AUSTRALIAN RESOURCES AND ENVIRONMENTAL ASSESSMENT (AREA) MODEL

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

ASSESSING THE IMPACT OF
PACIFIC ECONOMIC COMMUNITIES
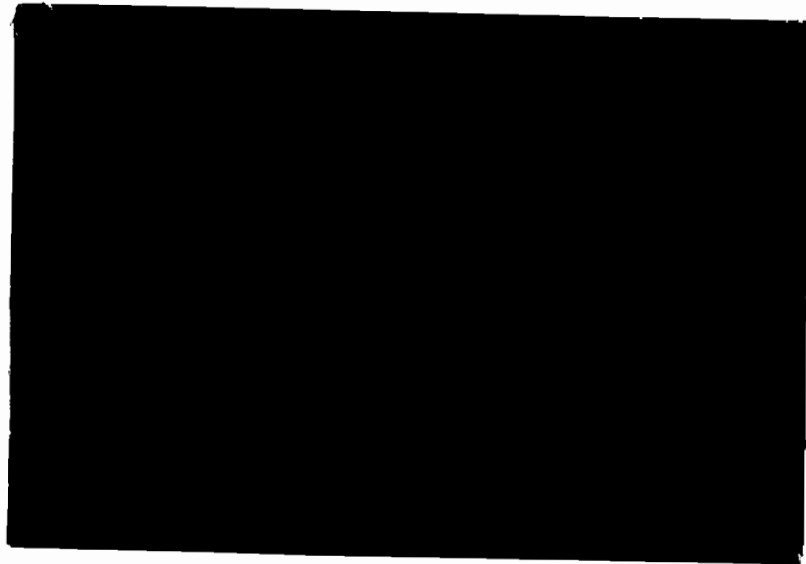ON AUSTRALIA AND NEW ZEALAND
USING AREAM

by

J.M. Mula

D. MacRae

K.T. Parker

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.

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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

This paper provides the underlying scenarios
or experiments that were used to consider various
environmental stresses produced from solid wastes. These
experiments are based on the formation of various Pacific
Economic Communities (PECs) by countries around the rim
of the Pacific Basin. Of the seven unions that have been
evaluated to-date, four are discussed in this paper.
These comprise various combinations of Australia, New
Zealand, Japan, East and South East Asia, China and North
America. From the simulations conducted, it appears that
the community which contains Australia, New Zealand, Japan
and East and South East Asia benefits all these regions the
most. After discussing the effects on all regions at the
macro level, the paper focuses on the domestic and trade
effects of PECs on Australia and New Zealand.

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ON AUSTRALIA AND NEW ZEALAND USING AREAM

J.M. Mula

D. MacRae

K.T. Parker*

Department of Science and the Environment

Canberra

Australia

1.   INTRODUCTION

The Australian Resources and Environmental Assessment Model (AREAM) has used SARUM as a basis for quantifying stress on the environment at the national level resulting from the impact of trade and demographic change throughout the world. In this paper we consider some of the trade scenarios underlying the case studies that dealt with the types of stresses on the Australian environment considered in the foregoing paper. These scenarios deal with various types of economic communities on the run of the Pacific, each containing Australia and New Zealand as separate countries.

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* On secondment from the Department of the Environment, London, U.K.. 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.

2. A REFERENCE SCENARIO

A reference scenario is required to assess the effects of policy changes as evaluated by a model such as AREAM. It suits our present purposes to use as a reference the scenario of low economic growth world-wide proposed by the large scale global research study, termed the INTERFUTURES Project (OECD 1979), and recently completed. Evaluation of this scenario was effected by the Interfutures Project using SARUM. This evaluation provides the context for the following analysis of Australia and New Zealand development, relative to alternative economic communities within the Pacific Basin.

Major assumptions underlying this scenario of low economic growth 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 convergance 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. Under the same conditions the model indicates that Japan and East and South East Asia would register the higher rates of growth of 6.6 per cent and 6.4 per cent respectively.

The reference scenario used here resembles the INTERFUTURES scenario for low economic growth in all aspects except the following:

- trading patterns are set, using a mechanism to reflect the extent of bias in trade between countries, according to the historical experiences of the early 1970's, such as the OPEC cartel action of 1973

- conditions set to liberalise trade between North and South are removed

- conditions set to create a flow of official aid from developed to developing countries are removed.

3. A MECHANISM FOR EFFECTING TRADE LIBERALISATION

The methodology used for modelling trade between various sectors of the world regions is described elsewhere (Parker 1977). The mechanism which describes how free market conditions or trade liberalisation is induced is based on the use of trade biases. A matrix of trade biases is applied to each commodity traded in order to modify the prices perceived by the importer depending on the source of the commodity. This bias explicitly accounts for factors such as distance and politics, which inhibit the functioning of a free trade market. By adjusting the elements of the

trade bias matrix of each of the commodities considered
here we are able 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.

The trade policies considered in this paper
relate to reduction in the tariff barriers between various
regions and/or countries in the Pacific Basin. The word
liberalisation is used because a perfect *free trade*
agreement would mean that trade biases would be eliminated.
This would imply that imported commodities can compete
perfectly with home produced goods. Since the biases
subsume the barrier of distance, this would mean that
the transportation costs are non-existent or negligible,
which is not the real world situation. For this reason
alone the biases only fall to the lowest values observed
in Australia and New Zealand in 1970. These ranged from
2 to 4 depending on the particular commodity where a value
of unity represents perfect free trading conditions.

In keeping with past change, this liberalisation
of trade was introduced gradually. From 1980 trade biases
were reduced at the rate of 10 per cent per annum to approach
the lowest value of the particular commodity observed in
practice. This reflects rate of change in tariff barriers
throughout the European Economic Community. Thus, trade biases
would have dropped to about 11 per cent of their original
value by the year 2000.

To gain insight into how different regions would
react to liberalisation of trade, various simulations introducing
each region or country separately into a trading union

were completed. This allowed measurement of the differences
in a region or country's economic performance in the comparison
as to whether the country is included or excluded from a
particular trading union.

4. PACIFIC ECONOMIC COMMUNITIES (PECs)

To date experiments have been conducted which have
evaluated the reference scenario (and other INTERFUTURES
scenarios) in relation to a series of economic communities in
the Pacific Economic Communities (PECs) as follows:

    PEC-0   Australia and New Zealand (ANZ)
    PEC-1A   ANZ + Japan
    PEC-1B   ANZ + East and South East Asia (ESEA)
    PEC-1C   ANZ + Japan + ESEA
    PEC-2   ANZ + Japan + ESEA + China
    PEC-3   ANZ + Japan + ESEA + China + NORAM
    PEC-4   ANZ + North America (NORAM)

The question of whether the economic potential of an overall
group of countries or regions and each region in isolation
would increase through the development of economic communities
PEC-0 to 4 is considered in this paper. Briefly, from
among these seven configurations, the grouping of regions
which maximised the lot of Australia and New Zealand by the
end of the simulation period occurred for PEC-1C (ANZ + Japan
+ ESEA). Of the six configurations PEC-1 to 4 listed above
the same grouping, PEC-1C, also maximises the GDP per capita
of ESEA. A detailed account of PEC-0 is provided elsewhere
(Mula and MacRae 1979). In this paper the reference scenario
is evaluated subject to regional economic communities PEC-1C,
PEC-2, PEC-3 and PEC-4.

As a word of caution, the authors view the results presented here and in earlier papers as purely illustrative. Before explicit implication could be drawn from work of this nature, more detailed refinement would be necessary of the structure and assumptions underlying the model, particularly in relation to the regional economic sub-systems.

5.   BROAD COMPARISONS OF PECs

The key issue that comes out of any of the PECs is that any union between developed and developing regions benefits both. However if there are closer unions between developed regions, particularly in a developed/developing grouping, the larger developed economies tend to take some of the cream from the top of the smaller economies' cake. Still, in such a case all the developed regions attain greater standards of living than if they stayed out of a union with developing regions.

Using the measure of GDP per capita, expressed in standard 1970 US dollars, as a surrogate for standard of living we see from Figure 1 that in the fifty year period to 2020, model evaluation of the reference scenario generates changes with respect to the ranking of the twelve world regions considered here. Each region reaches its highest and lowest GDP per capita by 2020 with respect to different community formations. North America would fare best in PEC-4 and worst in PEC-3. Japan would attain the highest GDP per capita with a figure of about $10000 for PEC-3, with PEC-1C yielding the lowest level it would achieve. Australia peaks

FIGURE 1
GROSS CONSUMPTION/CAPITA/YEAR, BY REGION
STD DOLLARS/HEAD/YEAR
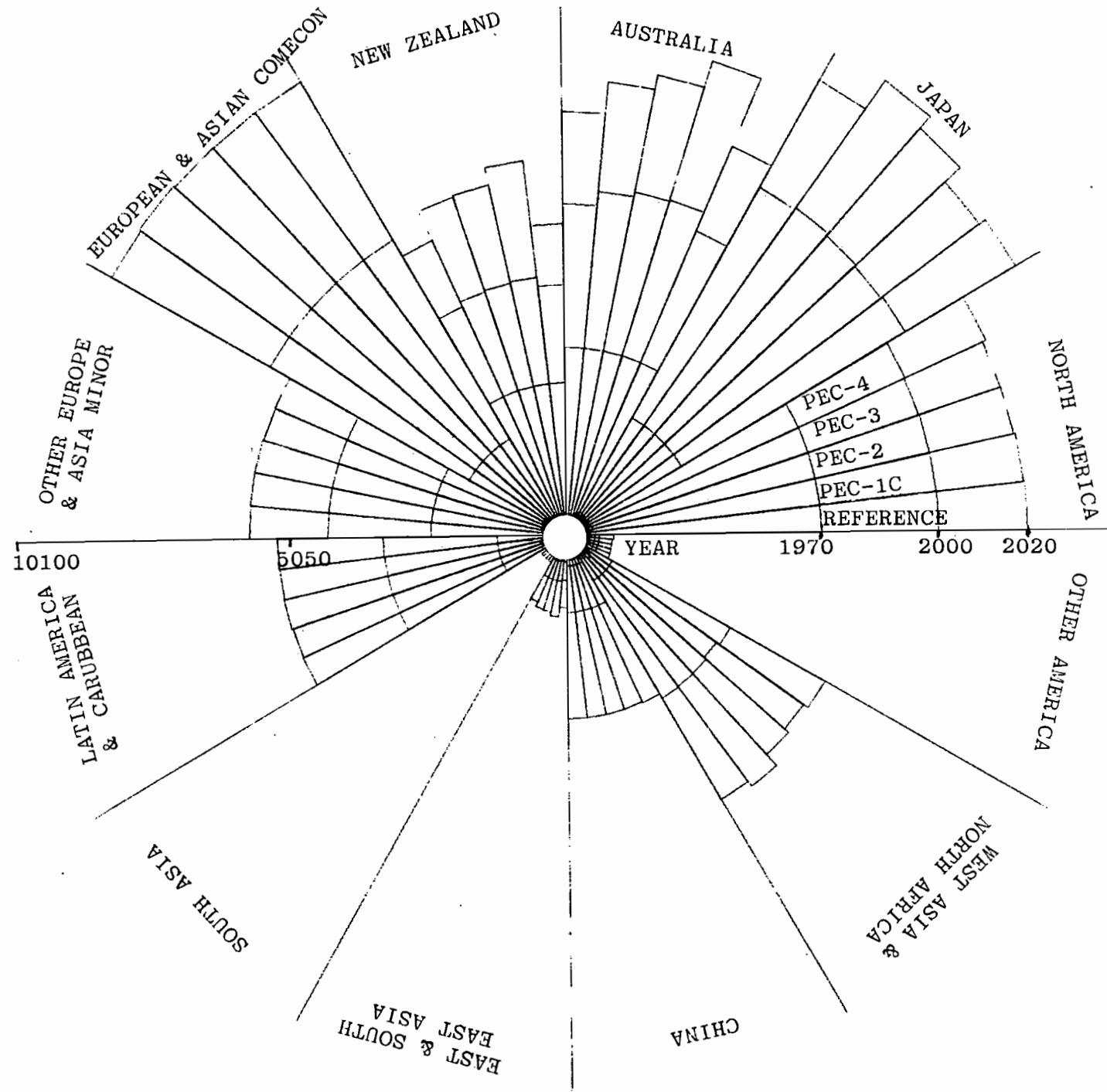
at \$9020 for PEC-2 and troughs at \$7680 for PEC-4 which is
the same level as the Reference scenario. New Zealand, on the
other hand, would increase its GDP per head in all community
combinations, faring best in PEC-1C with a figure of \$6850.
East and South East Asia improves every time a region is
added to the community reaching its highest level of \$1500 in
PEC-3. These results lead us to anticipate the result that
its lowest figure occurs in relation to the case when it is
omitted from the community. China exhibits little variation
in its GDP per capita. The values for the Reference
scenario and the four communities range from \$3342 to \$3364.
The lowest value occurs when all regions are grouped (PEC-3)
and the highest value results for the case in which there is
no formal grouping with other Asian countries (PEC-4). Other
regions not in one of these communities stay relatively
stable except for West Asia and North Africa (WANA) which
suffers a drop in the case of PEC-3 when North America is
able to obtain energy supplies from China, ESEA and Australia
at increasingly attractive rates. Any community formation
between developed countries and developing countries of
Asia produces a deterioration in the *standard of living* of
the poorest countries of the non-community regions of South
Asia and Africa other than WANA.

In terms of gross production as shown in Figure 2,
GNP per capita for Australia and New Zealand is dwarfed by
that of the larger population regions of China, Latin America
and the Soviet Block (EURCOM). The production of each of
North America and West Europe takes until 2020 to reach the

FIGURE 2
GROSS PRODUCTION/YEAR, BY REGION
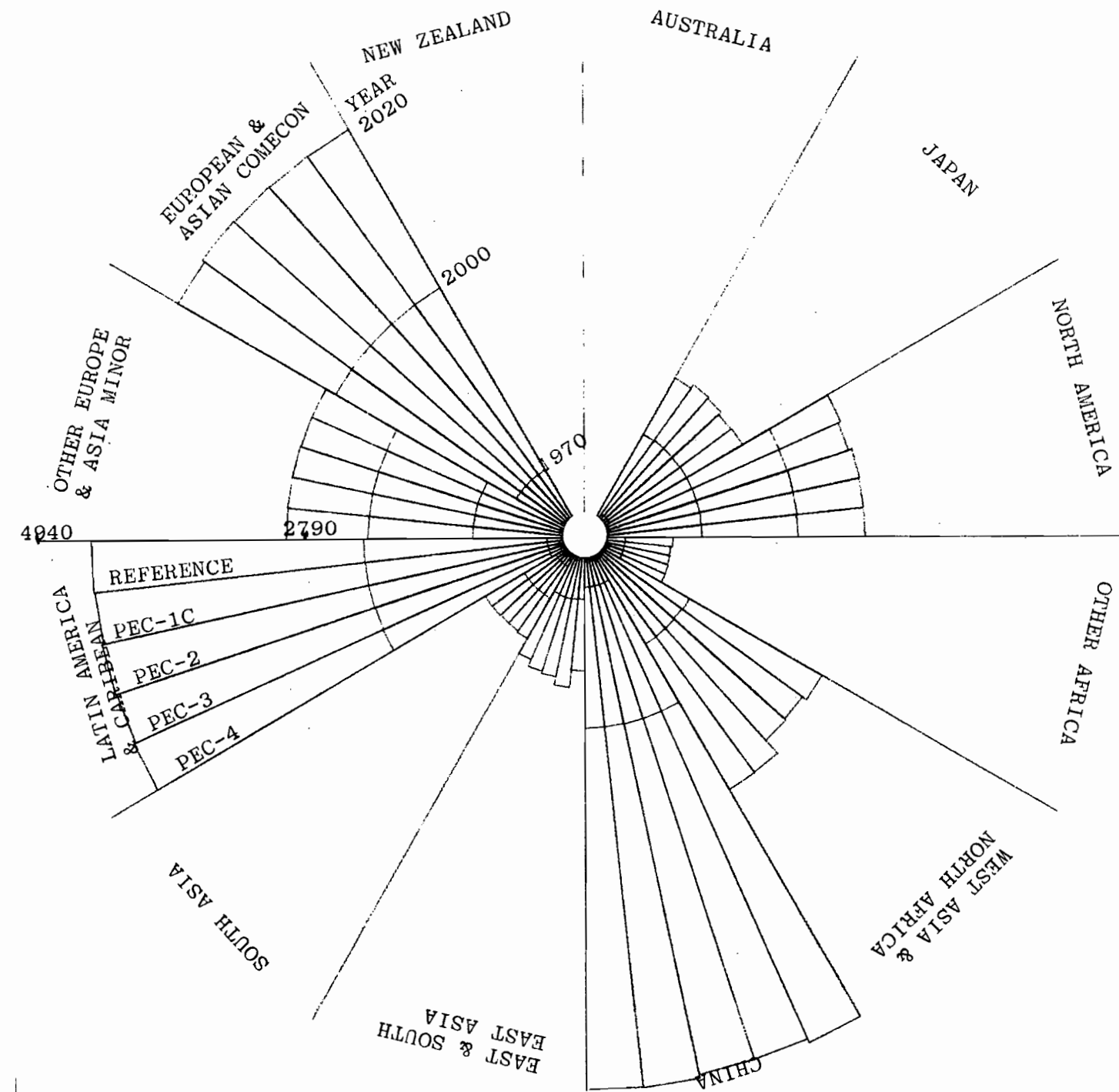BILLIONS STD DOLLARS/YEAR

FIGURE 3
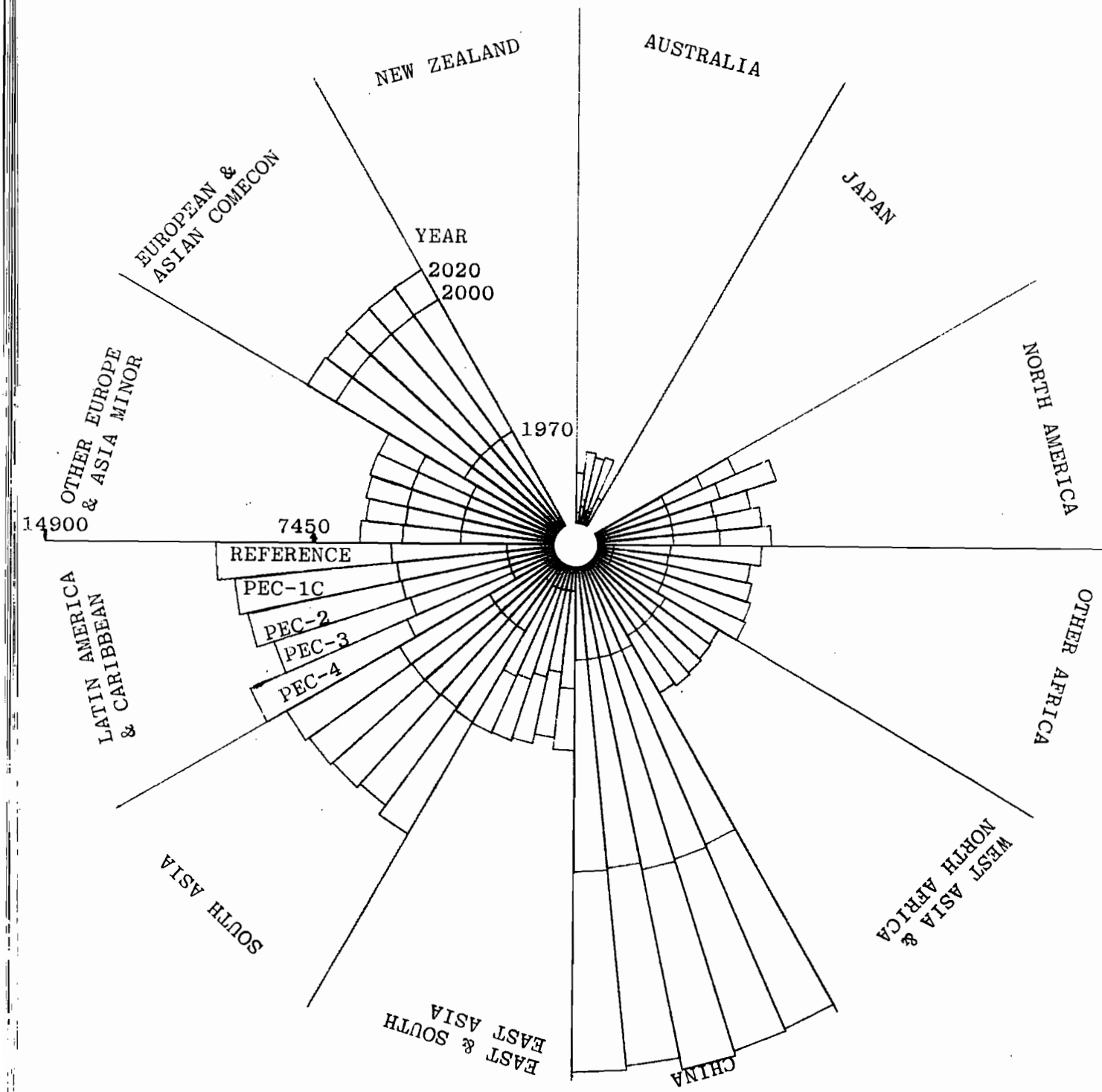SALES OF FOOD/YEAR, BY REGION
PETAJOULES/YEAR

NEW ZEALAND

AUSTRALIA

EUROPEAN & ASIAN COMECON

JAPAN

YEAR
2020
2000

OTHER EUROPE & ASIA MINOR

1970

NORTH AMERICA

14900   7450

REFERENCE
PEC-1C
PEC-2
PEC-3
PEC-4

OTHER AFRICA

LATIN AMERICA & CARIBBEAN

WEST ASIA & NORTH AFRICA

SOUTH ASIA

EAST & SOUTH EAST ASIA

CHINA

FIGURE 4
SHARE OF EXPORT OF FOOD BY NORAM.STD RUN

FIGURE 5
SHARE OF EXPORTS OF FOOD BY NORAM, PEC3
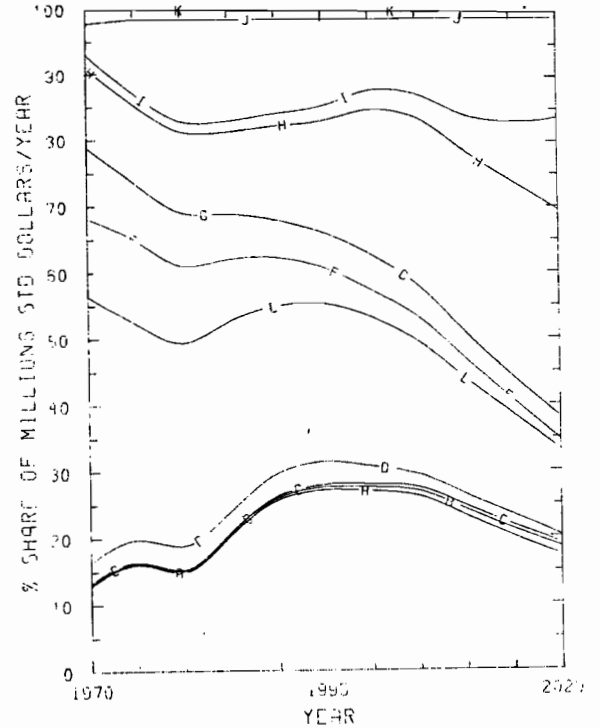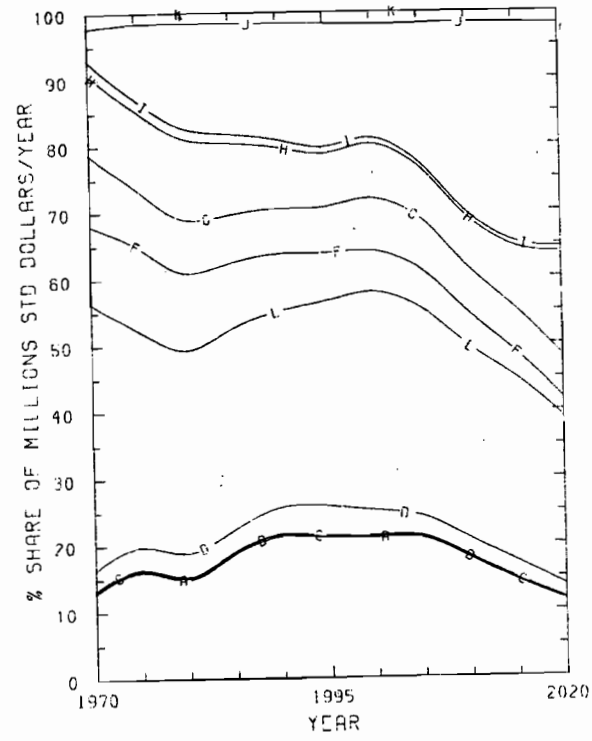
AREA UNDER CURVE IS SHARE OF NORAM TOTAL FOOD EXPORTS
GOING TO REGION

A — JAPAN
B — AUSTRALIA
C — NEW ZEALAND
D — EUROPEAN AND ASIAN COMECON
E — OTHER EUROPE AND ASIA MINOR
F — LATIN AMERICA AND THE CARIBBEAN
G — SOUTH ASIA
H — EAST AND SOUTH EAST ASIA
I — CHINA
J — WEST ASIA AND NORTH AFRICA
K — OTHER AFRICA

EURCOM level for the year 2000 (given the somewhat high growth rate for EURCOM set in the so-called low-growth Reference scenario). Some appreciable positive variations can be seen in the production of ESEA, particularly as a result of PEC-3. The WANA level for the Reference scenario is higher than for any of PEC-2, 3, and 4.

Turning now to food production, Figure 3 shows the sales of food per year by region measured in petajoules of cereal equivalent. Although this measure equates both cereal and animals as being interchangable, it gives a good macro measure of the food producing capabilities of a region given the physical constraints of that region. As can be seen from the polar graph, North America's access to the Asian market particularly ESEA, has a dramatic effect on their production. This effect is shown in Figures 4 and 5 when the ESEA share of exports jumps 17 per cent (from 15 to 32) by the year 2020 in the case of PEC-3 with respect to the Reference scenario. Appreciable increases are also realised by China. In both of these cases these increases are gained at the expense of reductions occurring mainly in Western Europe and WANA. Other than Australia (to be discussed later), the other region appreciably effected is Latin America and the Caribbean (LACARB). This region experiences reductions in food production in relation to each of the Pacific Economic Communities particularly when North America participates.

Disparities in food consumption per capita are shown in Figure 6. Australia and New Zealand reach the *glut*

FIGURE 6
FOOD CONSUMPTION/CAPITA/YEAR, BY REGION
GIGAJOULES/PERSON/YEAR
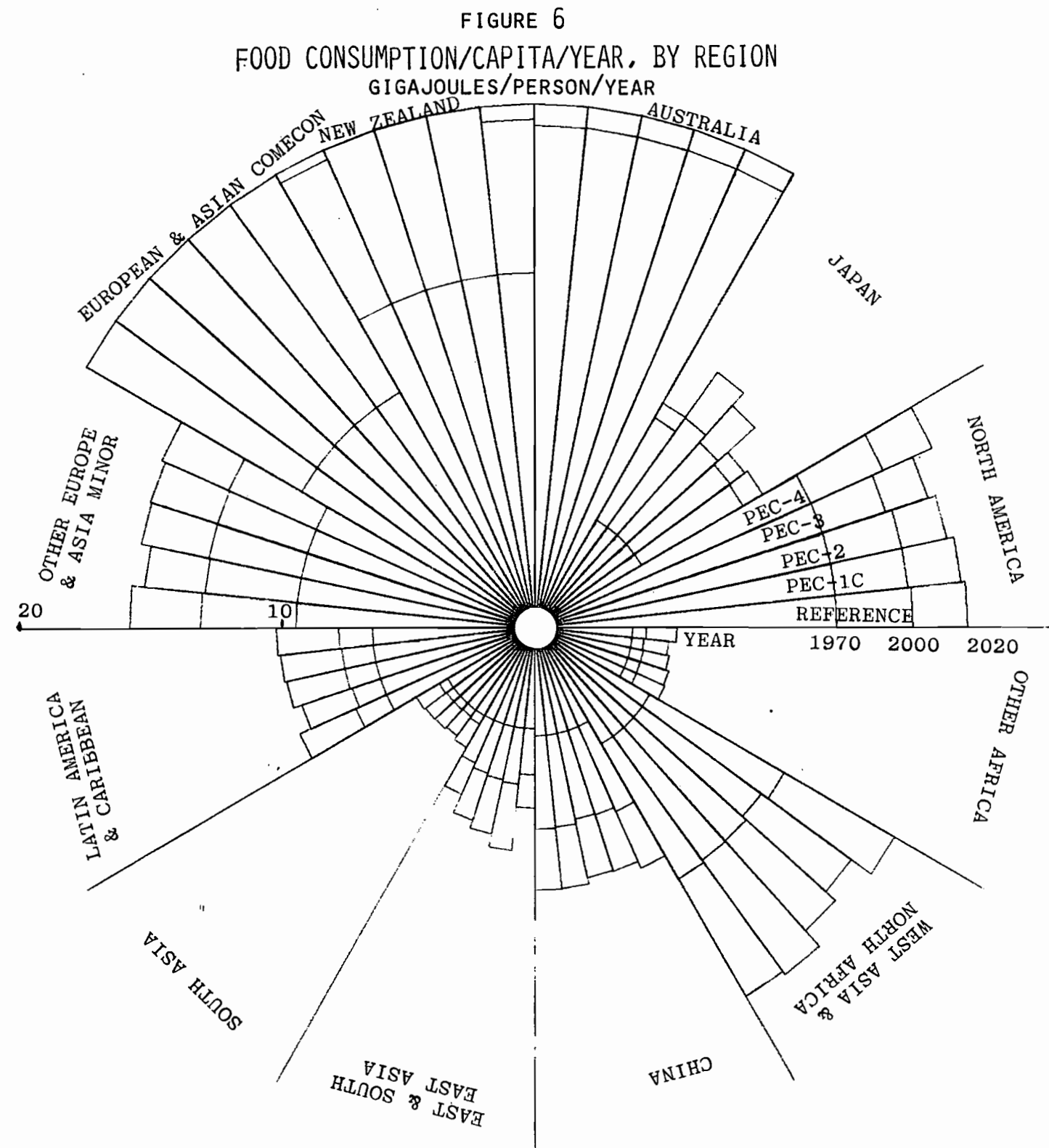
limit early in the simulation period. This limit is an
expression of the amount a person can physically consume.
Although the expenditure on food continues to increase for the
rich countries, we assume they are buying more expensive food
and also paying more for services such as retailing, preparation
and catering. The _glut_ limit is set to 20 gigajoules
per person per year and is the cereal equivalent of Australian
food consumption in the early 1970's. While increasing
wealth in ESEA leads to more than a doubling of its food
intake in PEC-1C by 2020, this is only a third of the
consumption per capita in Australia while Japan increases
by more than double to reach 11.5 gigajoules per person by the
same year. Although the largest food producer, China
achieves a consumption level similar to that of Japan and
LACARB, the size of the population to be fed is much greater.

6. EFFECT OF PECs ON DOMESTIC MARKETS IN AUSTRALIA AND NEW ZEALAND

An assessment of how the various Pacific Economic
Communities considered here effect Australia and New Zealand
is shown in Figures 7 and 8 in terms of GDP per capita for
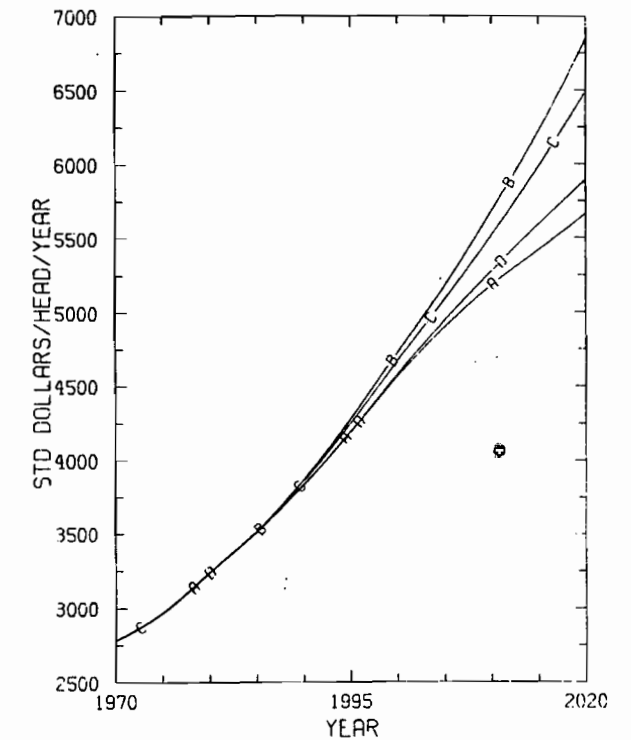the following cases:

A - Reference scenario

B - PEC-1C : AUS + NZ + JAPAN + ESEA

C - PEC-3 : PEC-1C + China + North America

D - PEC-4 : AUS + NZ + North America.

The output from these cases are labelled as above in the rest
of this paper unless otherwise stated. For both Australia and

FIGURE 7
GROSS CONSUMPTION/CAPITA - AUSTRALIA
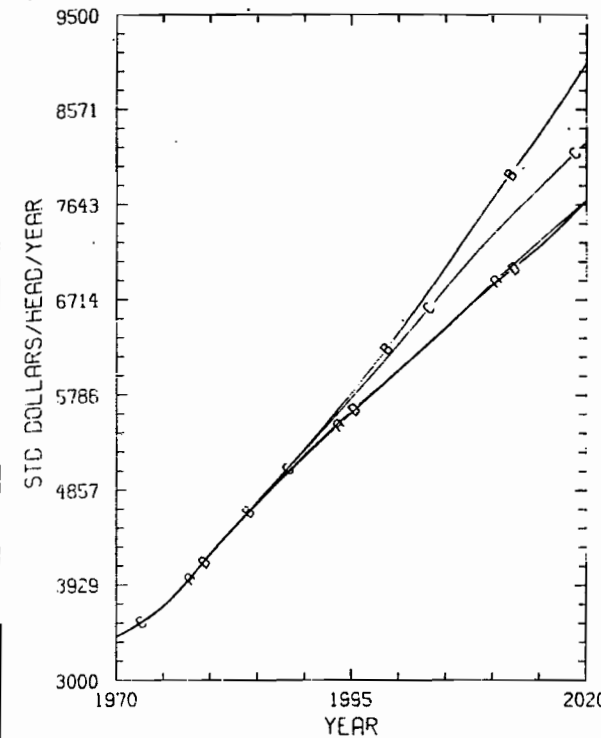
FIGURE 8
GROSS CONSUMPTION/CAPITA - NEW ZEALAND

A - REFERENCE SCENARIO
B - PEC-1C - ANZ + JAPAN + EAST & SOUTH EAST ASIA (ESEA)
C - PEC-3   - ANZ + JAPAN + ESEA + CHINA + NORTH AMERICA (NORAM)
C - PEC-4   - ANZ + NORAM

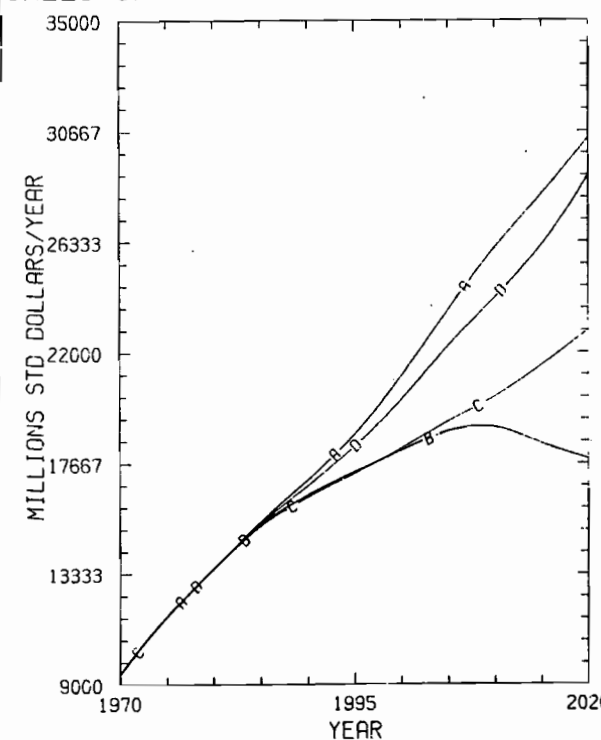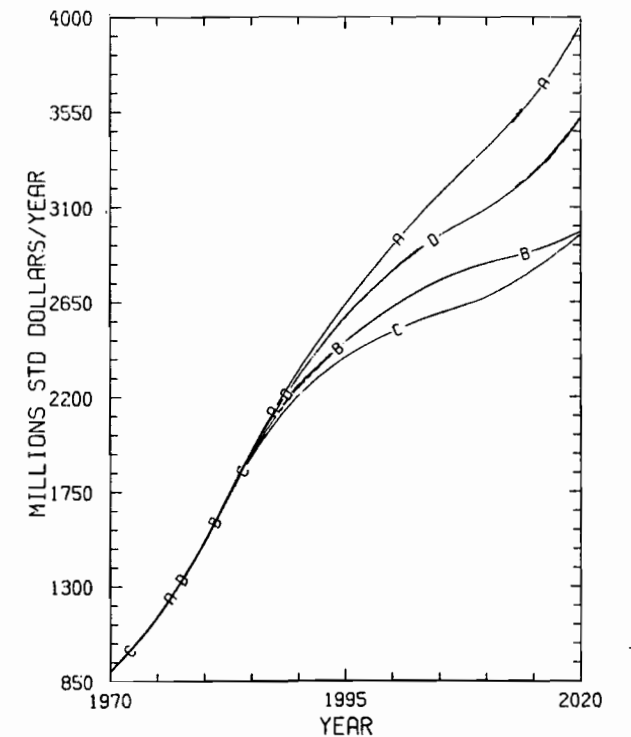FIGURE 9
SALES OF MANUFACTURES/YEAR - AUSTRALIA

FIGURE 10
SALES OF MANUFACTURES/YEAR - NEW ZEALAND

New Zealand the PEC-1C community produces the highest
standard of living expressed in GDP per capita terms. All
three groupings produce GDP per capita levels exceeding those
of the Reference scenario.

In an attempt to determine which areas of both
economies produce this increased standard of living, we will
examine the productive output of individual sectors. The
manufacturing sector in both Australia and New Zealand as
shown by Figures 9 and 10 show a down-turn in sales. The
major effect on the Australian manufacturing industry is
brought about by the PEC-1C run where the cheaper labour of
ESEA makes this area of the economy much less competitive.
Even in the PEC-4 case, where the Australian goods at home
and abroad only have competition from the manufactured
goods of New Zealand and North America, there is a lower rate
of production of manufactured goods in Australia relative to the
Reference scenario. This same pattern of development occurs
in New Zealand but to a lesser extent than in Australia
for the PEC-1C community. The labour force requirements
(measured in man-years per year) of the manufacturing sector
in Australia falls to half the number of the Reference run
by 2020 as a result of the PEC-1C grouping but the total
labour force for all sectors shows a marginal increase for
the same comparison.

Some of the additional labour force is taken up
by the energy and minerals sectors in Australia but most
jobs are created in the service sector. With the increase
in energy production in the PEC-1C run, as shown in Figure 11,
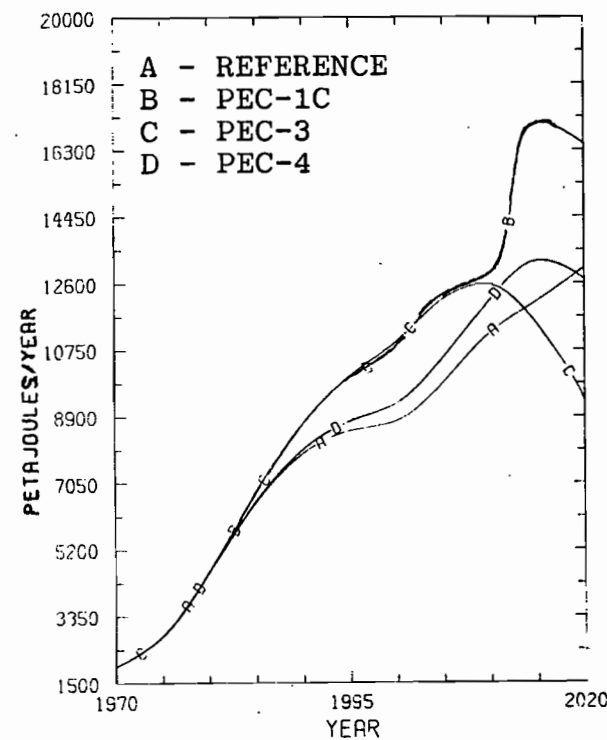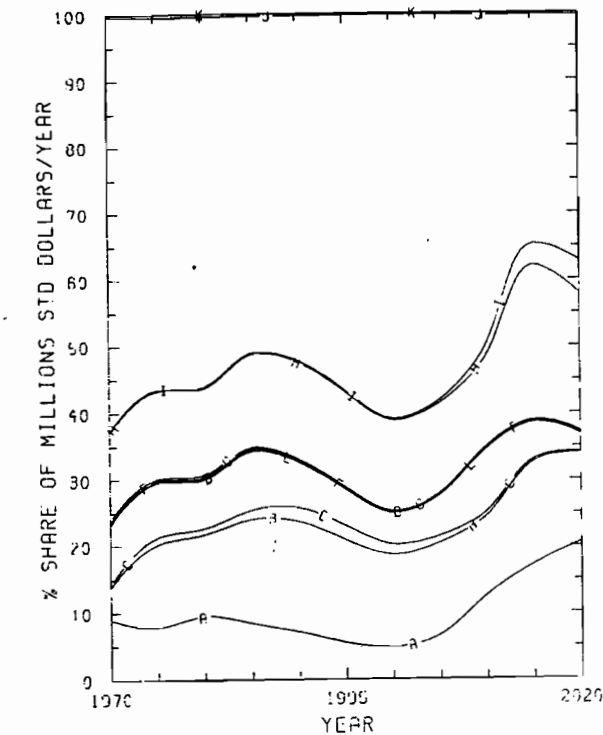
FIGURE 11
SALES OF ENERGY/YEAR - AUSTRALIA

A - REFERENCE
B - PEC-1C
C - PEC-3
D - PEC-4

FIGURE 12
SHARE OF IMPORT OF ENERGY BY JAPAN.PEC1C

THE FOLLOWING LEGEND RELATES TO FIGURES 12 AND 13

A - NORTH AMERICA
B - AUSTRALIA
C - NEW ZEALAND
D - EUROPEAN AND
ASIAN COMECON
E - OTHER EUROPE AND
ASIA MINOR

F - LATIN AMERICA & THE CARIBBEAN
G - SOUTH ASIA
H - EAST & SOUTH EAST ASIA
I - CHINA
J - WEST ASIA & NORTH AFRICA
K - OTHER AFRICA
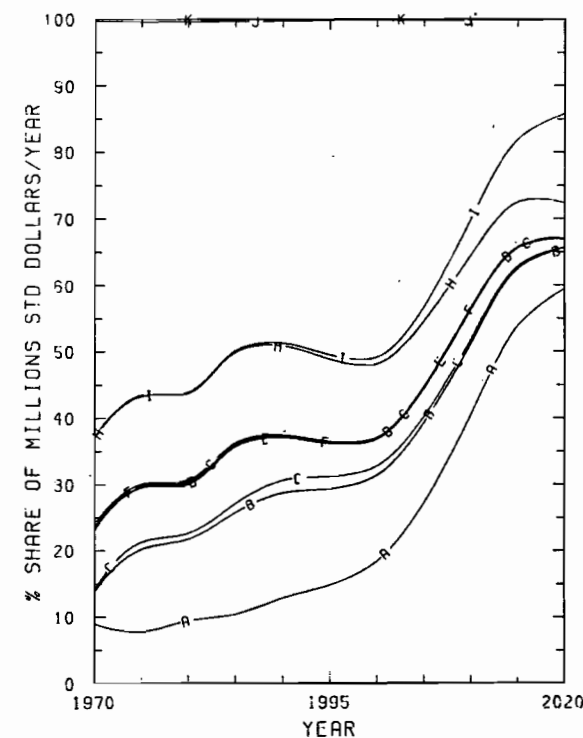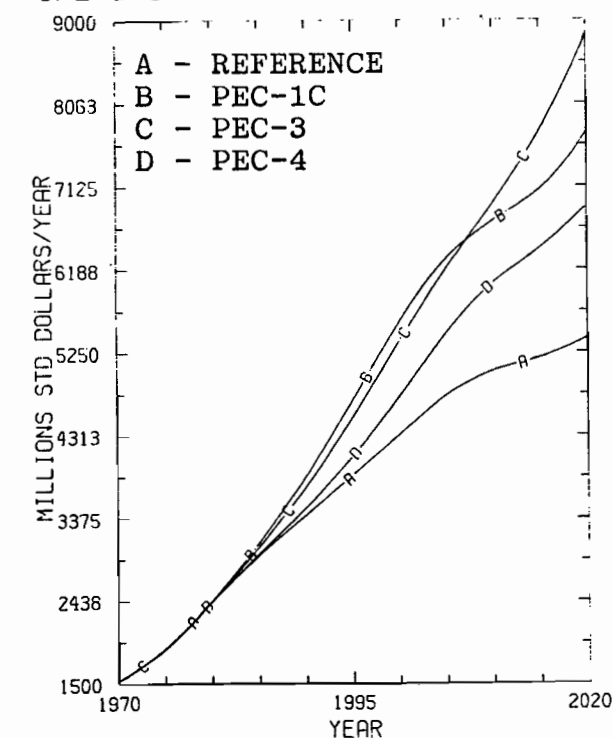

FIGURE 13
SHARE OF IMPORTS OF ENERGY BY JAPAN.PEC3

FIGURE 14
SALES OF MINERALS/YEAR - AUSTRALIA

A - REFERENCE
B - PEC-1C
C - PEC-3
D - PEC-4

jobs are created as a result of the greater exports, particularly to Japan. However, as can be seen from the PEC-3 run this market is not reliable. This arises because the Japanese show a preference for the NORAM market as North America enters the community. A clearer picture of this shift can be seen from a comparison of Figures 12 and 13. The North American share of the Japanese energy market moves from 20 per cent to nearly 60 per cent by 2020, whereas the Australian share falls from 19 per cent to 6 per cent over the same period. In the Reference case, the share by Australia and North America of the Japanese market by the end of the simulation period (2020) is 18 per cent and 25 per cent respectively. In the beginning of the 21st century Australian energy price per unit begins to increase as a result of higher costs of extraction after the easily won coal begins to run out. This produces a situation in the PEC-1C run where the Australian price starts to exceed that prevailing in North America. Thus, although North America is not in the PEC-1C community, the price difference is enough to cause a down-turn in Australian energy production. Mineral production in Australia shows gains for all community arrangements when compared with the Reference scenario as shown in Figure 14. The largest gain arises from the PEC-3 grouping. The grouping of Japan and North America generates larger export markets for Australia, with Japan taking some 65 per cent over the whole period. In the PEC-4 run, the effects of the exclusion of Japan from the community are noticeable.
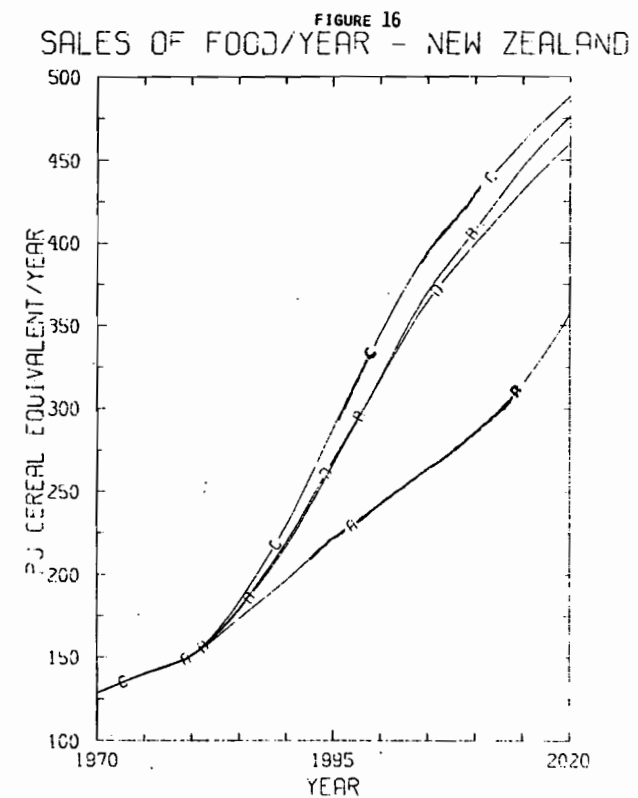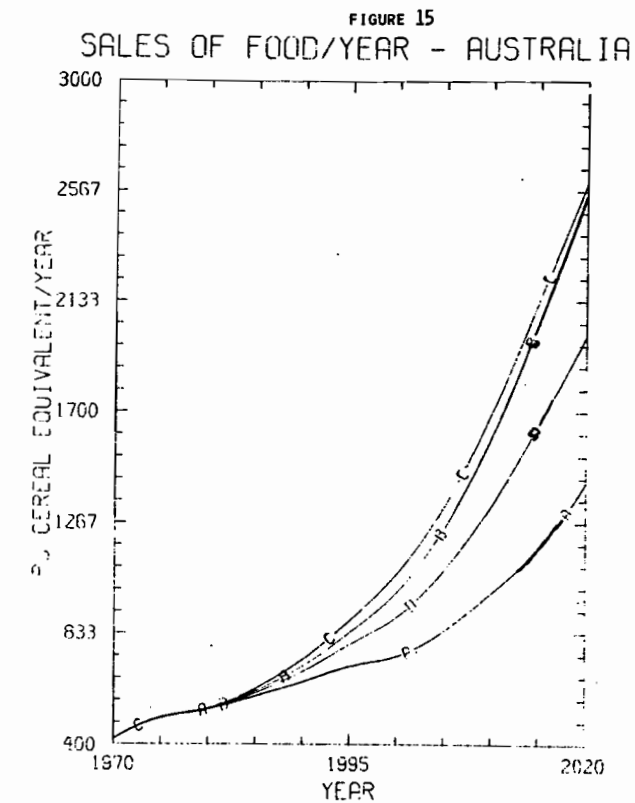
FIGURE 15
SALES OF FOOD/YEAR - AUSTRALIA
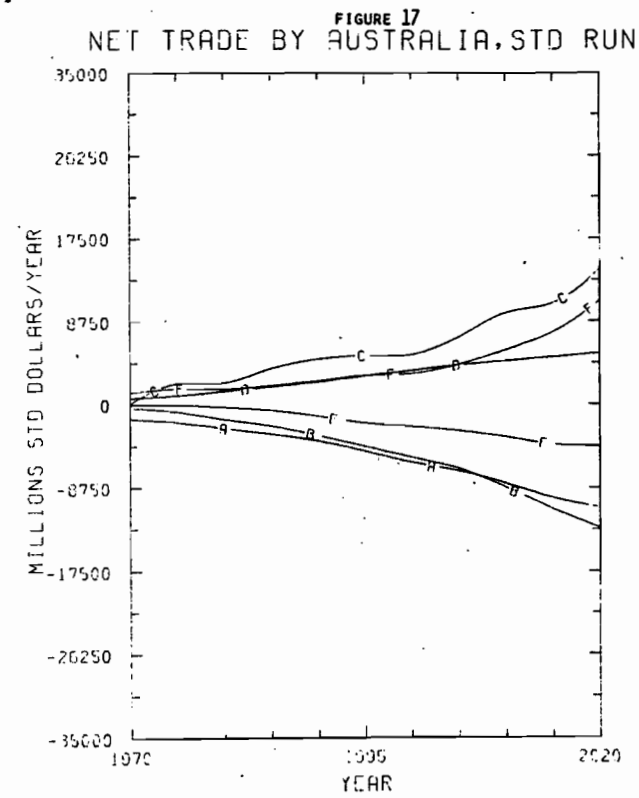
FIGURE 16
SALES OF FOOD/YEAR - NEW ZEALAND

A - REFERENCE SCENARIO
B - PEC-1C - ANZ + JAPAN + EAST & SOUTH EAST ASIA (ESEA)
C - PEC-3 - ANZ + JAPAN + ESEA + CHINA + NORTH AMERICA (NORAM)
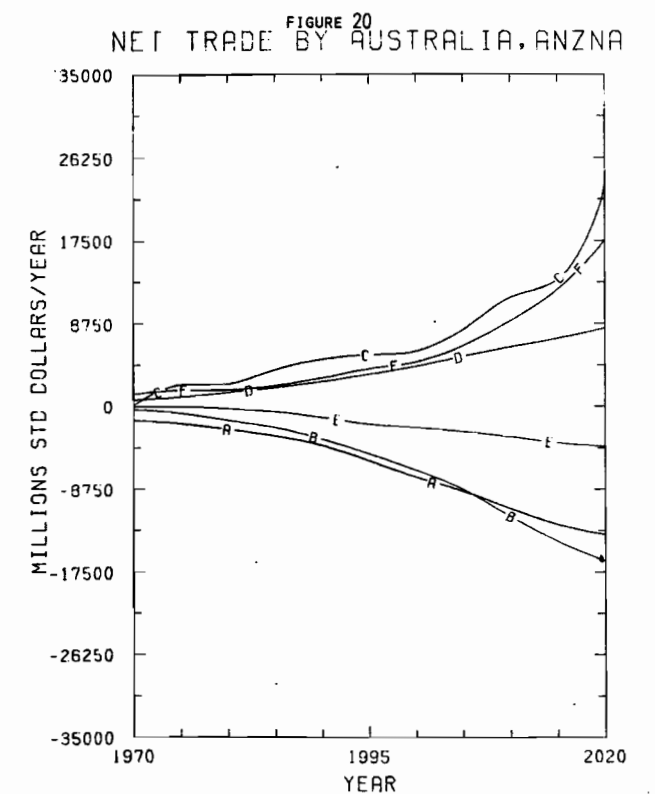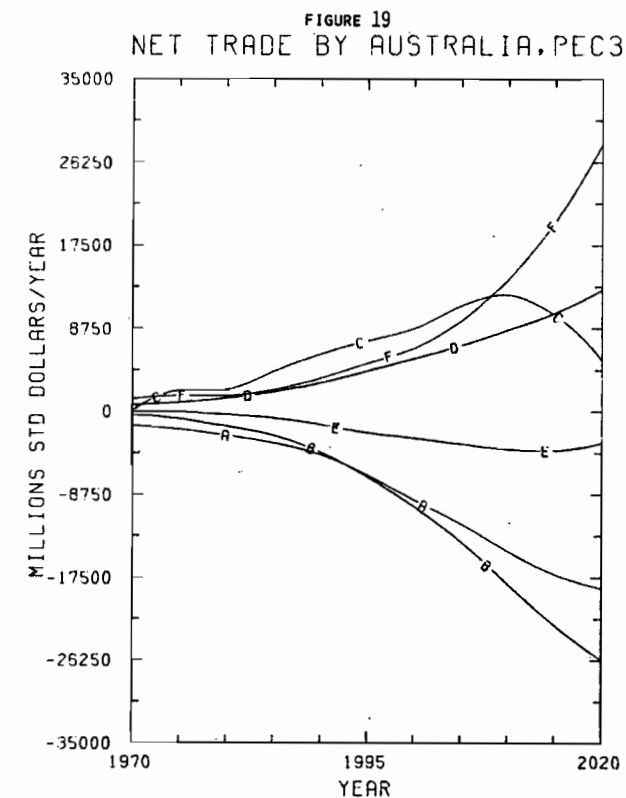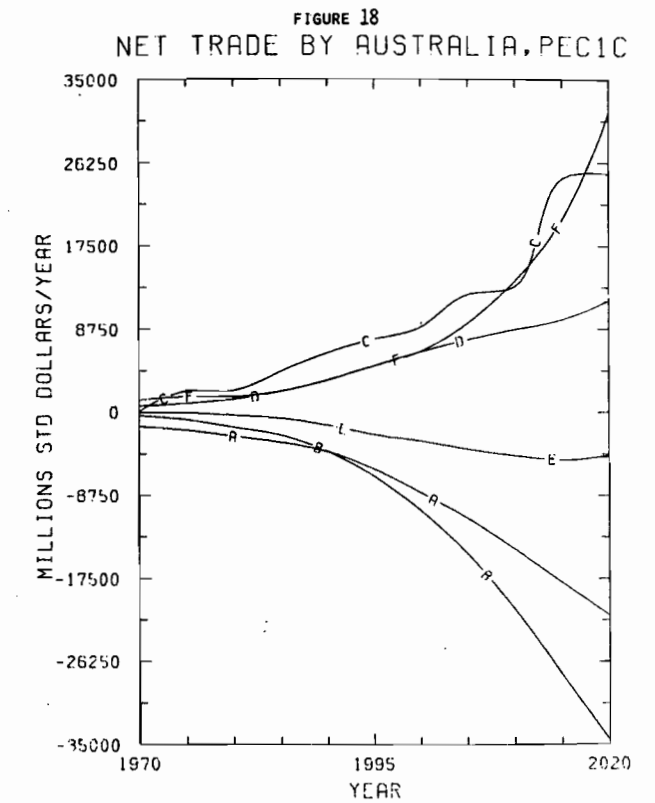D - PEC-4 - ANZ + NORAM

Food production plays a major role in the economies of Australia and New Zealand. For both countries the PEC-3 run opens up markets in the developed and developing countries resulting in the highest production levels over all cases. As the petajoule equivalent of food is shown in Figures 15 and 16, a marked increase in quantities produced is apparent. When expressed in dollars these increases appear even greater. It is interesting to note that both countries do increase their production within all of the communities considered here. This leads to the conclusion that both Australia and New Zealand would be competitive in their own right due, in part, of the complementarity of the type of agricultural commodities each produces - Australia with its wheat and beef and New Zealand with its lamb, cheese and butter.

7. EFFECT OF PECs ON TRADING BY AUSTRALIA AND NEW ZEALAND

Trade plays a major role in countries with small domestic markets such as Australia and New Zealand. However, doubts are raised as to whether such small economies can compete amicably with large economies within the context of economic communities. Such communities comprising countries with large and small economies and/or large and small populations may encounter problems arising mainly from the magnitude of size differences. To examine this we now consider the net trade of commodities for Australia and New Zealand.

FIGURE 17
NET TRADE BY AUSTRALIA, STD RUN
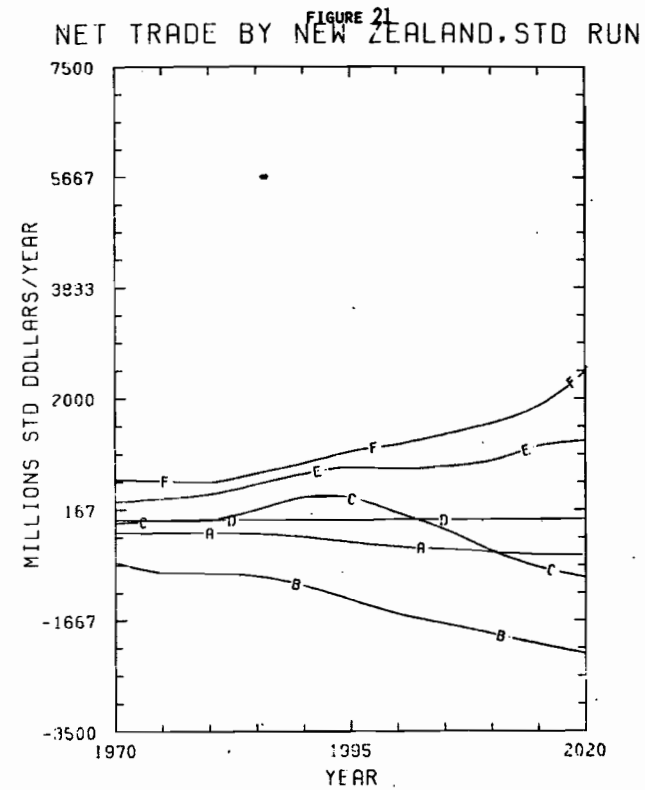

FIGURE 18
NET TRADE BY AUSTRALIA, PEC1C

A - MACHINERY   D - MINERALS
B - MANUFACTURES   E - NATURAL PRODUCTS
C - ENERGY   F - FOOD

FIGURE 19
NET TRADE BY AUSTRALIA, PEC3

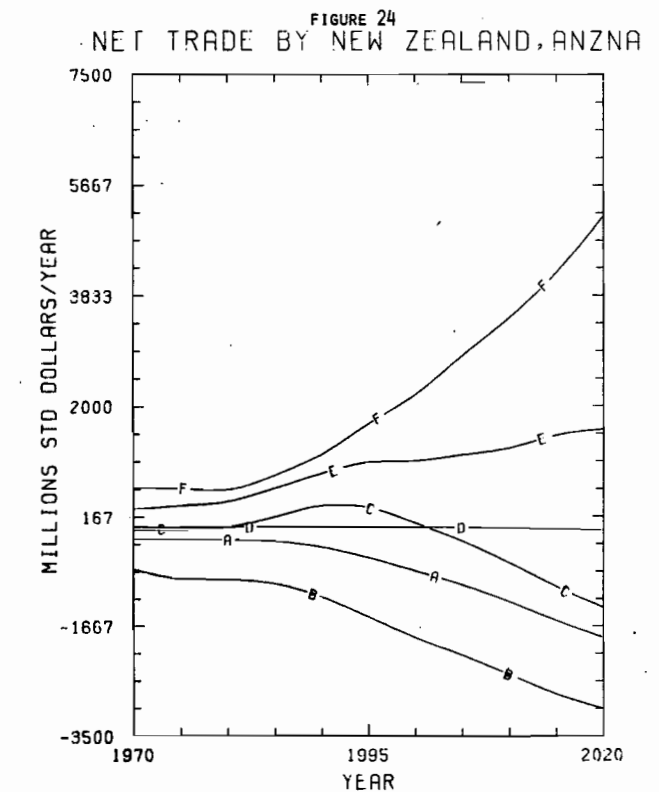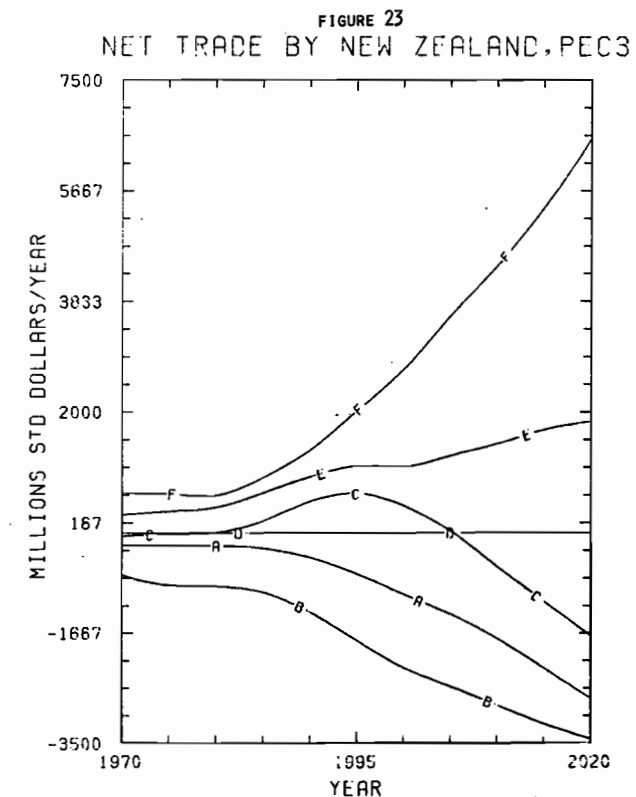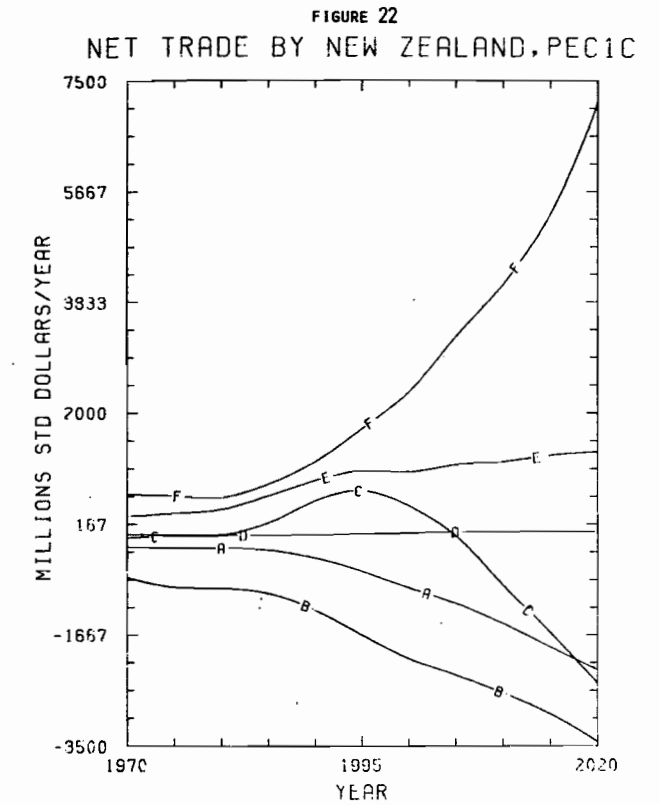FIGURE 20
NET TRADE BY AUSTRALIA, ANZNA

Of the cases considered here, PEC-1C gives
Australia its 'best' trade levels. While all four cases
show that Australia will be a net exporter of energy, food
and minerals, the ranking of these commodities as to which is
the largest by the year 2020 changes for each of the PECs
considered. In Figure 17 the Reference scenario shows
energy as yielding the largest net exports, followed by
food and minerals. In the cases of PEC-1C run (Figure 18)
and PEC-3 run (Figure 19) however, the food sector emerges
as the major exporter. For PEC-4, we see from Figure 20 that
energy once again tops the list. From Figures 18 and 19 we
also see that some of the declines shown earlier in the
production of energy can be attributed to a fall-off in
exports of energy. As these figures show net exports, the
full impact of the loss of energy exports is not fully
described here. Australia's major net import continues to
be manufactured goods reaching some $35 billion by the year
2020 in the PEC-1C case. This is followed by machinery and
natural products. With the access of the domestic market
to cheaper manufactured goods, the import of this commodity
has detrimental effects on the home industry. Thus, under the
assumptions of these cases, it would appear that Australia will
remain a *primary producer* with gains in the output levels
generated by the agricultural sector in recent decades,
resulting from the increasing demand for food following from
the increasing wealth of the developing countries in Asia.

New Zealand's net export earners remain the same
for all four cases. Food followed by natural products are

FIGURE 21
NET TRADE BY NEW ZEALAND, STD RUN

FIGURE 22
NET TRADE BY NEW ZEALAND, PEC1C

A – MACHINERY   D – MINERALS
B – MANUFACTURES   E – NATURAL PRODUCTS
C – ENERGY   F – FOOD

FIGURE 23
NET TRADE BY NEW ZEALAND, PEC3

FIGURE 24
NET TRADE BY NEW ZEALAND, ANZNA

the main exported commodities. In terms of energy supplies, however, New Zealand moves from being self-sufficient to a net exporter before swinging downward to the position of a net importer after about 2005. Demands made by its processing and service industries in the PEC-1C case (Figure 22) generate greater energy import requirements than in the Reference scenario (Figure 21). This applies to the other cases as well. Although able to meet its own mineral requirements, the demand for imports of machinery and manufactured products is great. This net importing situation is greatest in the PEC-3 case (Figure 23). Using Figure 24 we can compare the PEC-4 case with the other cases. In summary, then, New Zealand is also a primary producer for the period of the simulation in all four cases with energy fluctuating from a situation of net exports to net imports.

Both Australia and New Zealand are endowed with rich natural resources and are well placed to service markets which are less well placed in this respect. Both countries gain appreciably, in a trading sense, from participation in any of the communities considered here. However, when North America is introduced into the community the trade opportunities for these countries are reduced. This arises because North America is well endowed with natural resources similar to those drawn on by Australia and New Zealand. They thus compete with these countries for the increasingly open markets of Japan and ESEA. The impact on Australia's and New Zealand's trading prospects

caused by China participating in the community is not great, despite its considerable reserves of minerals and energy. Japan is shown to be increasing its energy imports from China. In each case the ESEA region remains a big importer of food from Australia and New Zealand. One of the reasons for this could be that the high trade biases operating at the beginning of the simulation period are hampering a rapid incursion of China's commodities into the rest of the Asian region. A more rapid liberalisation of trade between China and ESEA and its effects on the other countries would be of interest. In China's case, however, there are physical and population constraints which would hinder any major export drive particularly in food.

8. CONCLUSION

In this paper we have shown how global models can enhance the understanding of national issues. The feedback mechanisms mirror the world interdependence of regions. Even at this highly aggregated level we have been able to throw some light, in a systematic and quantitative way, on what to-date has been a highly qualitative evaluation of Pacific Economic Communities. However, for a more detailed analysis at the national level, we feel that joint investigations involving global and national modelling projects could only enhance the ability of economic models to provide authorative input into policy analysis of the PEC issue.

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