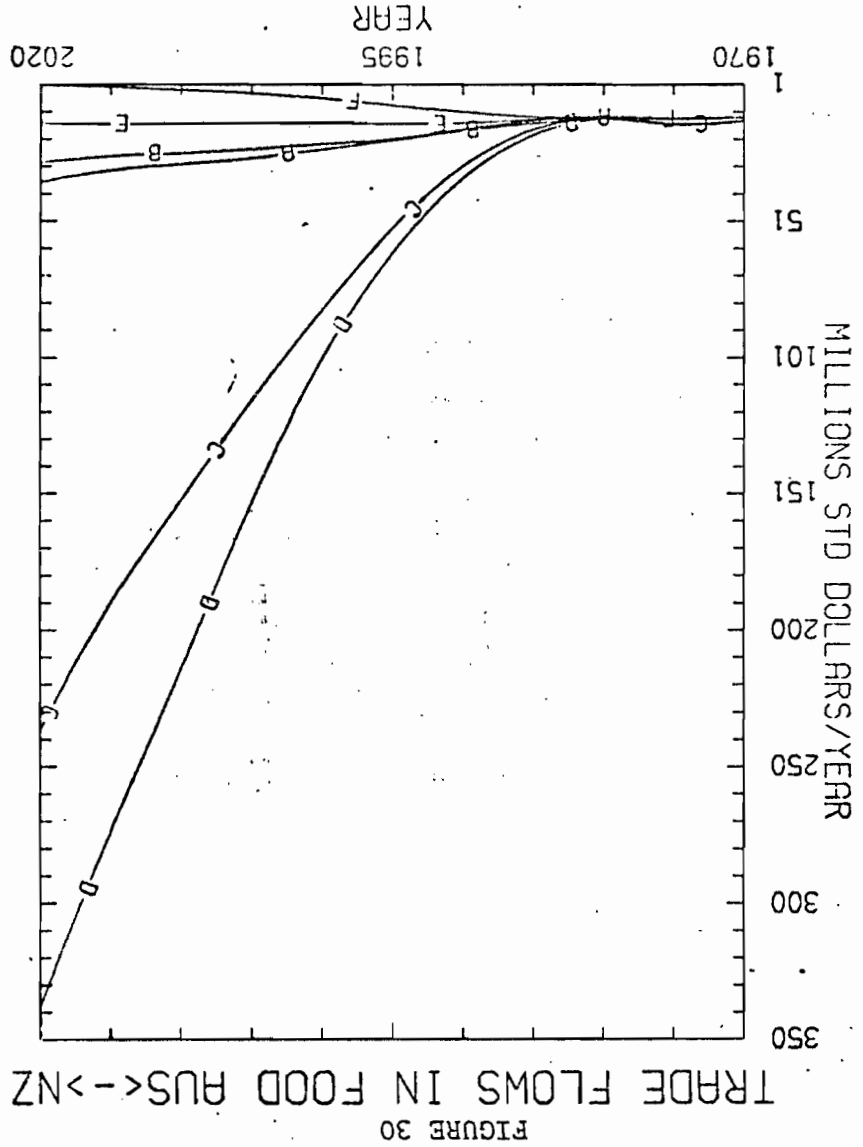
A B Reference  
C D Free Trade  
E F New Zealand Isolation

FIGURE 28

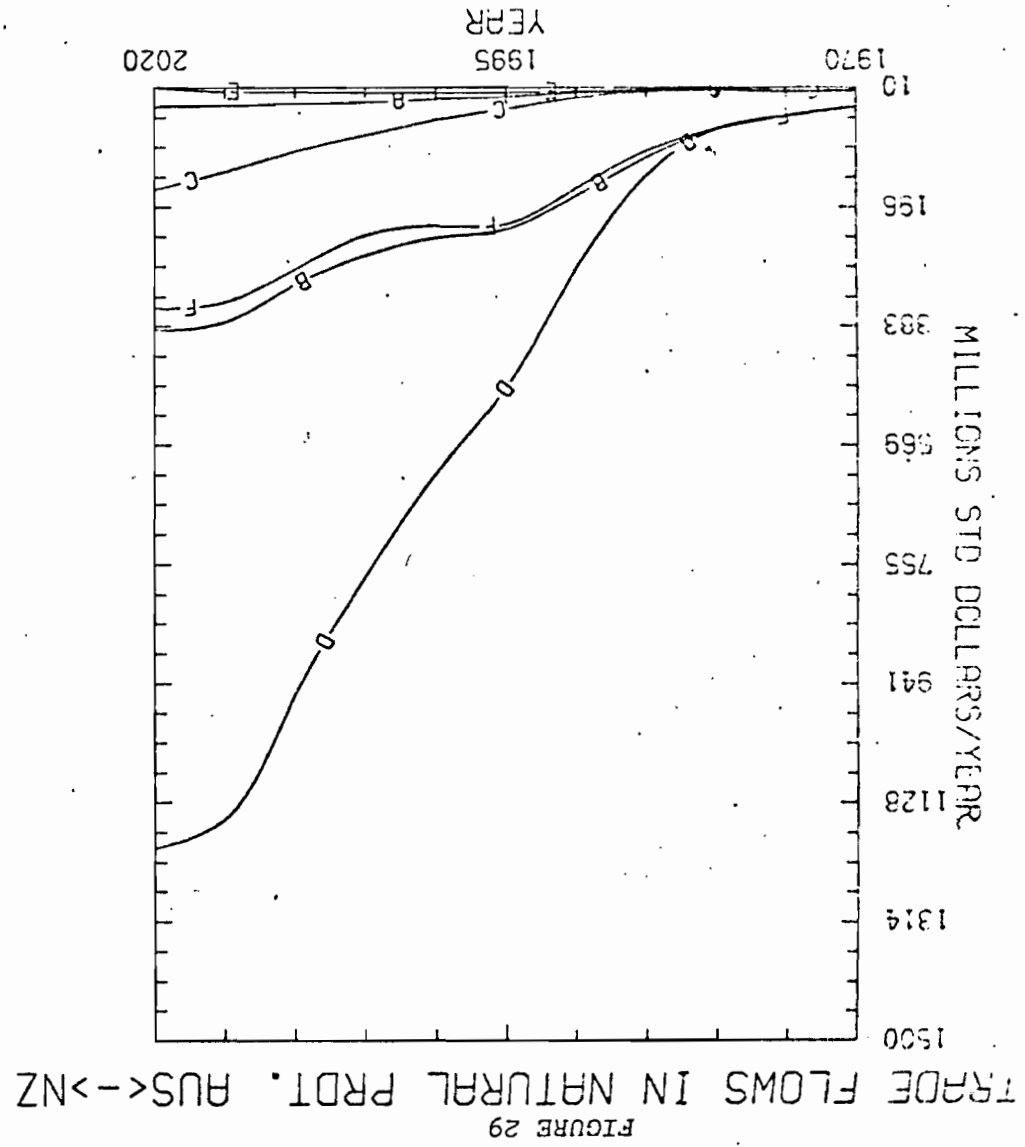
TRADE FLOWS IN MANUFACTURES AUS<->NZ



A B Reference  
C D Free Trade  
E F New Zealand Isolation



Legend as for Figures 27 and 28



New Zealand chooses to cut off most of its markets, particularly the major export earners of food and natural products, there is a drive towards self-sufficiency in machinery and manufactured goods. In fact, food trade falls to a level of self-sufficiency. The drive to build up manufacturing industries produces a 60 per cent increase in the labour force of that industrial sector by the year 2020. This compares with a 16 per cent increase generated by the free trade case. The decline in people employed in agriculture generated by the isolation case is more than offset by gains in the manufacturing and machinery sectors.

In order to get a detailed picture of trade flows across the Tasman, a number of figures are provided for key commodities. In the sectors for machinery (Figure 27) and manufactured goods (Figure 28) there are appreciable gains for both countries resulting from the free trade policy with greater benefits accruing to New Zealand. Industry sectors ailing in the reference scenario and employment are given a boost and employment is improved in both countries with the introduction of free trade. A similar picture emerges for the flow of natural products (Figure 29) and food (Figure 30). While, as before, New Zealand fares relatively better when the markets are opened both countries hold their domestic demands against the competition.

In summary, it would appear that the two economies are complementary in their ability to supply commodities to each other and still retain their other international trade relations. This is borne out by the free trade scenario. However, if New Zealanders felt that isolation and self-sufficiency is what they desire, they may have to face some reduction in their standard of living in comparison to that which they may have experienced under free trade or status-quo policies.

## 5. CONCLUSIONS

We have seen that global modelling may be used, in time, to evaluate broad economic policies of nation states and the interaction between such states in the context of global scenarios reflecting possible developments within and among major trading regions or blocks. The examination of different trading strategies between Australia and New Zealand has shown that, under certain conditions and assumptions, movement toward free trade between these Tasman neighbours could be mutually beneficial and if New Zealand moves to isolate itself, in a trading sense from the rest of the world, while continuing to trade with Australia as in the past, it may be at the expense of a reduced standard of living. At the global scale the rapidly expanding field of regional economic modelling is still in its infancy and trying to outgrow the label of being an unruly branch of political economics. The work described in this paper is purely exploratory. The process of assessing the basis and results of this work and comparing the different modelling approaches required, through fora such as this one, are viewed as essential elements in developing the basis for extending beyond the current exploratory phase.

#### ACKNOWLEDGEMENTS

We would like to acknowledge the invaluable computing contributions to this project made by Dr Kim Parker of the Systems Analysis Research Unit. Thanks are also due to Mr Doug Brown for producing the computergraphics.

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