IMPACT OF DEMOGRAPHIC CHANGE ON INDUSTRY STRUCTURE IN AUSTRALIA

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VALIDATION OF THE SNAPSHOT MODEL

by

Peter B. Dixon, John D. Harrower
and David P. Vincent

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Commonwealth Government Printing Unit, Melbourne

IMPACT Project, Industries Assistance Commission, 608 St. Kilda Road, Melbourne, Victoria 3004 Australia
Area Code 03 Telephone 51 8611

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Abstract

SNAPSHOT is a disaggregated, long-run programming model of the Australian economy. It provides (over approximately ten years) projections of the industrial composition of the GNP and of the occupational composition of the workforce under alternative scenarios concerning technology, demography and trading opportunities. In the present paper we validate the model as follows. We adopt 1962/63 as a base year. Then we show that the model projects an accurate picture of the 1971/72 economy if it is given an accurate description of the technological, demographic and trading conditions of 1971/72.

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endogenous variables. Ideally, we would like to arrive at a trade scenario which could be achieved with minimum distortions in the price system. Furthermore, such a scenario should reflect a realistic pattern of domestic production. Evans (1972b) has discussed the feasibility of varying import shares in response to price changes to reflect imperfect substitution. While the relavant substitution parameters have been estimated elsewhere in the IMPACT Project,[1] we have yet to determine whether the increased non-linearities necessitated by such an approach are computationally feasible for a non-linear programming model as large as SNAPSHOT.[2] On the export side, Evans also discussed the feasibility of introducing terms of trade effects and joint production. Again, such modifications would involve further non-linearities and inexorably lead to increased computational difficulties.

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1. See Alaouze, Marsden and Zeitsch (1977).

2. For Johansen-type models, such as ORANI -- see Dixon, Parmenter Ryland and Sutton (1977), which are linear in logarithmic differentials, computational feasibility presents no problem.

CONTENTS

their contribution to the forecasting accuracy of the model. This would indicate to the model user which components of the fairly extensive exogenous data list warrant the most effort in terms of forecasting their values for the snapshot year.[1]

5.1 Future Developments with SNAPSHOT

Initially, applications of the model will be concentrated on a snapshot year 1990. Hence the relevant data matrices and vectors on production technology, demography and trade will be formulated for this year. The construction of the 1990 data base is well advanced.[2]

One potential improvement in the theoretical design that we have given some consideration to concerns the endogenizing of the international trade component of the model. As the model is currently specified it is, strictly speaking, necessary to interpret both primal and dual solutions when the trade scenario is varied. That is, the additional price distortions resulting from the achievement of a specified export target or level of import penetration need to be taken into account when interpreting the pattern of industry outputs and other

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1. This exercise is currently being undertaken with the IMPACT Project.

2. The technology scenarios to be used in the 1990 simulations are outlined in Chapman and Wood (1978 (a), (b) and (c)). The trade scenarios are based on work carried out for the IMPACT Project by Freebairn (1978). Demographic information on the number of households constituting each of the household groups recognized by SNAPSHOT will be obtained as output projections from other research within the IMPACT Project. (See Filmer and Silberberg (1977) and Williams and Brooks (1978) (forthcoming).)

5. CONCLUSIONS AND FUTURE RESEARCH PRIORITIES

In this paper we have tested SNAPSHOT by determining how accurately the model can reproduce the 1971/72 economy from a base year of 1962/63. As a result of this exercise we have acquired considerable confidence in the model's ability to project both the key economic aggregates and the industry components of final demand to an acceptably high degree of accuracy. The very high projection accuracy of variables obtained from the primal solution, has not been achieved in the dual solution. In particular, we have noted the sensitivity of the exchange rate and hence the relationship between domestic and foreign prices for import competing and export industries to changes in the availability of foreign exchange.

The projection accuracy achieved should however be put in perspective. In the validation exercise, the essential components of the exogenous data base took on the values that were actually realised in the 1971/72 economy. Hence it is perhaps not surprising that the model was able to project the remaining components accurately. While the results here validate the economics of the model they say little about its forecasting potential. The model's forecasting potential could be evaluated by seeing how well the endogenous variables for 1971/72 are projected from say a 1962/63 base year assuming that the exogenous components of the data base in 1971/72 were those that would have been forecast from the view point of 1962/63. An experiment along these lines would seek to rank the items of data for the snapshot year in terms of

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1. INTRODUCTION

In this paper we report on the performance of the SNAPSHOT model in projecting the 1971/72 economy given initial conditions in the base period (1962/63) and given the production technology, demographic and trade scenarios for the snapshot year (1971/72). This exercise represents an initial validation of SNAPSHOT, a long term model being developed as part of the IMPACT Project. We have chosen 1962/63 as the base year because it is the earliest year for which information on base year capital stocks of input-output industries can readily be established. A 1971/72 snapshot year was suggested because the necessary exogenous information about the economy was largely available from work done within the IMPACT Project on updating the 1968/69 input-output (I-O) table to 1971/72.

The plan of the paper is as follows. In Section 2 we provide the reader with a brief résumé of the theoretical structure of SNAPSHOT. In Section 3 we outline the changes made to the model for the purpose of validation. In Section 4 we discuss the validation experiment and analyse the performance of the model with respect to a wide variety of industry and macro variables for 1971/72. Finally, Section 5 contains conclusions

on the work to date and a brief discussion of likely future developments in the SNAPSHOT research programme.

To avoid the paper becoming unnecessarily long and unwieldly, we have prepared as a separate document,[1] a discussion of the sources and construction of the data base used in this paper. This document is available on request.

2. THE THEORETICAL STRUCTURE OF THE MODEL

The economic specification of the SNAPSHOT model was originally outlined in Dixon, Harrower and Powell (1976). A non-technical description of the model and a review of its development to March 1977 has been given by Powell (1977). More recently, Harrower and Vincent (1977) have incorporated margins, non-competing imports and taxes into the model's economic specification. In the résumé now presented, we draw freely on all of these sources. The list of equations and the notation for the variables (which jointly characterize the structure of the SNAPSHOT model) are given in Table 1.

It is convenient to consider the economic behavioural basis of the SNAPSHOT equations under the following headings :

1. Harrower and Vincent (1978).

27 (prepared fibres), 28 (man-made fibres, yarns), 76 (leather products) and 77 (rubber products) all contracted over the 1962/63 to 1971/72 period.

4.6 Workforce Projections

SNAPSHOT provides estimates of the number of people in each of the nine occupational groups. A comparison of the projected with the actual numbers is shown in Table 14.

TABLE 14

WORKFORCE BY OCCUPATION

IMPACT Occupation	SNAPSHOT Projection (000)	Actual Number[a] (000)
1. Professional White Collar	173.2	172.7
2. Skilled White Collar	672.1	669.3
3. Semi- and Unskilled White Collar	1416.9	1412.2
4. Skilled Blue Collar (Metal and Electrical)	581.2	569.6
5. Skilled Blue Collar (Building)	266.5	268.4
6. Skilled Blue Collar (Other)	132.6	135.1
7. Semi- and Unskilled (Blue Collar)	168.9	167.8
8. Rural Workers	243.9	252.1
9. Armed Services	85.1	85.1

(a) Derived from ABS Population Census 1971 mapped into IMPACT occupations. The numbers represent the 9×1 vector of workforce by occupation (L) where $L = \ell X$ (ℓ is the SNAPSHOT labour matrix and X is the actual vector of industry outputs in 1971/72).

Table 13 (contd)

	Input-Output Industry	Actual (h) per cent per annum	Projected (h*) per cent per annum
86	Wholesale Trade	12	12
87	Retail Trade	6	6
88	Motor Vehicle Repair	2	3
89	Other Repairs	2	2
90	Road Transport	7	7
91	Railway Transport	3	3
92	Water Transport	10	10
93	Air Transport	11	11
94	Communication	9	9
95	Banking	10	10
96	Finance & Life Insurance	14	14
97	Other Insurance	4	4
98	Investment, Real Estate	13	13
99	Other Business Services	11	11
100	Ownership of Dwellings	5	6
101	Public Administration	3	3
102	Defence	3	3
103	Health	8	8
104	Education, Libraries	6	6
105	Welfare Services	11	11
106	Entertainment	13	13
107	Restaurants, Hotels	5	5
108	Personal Services	3	3
109	Business Expenses	9	9

TABLE 1

THE EQUATIONS SPECIFIYING THE SNAPSHOT MODEL

Equation No.	Equation	No. of Equation Equivalents	Description
(1.1)(a)	$C_i = f_i(p^c, Z_i)$, i=1,...,m	mg	Consumer demand functions
(1.1)(b)[1]	$p^c = Q'p + Q'\hat{t}_c\, p$	g	Consumer taxes
(1.2)	$Z_i = (1 - s_i)\, \alpha_i(GNP)$	m	Level of total private expenditure
(1.3)	$K(t) = (I + \hat{h})^t\, (\overline{K(0)})$	n	Capital stocks in snapshot year
(1.4)	$K(t + 1) = (I + \hat{h})(K(t))$	n	Post-snapshot year capital stocks
(1.5)	$J = K(t + 1) - (I - \hat{\eta})\, K(t)$	n	Gross investments
(1.6)(a)	$X \leq K(t)$, and	n	Capacity constraint and complementary slack condition
(1.6)(b)	$\Pi\,(X - K(t)) = 0$		
(1.7)	$r = \beta\bar{r}$	n	Absolute rate of return on capital
(1.8)(a)	$r \geq \widehat{(p^K)}^{-1}\, \Pi - \eta$	n	Rate of return on capital and complementary slack condition
(1.8)(b)	$\hat{J}(r - \widehat{(p^K)}^{-1}\, \Pi + \eta) = 0$		
(1.8)(c)[2]	$p^K = K'p + (T_2 * K)'p$	n	Taxes on capital
(1.9)	$E = \bar{E}$	n	Level of exports
(1.10)(a)	$M \leq \hat{\gamma}X$, and	n-1	Import restraint and complementary slack condition
(1.10)(b)	$\hat{\phi}\,(M - \hat{\gamma}X) = 0$		
(1.11)	$p = \Theta\overline{p^e} + \xi - \hat{t}_E\, p$	n	Export price equation
(1.12)(a)	$p' \leq \Theta(\overline{p^m})'(I + \hat{\bar{\tau}}) + \phi'$, and	n	Import price equation and complementary slack condition
(1.12)(b)	$[p' - \Theta(\overline{p^m})'(I + \hat{\bar{\tau}}) - \phi']\, \hat{M} = 0$		

... *continued*

1. ^ denotes diagonal matrix.

2. * denotes term by term multiplication.

Table 1 continued ....

Equation No.	Equation	No. of Equation Equivalents	Description
(1.13)(a)	$\bar{B} \geqslant (\overline{p^m})'M - (\overline{p^e})'E$	1	Balance of Trade
(1.13)(b)	$\theta(\bar{B} - (\overline{p^m})'M - (\overline{p^e})'E) = 0$		
(1.14)(a)	$p'(I - A) - w'\ell - \Pi' - p'(T_1 * A) \leqslant 0$	n	Commodity cost structure and complementary slack condition
(1.14)(b)	$[p'(I - A) - w'\ell - \Pi' - p'(T_1 * A)]\hat{X} = 0$		
(1.15)(a)	$X + M \geqslant Q \sum_{i=1}^{m} C_i + KJ + \bar{G} + E + AX$	n	Product market clearing and complementary slack condition
(1.15)(b)	$\hat{p}\,[X + M - Q \sum_{i=1}^{m} C_i - KJ - \bar{G} - E - AX] = 0$		
(1.16)(a)	$\bar{N} \geq 1'L$	1	Full employment of total labour force
(1.16)(b)	$\delta(\bar{N} - 1'L) = 0$		
(1.17)	$L = \ell X$	H	Production labour requirements
(1.18)	$w = \delta(\bar{w})$	H	Sets wage relativities
(1.19)	$GNP = w'L + \Pi'K(t) + [\theta(\overline{p^m})'\hat{\bar{\tau}} + \phi']M - \xi'E + p'[Q\hat{t}_c \sum_i C_i + (T_2 * K)J + \hat{t}_E\bar{E} + (T_1 * A)X]$	1	Gross national product
(1.20)	All endogenous variables (with the possible exception of h and ξ) must be non-negative.		Sign constraints

... *continued*

Table 13 (contd)

	Input-Output Industry	Actual (h) per cent per annum	Projected (h*) per cent per annum
44	Newspapers & Books	9	9
45	Commercial Printing	2	2
46	Chemical Fertilisers	11	11
47	Industrial Chemicals	14	14
48	Paints, Varnishes	7	7
49	Pharmaceuticals	14	14
50	Soap & Detergents	9	9
51	Cosmetics, Toiletry	13	13
52	Chemical Products n.e.c.	11	11
53	Oil & Coal Products	4	4
54	Glass	8	10
55	Clay Products	5	4
56	Cement	8	8
57	Ready Mixed Concrete	11	12
58	Concrete Products	9	10
59	Non-Metal Mineral Products	10	9
60	Basic Iron & Steel	8	9
61	Other Basic Metals	9	9
62	Structural Metal	6	5
63	Sheet Metal Products	6	6
64	Metal Products n.e.c.	7	7
65	Motor Vehicles, parts	14	14
66	Ship & Boat Building	12	12
67	Locomotives	3	3
68	Aircraft Building	7	7
69	Scientific Equipment	10	10
70	Electronic Equipment	10	10
71	Household Appliances	9	9
72	Electrical Machinery	7	7
73	Agricultural Machinery	1	3
74	Construction Equipment	4	4
75	Other Machinery	7	6
76	Leather Products	- 5	- 5
77	Rubber Products	- 5	- 5
78	Plastic Products	21	21
79	Signs, Writing Equipment	12	12
80	Other Manufacturing	8	8
81	Electricity	9	9
82	Gas	11	11
83	Water, Sewerage	9	13
84	Residential Building	6	5
85	Building n.e.c.	6	6

TABLE 13

INDUSTRY GROWTH RATES

	Input-Output Industry	Actual (h) per cent per annum	Projected (h*) per cent per annum
1	Sheep	3	3
2	Cereal Grains	4	4
3	Meat Cattle	4	4
4	Milk Cattle	3	3
5	Poultry	8	8
6	Other Farming	6	6
7	Services to Agriculture	- 2	- 2
8	Forestry	- 2	- 3
9	Fishing	4	4
10	Iron	16	16
11	Other Metallic Minerals	16	16
12	Coal & Crude Oil	15	15
13	Non-Metallic n.e.c.	6	6
14	Services to Mining	11	11
15	Meat Products	8	8
16	Milk Products	5	5
17	Fruit & Vegetable Products	4	4
18	Margarine, Oils & Fats	10	10
19	Flour & Cereal Products	4	3
20	Bread, Cakes	2	2
21	Confectionery	4	4
22	Food Products n.e.c.	5	5
23	Soft Drinks, Cordials	12	12
24	Beer & Malt	8	9
25	Alcoholic Drinks n.e.c.	13	13
26	Tobacco	4	4
27	Prepared Fibres	- 1	- 1
28	Man-Made Fibres	- 1	- 1
29	Cotton, Silk, Flax	1	1
30	Wool & Worsted Yarns	1	1
31	Textile Finishing	14	14
32	Textile Floor Covers	6	6
33	Textile Products n.e.c.	3	3
34	Knitting Mills	4	4
35	Clothing	4	4
36	Footwear	2	3
37	Sawmill Products	3	2
38	Plywood, Veneers	6	6
39	Joinery & Wood Products	6	5
40	Furniture, Mattresses	7	7
41	Pulp, Paper	8	9
42	Fibreboard	5	6
43	Paper Products n.e.c.	6	6

Table 1 continued ....

DEFINITION OF NOTATION

Endogenous Variables in the Snapshot Year

		Number of Variables
C_i	consumption of commodities by consumer group i	(gm)
p	commodity prices	(n)
p^c	consumer prices including taxes	(g)
Z_i	total expenditure of consumer group i	(m)
GNP	gross national product	(1)
h	average rate of growth of capital in each industry over the t-year snapshot period	(n)
K(t)	industry levels of capital stock in the snapshot year	(n)
K(t+1)	industry levels of capital stock in the year after the snapshot year	(n)
J	gross investments by using industries	(n)
X	outputs of commodities	(n)
Π	rental prices on capital by industries	(n)
p^K	price of capital goods including taxes	(n)
r	minimum acceptable rates of return by industry	(n)
β	variable reflecting the absolute rate of return demanded on new capital formation for Australian industry	(1)
E	exports of commodities (quantity)	(n)
M	imports of commodities (quantity)	(n)
Θ	exchange rate ($A per unit of foreign currency)	(1)
ϕ	excess tariff revenue per unit of imports	(n-1)

... *continued*

Table 1 continued ....

		Number of Variables
ξ	export subsidy	(n)
w	wage rates by occupation before taxes	(H)
L	the number of labour units in each occupational group in the snapshot year	(H)
δ	variable reflecting the absolute level of wages before taxes for the Australian labour force	(1)

Exogenous Variables in the Snapshot Year

s_i	consumer group i's average propensity to save out of disposable income	(m)
α_i	share of GNP which is disposable income for group i	(m)
t_c	ad valorem taxes on consumption	(n)
$\overline{K(0)}$	industry levels of capital stock in the base year	(n)
t	number of years of the snapshot period	(1)
η	industry specific depreciation rates applicable to the industry capital stocks	(n)
K	capital matrix in the snapshot year	(n × n)
T_2	ad valorem taxes on creation of capital stock	(n × n)
$\bar{r}$	relative rates of return to capital required to induce investment in each industry	(n)
$\bar{E}$	exports of commodities	(n)
t_E	ad valorem taxes on exports	(n)
γ	import shares of the domestic markets	(n)
$\overline{p^e}$	export prices (f.o.b.) in foreign currency	(n)

... *continued*

When viewed together, the results of Tables 11 and 12 imply that exports need to be subsidised and imports taxed to achieve the export and import levels for 1971/72. This suggests that the model is undervaluing foreign exchange or overvaluing the (US/A) exchange rate. Subsequent experiments with the model have indicated that the exchange rate is fairly sensitive to changes in the availability of foreign exchange. For example, solutions involving say a 10 per cent across the board increase in import prices or a 10 per cent across the board cut in the volume of exports result in substantial reductions in the additional tariffs and subsidies.

(f) Industry Growth Rates

Endogenous to SNAPSHOT is a vector of industry average rates of growth (h) over the t year snapshot period (in this case 1962/63 to 1971/72). Projections of industry rates of growth are compared with actual growth rates in Table 13.[1]

Not surprisingly, in view of the accurate projection of industry outputs, industry growth rates were also projected accurately. The mining industries (industries 10, 11 and 12) show the highest growth rates, which are between 15 and 16 per cent. At the other end of the scale industries 7 (services to agriculture), 8 (forestry),

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1. The actual growth rate for industry i (h_i^a) was calculated from :

$$K_{i\ 1971/72} = (1 + h_i^a)^9\ K_{i\ 1962/63}$$

where $K_{i\ 1962/63}$ is the actual base year capital stock of industry i in 1962/63 and $K_{i\ 1971/72}$ is the actual capital stock (total domestic output) of industry i in 1971/72.

competing. For example industry 6 contains the export oriented activity (sugar) and the import competing, and heavily protected activity (tobacco). Similarly, industry 12 contains coal (export) and crude oil (import competing). Because of the composite nature of these industries it is probably not valid to attribute any economic meaning to the size of their ε's and ϕ's -- for example, in terms of the information supplied to the model, it would appear to be both rational and possible to replace tobacco imports by diverting sugar away from being exported.[1] For the remaining industries, additional export subsidies of around 15 per cent of costs are required to achieve the stated exports. To some extent this reflects assistance to these industries not incorporated in our vector of export subsidies net of taxes. It would be difficult, however, to quantify such assistance.

Table 12 shows that additional tariffs of the order of 14 per cent of costs are required to restrict import penetration to the levels determined by the model (which are very close to the actual import levels for 1971/72). Again, the question is raised as to the extent to which the additional tariffs represent model error (arising for example, in the determination of domestic costs of import competing industries) or indicate barriers to imports not included in our vector of ad valorem tariffs (but affecting the vector of import shares (γ).[2]

1. The problem can best be resolved by separating the industries into export and import components thus recognizing an additional two industries. This is now being done within the IMPACT Project.

2. Temporary assistance, particularly in the form of quantitative import restrictions such as import licences or tariff quotas including voluntary restraint by overseas exporters have become a prominent feature of the Australian economy in recent years. In terms of the model, these features while inherent in the γ's (imports plus duty/output) do not enter the ad valorem tariffs (τ).

Table 1 continued ....

		Number of Variables
$\bar{p}^m$	import prices (c.i.f.) in foreign currency	(n)
$\bar{\tau}$	ad valorem tariff rates	(n)
$\bar{B}$	balance of trade deficit in foreign currency	(1)
A	input-output coefficients matrix	(n × n)
T_1	ad valorem taxes and other costs on intermediate usage	(n × n)
ℓ	labour requirements by occupation and industry per unit of output in the snapshot year	(H × n)
$\bar{G}$	government purchases of commodities	(n)
$\bar{N}$	total number of people in the workforce in the snapshot year	(1)
$\bar{w}$	relative wage rates, before taxes, for the various occupational groups	(H)

In addition to the above list of exogenous variables,

U_i, the utility function for the i^{th} consumer group, and

Q, the n×g transformation matrix between the consumer good classification and the industry classification, are exogenously specified.

The letters n, g, m and H represent the dimensions of variables and data as follows :

n = 110, the number of industry groups (including non-competing imports)

g = 9, the number of consumer goods

m = 9, the number of consumer groups

H = 9, the number of occupational groups.

(i) consumption ,

(ii) capital stocks ,

(iii) investment and rates of return ,

(iv) international trade and commodity prices ,

(v) balance of trade and exchange rate ,

(vi) cost structure of commodities ,

(vii) clearing of commodity markets ,

(viii) labour market and wages and

(ix) gross national product .

2.1 Consumption

The demands for consumer goods by different household types are specified by equations (1.1)(a), (1.1)(b) and (1.2) based on the linear expenditure system. Williams (1978) divides households into nine consumer groups on the basis of age of household head, number of children and number of adults in the household. Estimates of the consumer demand parameters for the nine household types were obtained by fitting the linear expenditure system to the data collected in the ABS, Household Expenditure Survey, 1974/75.[1]

The real after-tax proportional distribution of disposable income across demographic groups in the snapshot year is set exogenously. Since the real before-tax income distribution is endogenous within SNAPSHOT, this implies that there is an endogenous set of tax and transfer policies implicit in the background. To put it another way, the

1. See Williams (1978) for details.

TABLE 12

ADDITIONAL ad valorem TARIFFS ON IMPORTS (¢/p)

	Input-Output Industry	¢/p
28	Man-Made Fibres, Yarns	0.13
29	Cotton, Silk, Flax	0.14
37	Sawmill Products	0.14
41	Pulp, Paper	0.14
44	Newspapers & Books	0.13
47	Industrial Chemicals	0.14
49	Pharmaceuticals	0.14
52	Chemical Products n.e.c.	0.14
53	Oil & Coal Products	0.21
64	Metal Products n.e.c.	0.14
65	Motor Vehicles, parts	0.14
68	Aircraft Building	0.13
69	Scientific Equipment	0.14
70	Electronic Equipment	0.13
71	Household Appliances	0.14
72	Electrical Machinery	0.14
73	Agricultural Machinery	0.14
74	Construction Equipment	0.13
77	Rubber Products	0.12
78	Plastic Products	0.14
93	Air Transport	0.10
102	Defence	0.12
106	Entertainment	0.13
109	Business Expenses	0.13

TABLE 11

ADDITIONAL ad valorem SUBSIDIES ON EXPORTS (ϵ/p)

	Input-Output Industry	ϵ/p
1	Sheep	0.07
2	Cereal Grains	0.07
6	Other Farming	0.54
9	Fishing	0.22
10	Iron	0.17
11	Other Metallic Minerals	0.26
12	Coal & Crude Oil	0.25
15	Meat Products	0.13
16	Milk Products	0.13
22	Food Products n.e.c.	0.13
27	Prepared Fibres	0.14
60	Basic Iron & Steel	0.15
61	Other Basic Metals	0.21
90	Road Transport	0.15
91	Railway Transport	0.16
92	Water Transport	0.11
98	Investment, Real Estate	0.14

tax and transfer policies are assumed to be whatever is necessary to reconcile the exogenous after-tax income distribution with the endogenous before-tax distribution generated by the solution of the model. This is of importance to an understanding of SNAPSHOT, since it breaks the link between the consumption expenditures of individuals and their before-tax earnings from wages and assets. Of course, the exogenously specified distribution of after-tax real incomes may be varied, and the sensitivity of key variables in the model to this distribution ascertained.

The alienation of the determination of the distribution of real disposable personal income from the economic to the social and political area is consistent with widely accepted interpretations of observed long-term patterns in the distribution of personal incomes in western countries. It may be, however, that the continuance of observed trends of income distribution would imply, for example, that liberal policies of public investment in education continue to be followed (Tinbergen (1975)).

2.2 Capital Stocks

Capital stocks in the snapshot year are obtained by multiplying base year stocks in each industry by an endogenously determined average growth factor over the snapshot period (equation (1.3)). It is assumed that investment by each industry in the snapshot year is sufficient to maintain the average growth rates (equation (1.4)). Industry outputs in the snapshot year are constrained by the availability of capital in each industry ((1.6(a), and (1.6)(b)).

2.3 Investment and Rates of Return

For each industry there will be positive net investment in the SNAPSHOT year only if the rate of return on new capital equipment is projected to be at a satisfactory level from the viewpoint of the investing industry. The question of defining a 'satisfactory return' has proceeded on a basis of the recognition that different industries may require different rates of return to induce investment. These differences could be due to a variety of factors, none of which is explicitly modelled within SNAPSHOT. For instance, different degrees of risk may lead to different minimum expected rates of return being required for the generation of new investment. Again, industries dominated by one or a few firms, if they are insulated from import competition, may be in a position to demand a higher return on new investment than other industries, even after adjustment for risk. Equations (1.5), (1.7), (1.8)(a), (1.8)(b) and (1.8)(c) describe the investment and rates of return formulation.

This formulation does not allow rates of return to be affected by changes in productivity caused by demographic and/or technological change, by changes in world prices, or by changes in protection policy. The effects of these changes, however, are on the size (capital, output, employment) of the industry and not its rate of return to capital. Thus reduced profitability may cause some firms to leave an industry, reducing investment, output and employment in that industry, but probably not significantly affecting the relative rate of return to capital for that industry in the long-run.

ad valorem tariffs (ϕ).[1] ε can be interpreted as the model's projection of the subsidies (beyond those already exogenously specified) which would be required to achieve the exogenously specified export vector ($\bar{E}$). ϕ is the model's projection of the additional tariffs (beyond those already exogenously specified) which would be required to restrict imports to the exogenously given shares (γ). Since we attempted to incorporate the 1971/72 tariffs and subsidies into our validation run, we expected the industry exports and imports for 1971/72 to be achieved with little need for additonal export subsidies or additional import tariffs. In Table 11 we present the projected additional export subsidies (ε) for all major export industries (industries whose exports exceed both competitive imports and $50m). In Table 12 we present the endogenous excess tariffs for the major import competing industries (industries whose imports exceed exports and whose imports are at least $50m). In both cases, the results are expressed as a percentage of domestic costs.

Table 11 shows rather larger subsidy rates than were anticipated. The high figures for industries 6 (other farming) and 12 (coal and crude oil) require further comment. Both these industries contain activities which are strongly export oriented and others which are strongly import

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1. In the case of imports, the additional tariff (ϕ) shows up as the shadow price on the import constraint (equations (1.10(a)) and (1.10(b)). On the export side, the additional export subsidy is calculated as the difference between domestic and export prices in Australian currency after allowing for known export taxes net of subsidies. That is, $\varepsilon = P - \Theta\bar{P}e + \hat{t}_E P$ where P is the vector of domestic prices, $\bar{P}e$ is the vector of foreign currency export prices, Θ is the exchange rate and $\hat{t}_E$ is the diagonal matrix of known export taxes net of subsidies.

Table 10 (contd)

	Input-Output Industry	Projected ($m)	Actual ($m)	Per cent Error
47	Industrial Chemicals	230.2	230.2	-
48	Paints, Varnishes	5.4	5.5	1
49	Pharmaceuticals	59.1	58.8	
50	Soap & Detergents	6.0	6.0	-
51	Cosmetics, Toiletry	5.5	5.5	-
52	Chemical Products n.e.c.	65.8	65.9	-
53	Oil & Coal Products	146.9	144.8	2
54	Glass	43.6	43.5	-
55	Clay Products	34.2	36.5	6
56	Cement	2.0	2.9	-31
58	Concrete Products	0.2	0.2	-
59	Non-Metallic Mineral Products	14.3	15.0	5
60	Basic Iron & Steel	137.0	136.5	-
61	Other Basic Metals	27.5	27.5	-
62	Structural Metal	18.2	18.4	- 1
63	Sheet Metal Products	-	5.1	-
64	Metal Products n.e.c.	114.5	114.7	-
65	Motor Vehicles, Parts	377.0	370.5	2
66	Ship & Boat Building	12.8	12.7	1
67	Locomotives	9.4	9.4	-
68	Aircraft Building	84.8	85.6	- 1
69	Scientific Equipment	115.9	115.3	1
70	Electronic Equipment	165.2	165.4	-
71	Household Appliances	54.2	54.0	-
72	Electrical Machinery	174.8	174.3	-
73	Agricultural Machinery	53.7	38.1	41
74	Construction Equipment	78.9	78.7	-
75	Other Machinery	437.6	444.4	- 2
76	Leather Products	15.5	15.6	- 1
77	Rubber Products	52.2	51.2	2
78	Plastic Products	88.0	87.8	-
79	Signs, Writing Equipment	7.7	77.	-
80	Other Manufacturing	44.0	43.9	-
91	Railway Transport	7.6	7.6	-
92	Water Transport	106.5	106.0	-
93	Air Transport	179.9	176.7	2
94	Communication	25.0	24.9	-
96	Finance & Life Insurance	2.4	2.4	-
97	Other Insurance	3.0	2.9	2
98	Investment, Real Estate	50.8	51.0	-
99	Other Business Services	37.3	37.0	1
106	Entertainment	53.5	53.3	-
107	Restaurants, Hotels	2.6	2.5	3
108	Personal Services	1.5	1.5	-
110	Non-competing Imports	656.3	658.6	-

Some support for this view is provided by the fact that there appears to be no relationship between the rates of return to capital of an industry and its level of tariff protection.[1] The effect of an increase in tariff protection, it seems, is to increase the size of an industry, rather than to raise the rate of return to its capital.

2.4 International Trade and Commodity Prices

A major problem in models of international trade is the tendency toward solutions showing excessive specialization in production. In the SNAPSHOT model we obviate this problem at the expense of making international trade largely exogenous. The levels of exports are fully exogenous in SNAPSHOT (equation 1.9); on the import side, upper limits are placed on the shares of the market which imports are allowed to capture in the snapshot year in selected sheltered industries (equations (1.10)(a) and (1.10)(b)).

To enable the (physical) export target levels to be achieved, and in order to ensure that import penetration does not exceed the exogenously set tolerances, it is necessary to introduce a series of taxes and subsidies which allow the domestic price pattern to deviate from the (exogenous) pattern of world prices as projected for the snapshot year. In particular, discriminatory tariffs against imports competing with particular sheltered industries may be needed, and these tariff levels are determined endogenously. Similarly, in the light of the (endogenous)

1. See for example financial data presented by the Industries Assistance Commission, Annual Report 1973-74, Table 3.4.1 and Table 4.2.3.

domestic cost structure in the snapshot year, the local levels of demand for and outputs of exportables may not be consistent with the exogenously set export targets. Consistency in the SNAPSHOT solution is achieved by the endogenous imposition of an appropriate export tax or subsidy. Equations (1.11), (1.12)(a) and (1.12)(b) describe these price relationships.

2.5 Balance of Trade and Exchange Rate

The balance of trade is set exogenously. For long-run work a natural value is zero; if the user of SNAPSHOT has a set of prior beliefs about the net inflow or outflow of capital which is likely to be achieved over the long period, then he may prefer to set a balance of trade surplus or deficit which is consistent with this view about international capital movements. The exchange rate, which is endogenous, adjusts to ensure that the SNAPSHOT solution generates the required balance of trade deficit or surplus (equations (1.13)(a) and (1.13)(b)).

2.6 Cost Structure of Commodities

The cost of producing a commodity is made up of purchased materials, the wages and salaries bill, the return on capital and taxes levied on intermediate and other inputs. Should the cost of production of a commodity exceed its price, then that commodity is not produced in the snapshot year (equations (1.14)(a) and (1.14)(b)). The return to capital as appearing in the cost structure may or may not include an element of 'pure' profit due to an imperfectly competitive market structure. This is

TABLE 10

INDUSTRY IMPORTS

	Input-Output Industry *	Projected ($m)	Actual ($m)	Per cent Error
1	Sheep	2.9	2.9	-
2	Cereal Grains	0.3	0.3	-
3	Meat Cattle	1.2	1.2	-
6	Other Farming	39.3	39.4	-
8	Forestry	4.5	4.6	- 2
9	Fishing	4.9	5.0	- 1
10	Iron	0.1	0.1	-
11	Other Metallic Minerals	1.4	1.4	-
12	Coal & Crude Oil	112.1	111.6	-
13	Non-Metallic n.e.c.	24.8	25.2	2
15	Meat Products	8.0	7.9	2
16	Milk Products	8.7	8.8	- 1
17	Fruit & Vegetable Products	15.0	20.1	-25
18	Margarine, Oils & Fats	23.0	23.0	-
19	Flour & Cereal Products	2.1	2.1	-
20	Bread, Cakes	5.0	5.0	-
21	Confectionery	15.6	15.6	-
22	Food Products n.e.c.	52.9	53.1	-
23	Soft Drinks, Cordials	-	0.5	-
24	Beer & Malt	-	0.2	-
25	Alcoholic Drinks n.e.c.	22.7	22.1	3
26	Tobacco	8.7	8.5	3
27	Prepared Fibres	14.5	14.5	-
28	Man-Made Fibres, Yarn	163.4	163.6	-
29	Cotton, Silk, Flax	136.1	136.9	- 1
30	Wool & Worsted Yarns	7.4	7.4	-
31	Textile Finishing	0.1	0.1	-
32	Textile Floor Covers	30.3	29.7	2
33	Textile Products n.e.c.	32.5	32.3	1
34	Knitting Mills	16.1	16.3	- 1
35	Clothing	48.4	48.9	- 1
36	Footwear	28.4	28.7	- 1
37	Sawmill Products	63.8	67.0	- 5
38	Plywood, Veneers	9.8	9.9	- 1
39	Joinery & Wood Products	11.9	12.3	- 3
40	Furniture, Mattresses	9.1	9.0	1
41	Pulp, Paper	139.6	139.5	-
42	Fibreboard	14.8	14.8	-
43	Paper Products n.e.c.	7.9	7.9	-
44	Newspaper & Books	76.6	76.6	-
45	Commercial Printing	17.2	17.1	-
46	Chemical Fertilisers	8.5	8.5	-

* Actual and projected imports are zero in all omitted industries.

projected accurately. For industry 110 which represents non-competing imports the import level is left unbounded in the programming specification.

A comparison of projected with actual imports together with projection errors is shown in Table 10. For the most part, it appears that imports are projected accurately. Projection errors exceed 5 per cent or more for industry 73 (41 per cent or $15.6m over projection) industry 55 (6 per cent or $2.3m under projection) and industry 17 (25 per cent or $5.1m under projection). The explanation for industry 73 is the over projection of investment discussed earlier. Similarly, the explanation for industry 55 is in terms of the under projection of the output of residential buildings discussed previously. For industry 17 (fruit and vegetable products) imports are less than the exogenously set level (product of the import share by domestic production). That is, they are unbounded in the solution. The domestic price for industry 17 is slightly below the import price converted to domestic currency, hence the result. However, the price discrepancy and the amount of imports involved are both too small for this projection discrepancy to attract further comment.

(e) 'Additional' Export Subsidies and Tariffs (ε and ϕ)

The current treatment of international trade in SNAPSHOT leads to the introduction of 'additional' export subsidies (ε) and 'additional'

because the implicit rental prices on capital items are linked to the rates of return on new investment, and as explained above, the latter take into account the differing yields on capital needed to induce new investment in different industries.

2.7 Clearance of Commodity Markets

SNAPSHOT is a general equilibrium model which matches the demands and supplies of each commodity, i.e., the sum of domestic production and the net balance of imports over exports must be equal to demands generated by consumers, plus those generated by investors and by the government (equations (1.15)(a) and (1.15)(b)).

2.8 Labour Market and Wages

The total number of people in the workforce in the snapshot year is specified exogenously. We can make the assumption of either full or partial employment[1] in the long run. Although total employment is exogenous to SNAPSHOT (and given, possibly, by demographic projections), the composition of this employment is endogenous and demand determined. That is to say, SNAPSHOT will indicate which occupational composition of the labour force would be consistent with the projected structure of the the economy in the shapshot year, given an exogenously set figure for total employment.

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1. If full employment is thought to be unduly optimistic as a basis for long-run projection, various unemployment percentages can be set exogenously without in any way complicating the structure or solution of SNAPSHOT.

Within the IMPACT Project, work is in progress on the industrial and occupational wage structures in Australia. The weight of evidence at this point, however, seems to indicate that wage relativities move very slowly and in a way which, to the present time, remains poorly understood.[1] What has been observed is a considerable degree of long-term stability in relative margins for skills. Whilst it is true that over the last five years some variation in the relative earnings of different occupational groups has taken place, there are as yet no well defined criteria for judging the likely permanence or otherside of the new relativities.

Given the absence of an operationally explicit long run theory of occupational relativities in earnings, in SNAPSHOT these have been treated exogenously, hence closely paralleling the case of investment. The absolute wage level, however, is endogenous. Its level in the snapshot year is determined essentially by the productivity of the economy in the snapshot year and the requirement that the specified workforce be employed. Implicit is the assumption that between the base period and the snapshot year, occupational mobility, training and retraining, and the response of the educational system, are adequate to ensure that the supplies of different skills in the snapshot year match the demands for them.

1. See K. Hancock and K. Moore (1972) and B. Hughes (1973). Hughes comments that "action by strong unions to establish a relative wage advance will tend to be frustrated by matching wage increases elsewhere. Secondly, it may be doubted that social forces will allow the exploitation of large relative wage gains by strong unions". In K. Hancock and B. Hughes (1973) the conclusion is reached "that wage differences are not related to power variables in any simple and general fashion".

shows that projected outputs for 104 of the 109 I-O industries are within ± 5 per cent of actual outputs. The projected output of industry 73 (agricultural machinery) is 41 per cent ($50m) above actual output. This projection error reflects the over projection of investment (by $60m) reasons for which were given in the previous section. Similarly, the under projection of investment supplied by industry 84 (residential buildings) explains the 10 per cent under projection of its output. Projected output of industry 55 (clay products) is 6 per cent ($12.3m) below actual output. This industry is shown as making $146.6m of sales to residential buildings. Hence a 10 per cent under estimate in the output of residential buildings is sufficient to explain the $12.3m under estimate in the output of clay products. Similarly, the output of industry 37 (sawmill products) is 5 per cent ($17.6m) under estimated and the output of industry 59 (non-metallic mineral products) is 5 per cent under estimated ($5.1m). These industries make sales of $155.0m and $57.7m respectively to residential buildings. Hence a 10 per cent under estimate in the output of residential buildings is sufficient to explain the projection errrors.

(d) Imports

For import competing industries, imports are constrained by exogenously set shares of domestic production. Provision is made for the imposition of excess tariffs if necessary to limit imports to be no more than the stated share of domestic production. Since the shares used in the validation exercise are actual shares of domestic production in 1971/72, imports of the first 109 industries will be projected accurately provided their outputs and domestic production costs are

Table 9 (contd)

	Input-Output Industry	Projected ($m)	Actual ($m)	Per cent Error
86	Wholesale Trade	4074.1	4076.2	-
87	Retail Trade	3330.1	3308.5	1
88	Motor Vehicle Repair	732.6	702.4	4
89	Other Repairs	229.1	229.1	-
90	Road Transport	1743.3	1725.2	1
91	Railway Transport	772.5	771.3	-
92	Water Transport	694.2	691.1	-
93	Air Transport	537.5	527.9	2
94	Communication	1177.0	1173.3	-
95	Banking	936.2	933.4	-
96	Finance & Life Insurance	558.9	555.7	1
97	Other Insurance	446.8	442.0	1
98	Investment, Real Estate	944.9	947.9	-
99	Other Business Services	1407.6	1398.0	1
100	Ownership of Dwellings	3073.2	3053.2	1
101	Public Administration	1464.8	1464.8	-
102	Defence	1131.5	1131.5	-
103	Health	1647.0	1636.0	1
104	Education, Libraries	1425.8	1426.3	-
105	Welfare Services	472.1	472.1	-
106	Entertainment	774.4	771.9	-
107	Restaurants, Hotels	1230.7	1218.0	1
108	Personal Services	336.1	336.8	-
109	Business Expenses	3812.5	3802.1	-

Equations (1.16)(a), (1.16)(b), (1.17) and (1.18) describe the labour market and wages.

2.9 Gross National Product

GNP (in purchasers' prices) in the snapshot year is the sum of wages, rents on capital, taxation levies and tariff revenue, less export subsidies (equation (1.19)).

3. MODIFICATIONS TO THE THEORY FOR THE VALIDATION EXERCISE

We have made several modifications to the theoretical structure of the model in the light of its performance in the validation exercise.

3.1 Investment

In the initial specification, the relative rates of return on capital required to induce investment in each industry ($\bar{r}$) were set exogenously while the absolute rate of return demanded on new capital formation for Australian industry (β) was endogenous. In the computation of the solution, β was formulated as an iterative variable (denoted by β^+) in order to induce the programming problem to generate the appropriate level of savings.[1] That is, we used variations in β^+

1. For details and precise definitions of notation, see Dixon (1976) pp. 29-30.

to force the restriction

$$p' \sum_i C_i = GNP \sum_i \alpha_i (1 - s_i) \quad ,$$

where $\sum_i \alpha_i (1-s_i)$ is the exogenously specified consumption share of GNP and $p'C/GNP$ is the endogenous consumption share of GNP. If our programme generated too much savings at the (v-1)th iteration : i.e.,

$$\sum_i \alpha_i (1-s_i) > \left[\sum_i (p(v-1)' C_i (v-1)\right] \Big/ GNP (v-1) \quad ,$$

then the adjustment rule

$$\beta^+(v) = \beta^+(v-1) + \Lambda_2(v) \left[\sum_i \alpha_i (1-s_i) - \sum_i p(v-1)' C_i(v-1)\right]$$

indicates that β^+ should be increased.[1] This increases the costs associated with using capital - prices of capital intensive goods increase relative to those of labour intensive goods, hence demand and employment is switched to labour intensive industries, the capital stock declines, investment in the snapshot year declines and the consumption share of GNP increases.

Our experience has shown that the model solutions are largely insensitive to the value assigned to β^+ . That is, very large changes in β^+ produce only small changes in the consumption share of GNP. This

1. See Dixon (1976) p. 23. $\Lambda_2(v)$ is a positive parameter.

Table 9 (contd)

	Input-Output Industry	Projected ($m)	Actual ($m)	Per cent Error
44	Newspapers & Books	416.4	416.1	-
45	Commercial Printing	472.3	470.8	-
46	Chemical Fertilisers	163.5	164.1	-
47	Industrial Chemicals	434.2	434.2	-
48	Paints, Varnishes	145.8	147.6	- 1
49	Pharmaceuticals	254.0	252.6	1
50	Soap & Detergents	139.4	139.3	-
51	Cosmetics, Toiletry	92.8	92.7	-
52	Chemical Products n.e.c.	153.0	153.4	-
53	Oil & Coal Products	640.2	631.0	1
54	Glass	134.5	134.3	-
55	Clay Products	184.5	196.8	- 6
56	Cement	98.7	100.8	- 2
57	Ready Mixed Concrete	182.2	186.4	- 2
58	Concrete Products	204.7	210.3	- 3
59	Non-Metal Mineral Products	120.4	126.5	- 5
60	Basic Iron & Steel	1462.1	1456.2	-
61	Other Basic Metals	1077.2	1077.6	-
62	Structural Metal	534.1	539.8	- 1
63	Sheet Metal Products	487.0	482.8	1
64	Metal Products n.e.c.	650.1	651.4	-
65	Motor Vehicles, parts	1973.3	1938.5	2
66	Ship & Boat Building	214.8	213.6	1
67	Locomotives	218.4	218.0	-
68	Aircraft Building	120.6	120.5	-
69	Scientific Equipment	100.0	99.5	-
70	Electronic Equipment	368.4	368.7	-
71	Household Appliances	439.2	437.2	-
72	Electrical Machinery	631.2	629.3	-
73	Agricultural Machinery	170.8	121.1	41
74	Construction Equipment	186.2	185.7	-
75	Other Machinery	777.6	789.7	- 2
76	Leather Products	98.2	99.0	- 1
77	Rubber Products	267.2	261.9	2
78	Plastic Products	474.4	473.3	-
79	Signs, Writing Equipment	72.9	72.7	-
80	Other Manufacturing	93.8	93.5	-
81	Electricity	974.3	971.0	-
82	Gas	121.8	121.2	1
83	Water, Sewerage	443.8	442.3	-
84	Residential Building	1644.1	1832.1	-10
85	Building n.e.c.	4773.2	4762.5	-

TABLE 9

INDUSTRY OUTPUTS

	Input-Output Industry	Projected ($m)	Actual ($m)	Per cent Error
1	Sheep	770.8	772.7	-
2	Cereal Grains	543.8	544.6	-
3	Meat Cattle	561.4	565.1	- 1
4	Milk Cattle	620.2	625.3	- 1
5	Poultry	182.3	183.8	- 1
6	Other Farming	663.2	664.0	-
7	Services to Agriculture	219.2	219.8	-
8	Forestry	154.9	158.4	- 2
9	Fishing	93.8	94.1	-
10	Iron	344.7	345.2	-
11	Other Metallic Minerals	560.8	564.4	- 1
12	Coal & Crude Oil	657.6	654.9	-
13	Non-Metallic n.e.c.	188.3	192.0	- 2
14	Services to Mining	193.6	193.8	-
15	Meat Products	2006.9	2018.4	- 1
16	Milk Products	854.1	861.1	- 1
17	Fruit & Vegetable Products	292.9	289.4	1
18	Margarine, Oils & Fats	108.7	109.4	- 1
19	Flour & Cereal Products	278.4	280.3	- 1
20	Bread, Cakes	382.0	385.8	- 1
21	Confectionery	131.4	132.7	- 1
22	Food Products n.e.c.	779.6	783.1	-
23	Soft Drinks, Cordials	183.5	184.2	-
24	Beer & Malt	313.6	305.2	3
25	Alcoholic Drinks n.e.c.	100.1	97.5	3
26	Tobacco	232.6	226.4	3
27	Prepared Fibres	117.3	117.6	-
28	Man-Made Fibres	162.6	163.0	-
29	Cotton, Silk, Flax	155.7	156.6	- 1
30	Wool & Worsted Yarns	123.0	123.6	-
31	Textile Finishing	68.9	69.2	-
32	Textile Floor Covers	119.0	116.5	2
33	Textile Products n.e.c.	99.6	99.0	1
34	Knitting Mills	265.2	267.9	- 1
35	Clothing	624.8	631.3	- 1
36	Footwear	194.3	196.4	- 1
37	Sawmill Products	320.7	337.1	- 5
38	Plywood, Veneers	99.8	101.2	- 1
39	Joinery & Wood Products	254.6	264.1	- 4
40	Furniture, Mattresses	322.9	318.7	1
41	Pulp, Paper	256.9	256.6	-
42	Fibreboard	263.8	263.8	-
43	Paper Products n.e.c.	115.9	116.0	-

suggests that the shares of capital and labour in income (and hence the absolute rate of return on new investment) are poorly determined by the model. Given that the model apparently has very little to say about the absolute rate of return, the endogenous determination of β would be unwise. If we set the β^+ such that $\bar{r}\beta^+$ represents the actual vector of rates of return in the snapshot year, then our experience is that the model will generate the appropriate level of savings. Hence in the validation experiment reported here, the $\bar{r}\beta^+$ vector represents the actual rates of return by I-O industries for 1971/72; that is, rates of return are fully exogenous.

3.2 Consumption

The theoretical framework is designed to capture the longer term demand effects of changing demography by specifying nine 'representative' consumers, one for each of the socio-economic/demographic groups distinguished. The consumption behaviour of the different groups is taken to be described by the constrained maximization of Klein-Rubin utility functions, i.e., consumption by group i is determined by maximizing

$$U_i(C_i) \equiv \sum_{j=1}^{g} \beta_{ij} \ell n(C_{ij} - \gamma_{ij})$$

subject to $$(p^C)'C_i = (1 - s_i)\alpha_i \, GNP$$

where $U_i(C_i)$ is an index of utility of consumer group i, C_{ij} is the quantity of consumer good j purchased by the i^{th} consumer group and the γ_{ij} are parameters which may be thought of as 'subsistence quantities', utility being defined only when $C_{ij} > \gamma_{ij}$. The β_{ij} represent marginal budget shares, α_i is the share of GNP which is disposable income for group i i and s_i is group i's average propensity to save.

This specification requires estimates of the parameters β_{ij}, γ_{ij}, s_i and α_i. These have recently become available in Williams (1978). However, in our initial validation exercise we have evaluated the model's performance with the much less demanding (in terms of parameters) Cobb-Douglas utility specification (hereafter referred to as the simplified consumption specification).

The Cobb-Douglas utility function may be written :

$$U_i = \sum_j \beta_{ij} \ell n\, C_{ij} \quad .$$

We further simplify the above function by recognizing only one representative consumer, i.e., $\beta_{ij} = \beta_j$ (for all i and j). The β_j may be set by using observed budget shares (in purchasers' prices). Hence our preliminary validation proceeded without the estimation of any demand parameters. When satisfactory performance of the model with this simplified consumption specification was achieved, the original consumption specification (hereafter referred to as the expanded consumption specification) was restored. The difference in model performance between the two experiments is discussed briefly in section 4.5(a).

In the case of residential buildings, the explanation for SNAPSHOT's comparatively poor projection performance is not so clear. The residential buildings industry supplies capital to the ownership of dwellings industry. The output of ownership of dwellings represents the imputed rent on owner-occupied dwellings. Hence the concept of the ownership of dwellings industry is somewhat different from other industries. Information on for example the industry's rate of return to capital, its depreciation rate and its base year (1962/63) capital stock (all of which are particularly important because of the nature of the industry's output) are difficult to establish. In addition to these data problems, a further reason for the projection error could concern accounting inconsistencies within the I-O table. For example, in 1971/72 residential buildings is shown as supplying $84m of capital to dwellings in the government sector. If the output of ownership of dwellings did not fully reflect the imputed rent on these dwellings then we could expect investment supplied by residential buildings to be understated. One further possibility is that investment in ownership of dwellings in 1971/72 was above the trend over the snapshot period. To test this proposition, a logarithmic trend was fitted to Australian National Accounts data on real capital expenditure on dwellings (private and public) for the period. The results, however, indicated that the 1971/72 expenditure was slightly below trend.

(c) Outputs

The comparison of projected with actual industry outputs together with the percentage discrepancy is shown in Table 9. The table

machinery in 1971/72 was only 49 to 69 per cent of that which would have been required to maintain into 1972/73 the average rate of growth in the stock of plant and machinery that took place over the period 1952/53 to 1971/72. This explains the SNAPSHOT projection (actual investment supplied by industry 73 in 1972/73 was about 60 per cent of the projected figure). Thus in the case of agricultural machinery, the model's performance in projecting a surplus investment of $59m should be viewed not so much as a failure to project short run swings in agricultural investment but as evidence of the successful functioning of its long run investment theory.

TABLE 8

CAPITAL STOCK GROWTH RATES AND AGRICULTURAL INVESTMENT : BAE ZONES[a]

	Zone		
	Pastoral	Wheat/ Sheep	High Rainfall
Trend rate of growth of capital stock (per cent)	0.6	3.2	1.7
Assumed depreciation rate (per cent)	12.5	12.5	12.5
Actual capital stock (1972/73)	8557	8992	5260
Projected capital stock (1972/73)	9639	10660	5821
Actual investment (1971/72)	618	759	561
Projected investment to maintain 1962/63 - 1971/72 capital stock growth rate (1971/72)	1255	1546	813
Ratio of actual to projected investment	0.49	0.49	0.69

(a) Units for investment and capital stocks are real dollars of 1952/53 purchasing power per 'average' farm.

4. VALIDATION DATA BASE AND RESULTS

In this section we analyse performance of the SNAPSHOT model by computing a solution for the 1971/72 snapshot year from a 1962/63 starting base. To assist in describing the experiments and the results we have set out in figure 1 the contents of the input-output data file for 1971/72. The essential features of the data base are discussed in reference to this diagram. This discussion is followed by the results. We first concentrate on the macro projections - GNP and its components. This is followed by a discussion of the industry projections. An important task envisaged in the construction of SNAPSHOT is to identify the long run consequences for individual industries of changes in technology, demography and international trade. Hence in the validation phase we must be confident that the model is capable of projecting to a satisfactory level of approximation, not only the major economic aggregates but also industry outputs, investment, consumption and imports.

Our approach in reporting the industry results is to concentrate the discussion on instances where the model has failed to project satisfactorily. Satisfactory performance of the model in projections at an industry level receives scant or no comment. Because of limitations of space we present the results for all variables other than consumption using our simplified consumption specification outlined in section 3.2 . The projections for consumption by I-O industry are presented for both the simplified and expanded consumption specifications.

4.1 The Setting of the Values for the Exogenous Variables and Parameters

The input-output data file describing the 1971/72 economy is set out in figure 1[1] and the major components of the exogenous input required for the simulation experiment are listed in Table 2. In our validation exercise, the values for most of the exogenous inputs for SNAPSHOT were set by using the information in figure 1. In the remainder of this subsection we provide brief notes on the setting of each of the exogenous variables and parameters.

(a) Government Expenditure ($\bar{G}$)

The vector $\bar{G}$ is set by adding Q2 (figure 1) to Q6. That is we have added the vector of increase in stocks (Q6) to the vector of government consumption expenditure. Our theory makes no explicit provision for the treatment of stocks. However, the accumulation of stocks uses inputs and the run down of stocks 'saves' inputs; hence the vector of changes in stocks needs to be accounted for somewhere in the model for the validation exercise. A simple way of incorporating stocks into the analysis for the validation run is to add them to final demand via the exogenous government expenditure vector.

(b) Exports ($\bar{E}$)

The vector of exports is simply column Q7 of figure 1.

(c) Imports

It will be recalled that the SNAPSHOT theory requires exogenous import shares of the domestic market. The import share vector (γ) is set as :

1. The data file of figure 1 is the 1971/72 Input-Output Table Update - see Lawson (1978) (forthcoming).

by the level of residual funds available to agricultural firms. The snapshot year 1971/72 represented the third year of a period of heavily depressed incomes in Australian agriculture, due largely to very low wool prices and quotas on wheat production. In terms of SNAPSHOT, if actual investment by the using (agricultural) industries in 1971/72 were considerably less than that required to maintain the average rate of growth in the agricultural machinery capital stock over the 1962/63 to 1971/72 period, then the model as currently constructed would considerably overstate the investment (and hence output) supplied by industry 73 (agricultural machinery).

To test whether agricultural investment in 1971/72 was below trend, we analysed time series information on investment and capital stocks of plant and machinery in constant (1952/53) prices for three major geographic zones of the agricultural sector.[1] First, logarithmic trends were fitted to the constant price capital stock data for each zone for the period 1962/63 to 1971/72 and the resultant trend equations used to project the capital stock for the post-snapshot year 1972/73 on the assumption that the trend rate of growth continued. The projected capital stocks for 1972/73 were compared with the actual capital stocks in 1972/73 and the amount of investment required in the snapshot year to maintain the growth rate was compared with that which actually occurred. The results are summarised in Table 8. They suggest that investment by agricultural firms in plant and

1. These zones, namely, the pastoral zone, the wheat/sheep zone, and the high rainfall zone, are those delineated by the Bureau of Agricultural Economics (BAE) in their Australian Sheep Industry Survey (ASIS). The data analysed were initially constructed for IMPACT's study of agricultural supply. (See Vincent, Dixon and Powell (1977.))

In addition, some fine tuning along the rows for some capital supplying industries was undertaken in light of early projections from the SNAPSHOT model on the vector of investment by supplying industry.[1]

A comparison of the projected vector of investment by supplying industry with the actual vector (Q3 + Q4 + Q5 of figure 1) is contained in Table 7. Investment supplied is projected satisfactorily for most significant capital supplying industries. The two notable exceptions are agricultural machinery in which investment is over projected by 67 per cent and residential building in which investment is under projected by 10 per cent.

We attribute the model's large projection error in the case of industry 73 (agricultural machinery) to the fact that investment behaviour in using industries to which the capital was supplied (the six agricultural industries) was atypical in the snapshot year compared with average investment behaviour over the snapshot period.[2] Agricultural investment is notoriously unstable over time. While no entirely convincing explanations of the investment behaviour of farmers have yet emerged there is a general consensus that investment behaviour is motivated to a substantial extent

1. While the projections of investment by using industry, J , looked reasonable, the early calculations of KJ indicated problems in the K matrix. We made various corrections to the outdated Monash capital coefficients matrix as an interim measure pending the completion of IMPACT's 1971/72 capital matrix. (See Senior (1978) in preparation.)

2. A key postulate of the investment specification is that investment by each industry in the snapshot year is sufficient to maintain the endogenous growth rates (established for the snapshot period) into the post-snapshot year (equation (1.4)). Hence, if for some reason actual investment in a particular industry for 1971/72 was below the trend value indicated by investment behaviour over the period 1962/63 to 1971/72, we would expect the model's projection of investment for that industry to be overstated compared with that which actually occurred.

FIGURE 1

DATA FILE REPRESENTING THE 1971/72 ECONOMY

		Industry 1 → 109	Q1 Household consumption	Q2 Government consumption	Q3 Private investment	Q4 Public enterprise investment	Q5 General government investment	Q6 Increase in stocks	Q7 Exports
Industry 1 → 109									
Wages, salaries	P1								
Gross operating surplus	P2								
Taxes-subsidies	P3								
Indirect taxes n.e.c.	P4								
Sales by final buyers	P5								
Complementary imports	P6A								
Duty on P6A	P7A								
Domestic Production	P7								
Competing Imports	P6BC								
Duty on P6BC	P7BC								

TABLE 2

MAJOR COMPONENTS OF EXOGENOUS INPUT[a]

Technology (I-O coefficients matrices)

A	:	input-output coefficients matrix
ℓ	:	labour requirements matrix
K	:	capital requirements matrix

Demography and Wages

$\bar{N}$	:	number of people in the workforce
$\bar{w}$	:	relative wage rates, before taxes, by occupation

Trade

$\bar{Pe}$	:	export prices (f.o.b.) in foreign currency
$\bar{Pm}$	:	import prices (c.i.f.) in foreign currency
$\bar{B}$	:	balance of trade deficit in foreign currency
γ	:	import shares of the domestic markets
τ	:	ad valorem tariff rates
$\bar{E}$	:	exports of commodities

Capital Stocks; Rates of return, Depreciation

$K(0)$	:	industry levels of capital stock in the base year
$\bar{r}$	:	relative rates of return to capital required to induce investment in each industry
η	:	industry specific depreciation rates

Taxes

T_1	:	ad valorem taxes and other costs
T_2	:	ad valorem taxes on creation of capital
t_c	:	ad valorem taxes on consumption
t_E	:	ad valorem taxes (net of subsidies) on exports

Government

$\bar{G}$	:	government consumption expenditure

(a) For a detailed description of the source and method of construction of all components of the SNAPSHOT data base see Harrower and Vincent (1978).

TABLE 7

INVESTMENT BY SUPPLYING INDUSTRY[a]

	Input-Output Industry[b]	Projected ($m)	Actual ($m)	Per cent Error
11	Other Metallic Minerals	13.1	16.5	-21
12	Coal & Crude Oil	10.2	11.9	-14
39	Joinery & Wood Products	23.6	24.6	- 4
40	Furniture, Mattresses	45.1	46.8	- 4
62	Structural Metal	151.7	157.1	- 3
63	Sheet Metal Products	169.8	171.1	- 1
64	Metal Products n.e.c.	14.7	14.7	-
65	Motor Vehicles, parts	700.4	706.0	- 1
66	Ship & Boat Building	68.8	68.0	1
67	Locomotives	54.8	54.6	-
68	Aircraft Building	21.3	22.2	- 4
69	Scientific Equipment	63.2	62.8	1
70	Electronic Equipment	61.9	65.8	- 6
71	Household Appliances	77.6	75.0	4
72	Electrical Machinery	242.5	238.9	2
73	Agricultural Machinery	151.1	90.7	67
74	Construction Equipment	207.6	207.0	-
75	Other Machinery	761.5	781.6	- 3
78	Plastic Products	2.4	2.4	-
79	Signs, Writing Equipment	11.8	11.8	-
84	Residential Building	1644.1	1832.1	-10
85	Building n.e.c.	3575.1	3566.6	-
86	Wholesale Trade	464.8	465.0	-
87	Retail Trade	137.9	135.8	2
90	Road Transport	126.9	126.2	1
91	Rail Transport	33.5	36.5	- 8
92	Water Transport	17.0	21.8	-22
93	Air Transport	3.2	3.8	-16
97	Other Insurance	0.5	0.6	-17
98	Investment, Real Estate	134.2	139.5	- 4
99	Other Business Services	204.2	197.1	4

(a) Only industries that actually supplied investment goods for 1971/72 are shown in the table. For those industries not supplying investment, the projected investment will also be zero. This follows because the relevant rows of the capital matrix will contain only zeros.

(b) Industry 94 (communication) is shown in the Input-Output table as supplying no capital to private investment but $222.4m of capital to public enterprise investment. We have treated this investment as exogenous and have included it in the government expenditure vector.

category. They are industry 65 (motor vehicles and parts), industry 88 (motor vehicle repair) and industry 90 (road transport). In the case of industries 65 and 88, virtually all the output consumed falls into the transport category, hence the projection errors of 16 per cent. However, for industry 90 only 65 per cent of its output going to consumption is represented by transport (the remainder represents road transport mark-ups on other consumer goods categories). Hence the projection error is reduced to 9 per cent. For medical goods, the major industries involved are 49 (pharmaceuticals) and 103 (health). In both cases, nearly all their output passing to final consumption is medical goods. Hence the projection errors correspond in size and sign to those of 'medical' in Table 5. In the case of the food category, the under projection of about 10 per cent results in under projections of the same amount for the following industries whose sales to households are classified entirely into 'food' : 1, 3, 4, 5, 9, 15, 16, 17, 18, 19, 20, 21 and 23.

(b) Investment

SNAPSHOT provides a vector of investment by supplying industries (KJ) where K is the capital coefficients matrix and J is the endogenous vector of gross investment by using industries. Hence the accuracy of the projections of investment by supplying industry will depend heavily on the extent to which the capital coefficients matrix depicts the economy's capital input technology in the snapshot year. As stated earlier the column totals of the Monash capital matrix were standardised so that they were consistent with information on payments to capital in the I-O tables.

γ = Competing imports plus duty (rows P6BC + P7BC of figure 1)/ Domestic production (row P7 of figure 1)

Hence the endogenous vector of imports should reproduce the sum of the competing imports plus duty rows (P6BC plus P7BC).

(d) Tariffs (τ)

The vector of ad valorem tariffs on imports was obtained by dividing the vector of duty paid on competing imports (row P7BC of figure 1) by the vector of competing imports (row P6BC of figure 1).

(e) Technology and Tax Coefficients (A, K, ℓ, T_1, T_2, t_c, t_E)

The input-output coefficients matrix (A) represents the industry by industry basic values gross indirect allocation flows table for 1971/72 with each element divided by its corresponding column industry output. That is, a typical element of A (a_{ij}) shows the amount of output of industry i required to produce a unit of output of industry j.

The capital coefficients matrix (K) currently being used in SNAPSHOT is based on the capital matrix which was prepared for the Monash University Tariff study.[1,2] After the Monash coefficients had been mapped into the 1968/69 I-O classification the coefficients were adjusted so that the column totals (industry capital-output ratios) when capitalised reflected that part of the gross operating surplus representing payments to fixed capital.

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1. See Evans et al. (1973), Feiger (1972) and Brown (1972).

2. K is a square matrix whose typical element k_{ij} is the quantity of good i required in the capital stock necessary to support the production of one unit of output from industry j.

The labour coefficients matrix (ℓ) is based on a matrix showing the number of persons employed in each of the nine occupational groups used in the IMPACT Project.[1] The 'persons' matrix was then converted to a coefficients matrix by dividing each element by its respective column industry output in 1971/72.

The first step in forming the T_1 matrix of taxes and other costs was to sum three vectors. The three vectors were (i) the P3 (taxes-subsidies) row of figure 1, (ii) the P4 (indirect taxes n.e.c.) row of figure 1 and (iii) a row including P5 (sales by final buyers) and the residual of gross operating surplus not accounted for by payments to fixed capital and payments to owner-operator labour.[2] Having formed the sum of the three vectors, we obtained the T_1 matrix by assuming that the ad valorem rates of taxes and other costs are uniform over the elements in any given column of the intermediate flows matrix.[3]

The vector of ad valorem taxes on consumption (t_c) for 1971/72 was constructed by dividing the vector of taxes on consumption by the vector of household consumption (Q1 of figure 1). Similarly, the vector of ad valorem taxes (net of subsidies) on exports (t_E) was obtained by

1. This matrix was constructed from information in the ABS 1971 Census of Population and Housing.

2. For the land using agricultural industries, industries 1-4 and 6, a substantial part of the gross operating surplus represents payments to land. In other industries, the residual gross operating surplus represents payments to working capital.

3. Since no substitution is permitted between intermediate inputs, the method of allocating these additional costs up the columns of the intermediate flows table does not affect model solutions.

Table 6 (contd)

	Input-Output Industry	Simplified Specification			Expanded Specification		
		Projected ($m)	Actual ($m)	Per cent Error	Projected ($m)	Actual ($m)	Per cent Error
86	Wholesale Trade	1271.2	1259.9	1	1261.8	1259.9	-
87	Retail Trade	2804.5	2786.3	1	2784.8	2786.3	-
88	Motor Vehicle Repair	541.0	510.6	6	593.4	510.6	16
89	Other Repairs	86.6	86.9	-	94.4	86.9	9
90	Road Transport	607.2	584.5	4	639.7	584.5	9
91	Railway Transport	169.5	163.9	3	181.0	163.9	10
92	Water Transport	148.1	140.7	5	160.9	140.7	14
93	Air Transport	234.4	222.4	5	256.7	222.4	15
94	Communication	232.9	231.4	1	236.7	231.4	2
95	Banking	70.7	70.9	-	77.0	70.9	9
96	Finance & Life Insurance	285.0	283.0	1	272.2	283.0	- 4
97	Other Insurance	164.8	160.9	2	170.8	160.9	6
98	Investment, Real Estate	101.7	102.0	-	110.8	102.0	9
99	Other Business Services	109.1	109.4	-	118.9	109.4	9
100	Ownership of Dwellings	3073.2	3053.2	1	3123.3	3053.2	2
101	Public Administration	47.9	48.0	-	52.2	48.0	9
103	Health	993.5	982.5	1	891.9	982.5	- 9
104	Education, Libraries	196.4	197.0	-	214.1	197.0	9
105	Welfare Services	128.9	129.3	-	140.5	129.3	9
106	Entertainment	368.9	367.3	-	399.1	367.3	9
107	Restaurants, Hotels	1088.1	1076.0	1	1119.7	1076.0	4
108	Personal Services	281.1	281.9	-	306.3	281.9	9
110	Non-competing Imports	134.0	134.2	-	139.6	134.2	4

Table 6 (contd)

	Input-Output Industry	Simplified Specification			Expanded Specification		
		Projected ($m)	Actual ($m)	Per cent Error	Projected ($m)	Actual ($m)	Per cent Error
44	Newspapers & Books	179.7	180.2	-	195.8	180.2	9
45	Commercial Printing	44.8	44.9	-	48.8	44.9	9
46	Chemical Fertilisers	4.7	4.7	-	5.1	4.7	9
47	Industrial Chemicals	0.4	0.4	-	0.4	0.4	-
48	Paints, Varnishes	4.7	4.7	-	5.1	4.7	9
49	Pharmaceuticals	104.2	103.1	1	94.2	103.1	- 9
50	Soap & Detergents	70.1	70.2	-	74.5	70.2	6
51	Cosmetics, Toiletry	72.9	72.8	-	75.1	72.8	3
52	Chemical Products n.e.c.	24.6	24.6	-	26.7	24.6	9
53	Oil & Coal Products	176.3	167.2	5	192.3	167.2	15
54	Glass	20.9	20.3	3	22.1	20.3	9
55	Clay Products	7.9	7.7	3	8.4	7.7	9
56	Cement	0.4	0.4	-	0.4	0.4	-
58	Concrete Products	0.3	0.3	-	0.3	0.3	-
59	Non-Metal Mineral Products	3.8	3.8	-	4.1	3.8	8
60	Basic Iron & Steel	0.7	0.7	-	0.8	0.7	14
61	Other Basic Metals	7.4	7.4	-	8.0	7.4	8
62	Structural Metal	9.1	9.0	1	9.8	9.0	9
63	Sheet Metal Products	11.1	10.8	3	11.7	10.8	8
64	Metal Products n.e.c.	63.2	62.2	2	66.7	62.2	7
65	Motor Vehicles, parts	469.5	444.0	6	514.5	444.0	16
66	Ship & Boat Building	11.0	10.7	3	11.6	10.7	8
68	Aircraft Building	0.4	0.4	-	0.4	0.4	-
69	Scientific Equipment	47.3	46.8	1	50.2	46.8	7
70	Electronic Equipment	106.6	103.7	3	112.7	103.7	9
71	Household Appliances	214.6	208.8	3	226.9	208.8	9
72	Electrical Machinery	29.1	28.1	4	31.0	28.1	10
74	Construction Equipment	0.2	0.2	-	0.2	0.2	-
75	Other Machinery	5.8	5.6	4	6.1	5.6	9
76	Leather Products	58.7	59.1	- 1	57.7	59.1	- 2
77	Rubber Products	100.8	96.0	5	110.1	96.0	15
78	Plastic Products	99.4	97.7	2	105.6	97.7	8
79	Signs, Writing Equipment	4.9	4.9	-	5.3	4.9	8
80	Other Manufacturing	112.1	111.6	-	120.2	111.6	8
81	Electricity	393.6	391.0	1	400.0	391.0	2
82	Gas	91.6	91.0	1	93.1	91.0	2
83	Water, Sewerage	16.1	16.1	-	17.5	16.1	9

dividing the vector of export taxes (net of subsidies) by the vector of exports (Q7 of figure 1).[1]

The T_2 matrix represents ad valorem taxes on capital flows. This matrix was constructed from the 1968/69 vector of taxes on investment,[2] where investment is represented by the three vectors of fixed capital expenditure (columns Q3, Q4 and Q5 of figure 1). The tax vector was divided by the 1968/69 vector of investment flows and the resultant ad valorem vector converted to a square matrix by replicating the vector. That is, we have assumed that the ad valorem tax on the investment flow from industry i to industry j is the same for all j.

All inputs are fully accounted for by the matrices of technology and taxes. That is, if the model were to generate the exact vector of industry outputs in the snapshot year, the industry inputs would correspond exactly to those of the 1971/72 table. For example, consider the input structure of a typical industry in the I-O table. The first 109 rows are intermediate inputs, then follows the two primary input rows, then taxes, sales by final buyers and non-competing (or complementary) imports. These inputs are accounted for as follows. The 109 intermediate input rows and the complementary imports row are reflected in the intermediate usage coefficients matrix (A).[3] The wages, salaries row together with the share

1. Tax vectors on consumption and exports have been compiled for 1971/72 by Lawson (1978)(forthcoming).

2. Information on taxes on investment flows for the 1971/72 I-O table is at present incomplete. Hence the underlying assumption is that ad valorem rates in 1971/72 can be approximated by the 1968/69 rates. In any case, taxes on capital flows are very small.

3. The 110th row represents the amount of non-competing imports required in the production of a unit of output of the corresponding column industry.

of gross operating surplus represented by payments to imputed labour are incorporated via the labour coefficients matrix (ℓ) . If we convert the ℓ matrix into a 'persons' matrix by multiplying each column by the respective industry output, then to a wage bills matrix by multiplying by the vector of average wages for each occupation, the resultant column totals of the wage bills matrix represent the row (P1) of wages, salaries, plus the share of gross operating surplus representing payments to owner-operator labour.

The share of gross operating surplus representing payments to fixed capital is accounted for by the capital coefficients matrix (K) . The column totals of the K matrix (representing industry capital stock/output ratios) are constrained as follows :

$$\left(K/X\right)_i = GOS_i \times \left[\frac{FC}{GOS}\right]_i \times \frac{1}{(r_i+\eta_i)} \times \frac{1}{X_i}$$

That is, the capital output ratio for industry i represents the share of gross operating surplus accruing to fixed capital for industry i $\left[GOS \times \frac{FC}{GOS}\right]_i$, capitalised at the gross rate of return for industry i and divided by the output of industry i (X_i) .

The remaining inputs representing the taxes-subsidies row (P3), indirect taxes n.e.c. (P4), sales by final buyers (P5) and the share of gross operating surplus not accounted for by payments to fixed capital (via the capital coefficients matrix) and payments to imputed labour (via the labour coefficients matrix) are accounted for by the matrix of other costs (T_1) .

TABLE 6

CONSUMPTION BY INPUT-OUTPUT INDUSTRY

	Input-Output Industry *	Simplified Specification			Expanded Specification		
		Projected ($m)	Actual ($m)	Per cent Error	Projected ($m)	Actual ($m)	Per cen Error
1	Sheep	14.0	14.1	- 1	12.8	14.1	- 9
3	Meat Cattle	8.8	8.9	- 1	8.1	8.9	- 9
4	Milk Cattle	26.5	26.8	- 1	24.3	26.8	- 9
5	Poultry	108.8	109.9	- 1	99.5	109.9	-10
6	Other Farming	260.6	263.1	- 1	243.3	263.1	- 8
8	Forestry	10.2	10.1	1	10.3	10.1	- 2
9	Fishing	30.2	30.5	1	27.9	30.5	- 9
11	Other Metallic Minerals	0.1	0.1	-	0.1	0.1	-
12	Coal & Crude Oil	11.4	11.3	1	11.6	11.3	3
13	Non-Metallic n.e.c.	1.3	1.3	-	1.4	1.3	8
15	Meat Products	913.6	922.9	- 1	835.7	922.9	-10
16	Milk Products	530.3	535.7	- 1	485.0	535.7	-10
17	Fruit & Vegetable Products	235.1	237.5	- 1	215.0	237.5	-10
18	Margarine, Oils & Fats	56.8	57.4	- 1	52.0	57.4	- 9
19	Flour & Cereal Products	86.2	87.1	- 1	79.1	87.1	- 9
20	Bread, Cakes	381.2	385.1	- 1	348.6	385.1	-10
21	Confectionery	113.4	114.5	- 1	103.7	114.5	- 9
22	Food Products n.e.c.	225.2	227.2	- 1	212.2	227.2	- 7
23	Soft Drinks, Cordials	164.8	166.5	- 1	150.7	166.5	-10
24	Beer & Malt	240.1	233.3	3	228.7	233.3	- 2
25	Alcoholic Drinks n.e.c.	120.5	117.1	3	114.8	117.1	- 2
26	Tobacco	224.3	217.9	3	213.6	217.9	- 2
28	Man-Made Fibres	12.8	12.9	- 1	12.2	12.9	- 5
29	Cotton, Silk, Flax	90.2	91.2	- 1	86.2	91.2	- 6
30	Wool & Worsted Yarns	30.5	30.8	- 1	29.1	30.8	- 6
31	Textile Finishing	18.0	18.2	- 1	17.2	18.2	- 6
32	Textile Floor Covers	101.9	99.1	3	107.7	99.1	9
33	Textile Products n.e.c.	15.1	14.8	2	15.9	14.8	7
34	Knitting Mills	173.8	175.8	- 1	166.1	175.8	- 6
35	Clothing	606.4	613.3	- 1	579.6	613.3	- 6
36	Footwear	213.2	215.6	- 1	203.8	215.6	- 6
37	Sawmill Products	5.4	5.3	2	5.8	5.3	9
38	Plywood, Veneers	5.8	5.7	2	6.2	5.7	9
39	Joinery & Wood Products	36.6	36.5	-	39.6	36.5	9
40	Furniture, Mattresses	230.5	224.5	3	243.6	224.5	9
41	Pulp, Paper	3.8	3.8	-	4.1	3.8	8
42	Fibreboard	0.3	0.3	-	0.3	0.3	-
43	Paper Products n.e.c.	38.6	38.6	-	40.1	38.6	4

* Actual and projected consumption is zero in all omitted industries.

TABLE 5

CONSUMPTION BY CONSUMER GOOD CATEGORY

A. Simplified Consumption Specification

Category[b]	Projected $m[a]	Actual $m[a]	Per cent Projection Error
1. Food	4395	4439	-1.0
2. Cigarettes, alcohol, tobacco	1299	1262	2.9
3. Clothing	2064	2088	-1.1
4. Household Overheads	3852	3827	0.7
5. Durables	1491	1450	2.8
6. Medical	1582	1565	1.1
7. Transport	2673	2523	5.9
8. Recreation	558	556	0.4
9. Other	3139	3148	-0.3
Total	21053	20858	0.9

B. Expanded Consumption Specification

Category[b]	Projected $m[a]	Actual $m[a]	Per cent Projection Error
1. Food	4019	4439	-9.5
2. Cigarettes, alcohol, tobacco	1237	1262	-2.0
3. Clothing	1973	2088	-5.5
4. Household Overheads	3915	3827	2.3
5. Medical	1418	1565	-9.4
6. Transport	2932	2523	16.2
7. Luxuries (including Durables, Recreation and Other in A)	5601	5154	8.7
Total	21094	20858	1.1

(a) These consumption flows are valued in purchasers prices before consumer commodity taxes. The purchasers price equivalents may be obtained by multiplying by (1 + ad valorem consumer tax rate) for that category.

(b) The consumer goods categories correspond closely to the categories of final consumption expenditure distinguished in the Australian National Accounts (see Australian Bureau of Statistics (1974)).

(f) Workforce ($\bar{N}$) and Wages ($\bar{w}$)

The total number of people in the workforce in 1971/72 is simply the total number of people in the 'persons' matrix; that is, $\bar{N} = 1'\ell X$ where X is the 1971/72 industry output vector. The vector of relative wages for 1971/72 for each of the nine occupations was constructed from wage information supplied to the IMPACT project by the Australian Bureau of Statistics.

(g) Export prices ($\bar{Pe}$), Import prices ($\bar{Pm}$) and Balance of Trade ($\bar{B}$)

Export and import prices are expressed in foreign currency f.o.b. and c.i.f. respectively. They are set so that in the case of exports $\hat{\bar{P}e}\bar{E}$ will reproduce the 1971/72 f.o.b. vector of exports (Q7 of figure 1) and $\hat{\bar{P}}mM$ (where M is the vector of imports) will reproduce the c.i.f. vector of imports (row P6BC of figure 1). The method of construction is that followed by Evans (1972a). First, industries were classified as exporting or import competing on the basis of positive or negative net exports for 1971/72. One 1971/72 Australian dollar has been defined as the unit of quantity, that is, the price of this unit of quantity is one dollar. Export and import prices are then defined in terms of 1971/72 domestic prices of unity.

For import competing industries, the domestic price (Pd) will equal the duty paid import price. That is, $Pd = \bar{P}m\ (1+\tau)$. Hence $\bar{P}m = 1/(1+\tau)$. In the case of the export price of import competing industries, it was assumed that the c.i.f. price equalled the world price ($\bar{P}w$) plus transport costs. Since $\bar{P}e = \bar{P}w$ - (transport) and $\bar{P}m = \bar{P}w$ + transport, $\bar{P}e = \bar{P}m$ - 2 (transport). We have arbitrarily assumed that transport equals 0.1, that is, 10 per cent of the price for all traded goods.

For export industries, the export price was assumed equal to the domestic price.[1] The import price was estimated by assuming that the f.o.b. export prices equalled world prices 'on board' at Australian ports. To allow for handling charges, a one per cent margin has been allowed. That is, $\bar{P}m = 1.01\ \bar{P}e$.

For non-traded industries, the export price was set to zero and the import price was arbitrarily set to 10 (to ensure no imports). In summary then ;

Price	Exporting Industry	Import Competing Industry	Non-traded Industry
$\bar{P}e$	1	$\bar{P}m - 0.2$	0
$\bar{P}m$	1.01	$1/(1+\tau)$	10

The balance of trade deficit $\bar{B}$ was set by multiplying the f.o.b. value of exports ($\bar{E}$) by the export price vector ($\bar{P}e$) , and subtracting from this both the product of the import price vector ($\bar{P}m$) and the duty paid value of competing imports (M) and the value of non-competing imports.

(h) Capital Stocks (K(0)), Rates of Return ($\bar{r}$) and Depreciation (η)

By definition, the base year capital stocks for the 109 industries in the 1971/72 I-O table are the outputs of these industries in 1962/63.

1. Strictly speaking, we should have modified the export price vector to reflect taxes and subsidies. However, these are negligible for the major export industries in the 1971/72 economy.

the expanded specification of consumer demand.[1] The projections for the nine (seven) consumer goods categories are then mapped into the 109 input-output industries plus the complementary imports 'industry' using consumption matrix classifiers. The comparison of projected consumption for each of the consumer goods categories with actual consumption is shown in Table 5.

In the case of the simplified consumption specification, consumption by consumer good category is projected accurately. This is not surprising since with the Cobb-Douglas production function, the budget shares are exogenous and we set them at the 1971/72 values. The results do indicate, however, that the prices of consumer goods have been projected satisfactorily. As would be expected, the projections based on the expanded consumption specification (where the budget shares are endogenous) are less precise. In particular, consumption of the transport category is too high and consumption of the food and medical categories are too low. Further research will be required to explain these problems.

Table 6 contains projections of consumption by I-O industry. Since these results are obtained via the matrix classifier and the results of Table 5 the simplified consumption specification yields very accurate projections while those of the expanded specification are somewhat less accurate. Consider for example, the major components of the transport

1. In estimating the Klein-Rubin consumption parameters for the different household types from the ABS Household Expenditure Survey, 1974-75 it was found that the data was not sufficient to support an analysis on the basis of the nine consumer goods categories originally outlined. See Williams (1978) for reasons for the amalgamation of consumer goods categories.

TABLE 4

PAYMENTS TO CAPITAL AND TO LABOUR

Components	Estimate	Actual
Payments to labour ($m)	22124	22213
Payments to fixed capital ($m)	9814	9618
Average wage[(a)] ($)	4220	4237
Payments to labour as a proportion of payments to labour plus capital	0.69	0.70

(a) Average wage = total payments to wages, salaries, imputed labour/ total workforce.

4.5 Industry Analysis

In this subsection we concentrate on the performance of the endogenous variables, consumption, investment, imports and domestic output at an I-O industry level. The approach is to compare in turn the projection for each endogenous vector with the corresponding actual vector (as given in the 1971/72 I-O tables). As a general rule, whenever the projection lies within 5 per cent of the actual figure, no comment is made about the result.

(a) Consumer Demand

The model projects consumption for nine consumer goods categories in the case of the experiment with the simplified consumption specification and for seven consumer goods categories in the case of the experiment with

The 105 industry outputs for 1962/63 were mapped into the 109 I-O industries then expressed in 1971/72 prices using price indexes for the 1962/63 to 1971/72 period. Rates of return (before tax) to fixed capital were assembled from a number of sources; annual reports and industry inquiry reports of the Industries Assistance Commission in the case of manufacturing and mining industries, Bureau of Agricultural Economics surveys in the case of rural industries and Reserve Bank statistical bulletins in the case of service industries. Industry specific depreciation rates were assembled from information used in the ORANI model and from information collected as part of the IMPACT capital matrix project.

4.2 The Validation Experiment

The aim of the validation experiment is to determine how accurately SNAPSHOT can reproduce the key economic aggregates of the 1971/72 economy and the industry vectors of household consumption (column Q1 of figure 1), investment (the sum of columns Q3, Q4 and Q5), domestic production (row P7), industry growth rates and workforce labour demands by occupation given the exogenous inputs listed in the previous subsection.

4.3 Macro Projections

The convention adopted was that all output quantity units were defined so that the basic value of a unit of each good was $1 in 1971/72. Hence the projected final demand components can be added to arrive at real GNP in 1971/72 prices. Since GNP is conventionally defined in terms of 'purchasers' prices and the aggregates projected in SNAPSHOT are in basic

values, in the following comparison of actual and projected GNP (Table 3) we include the projections (in 1971/72 prices) of commodity taxes (net of subsidies) for each of the aggregates. The results in Table 3 show that the model projects the demand-side aggregates to a high degree of accuracy.

TABLE 3
PROJECTION OF GNP AND ITS COMPONENTS

Item	SNAPSHOT Projection ($m 1971/72)	Actual ($m 1971/72)
Consumption (basic values)	21053	20858
Net taxes on consumption	1404	1361
Private investment (basic values)	9194	9355
Net taxes on investment	73	79
Government expenditure	4942 (exogenous)	4942
Exports (basic values)	5429 (exogenous)	5429
Net taxes on exports	-38 (exogenous)	-38
Imports - competing	4342	4337
- non-competing	656	658
GNP	37059	36991

Gross national product can also be computed from the income side of the national income identity. That is, GNP can be computed by summing the payments to wages, rents on capital, tariff revenue less export subsidies (net of taxes) plus the various tax components on

consumption, exports, intermediate flows, capital flows and indirect taxes n.e.c. SNAPSHOT, in common with other general equilibrium programming models, tells us nothing about the absolute price level in the economy. If we compare the value of GNP obtained by adding the various projected components on the income side (which reflect SNAPSHOT solution prices) with that obtained by adding the endogenous and exogenous components of final demand (Table 3) (where components of final demand have been calculated assuming all prices are unity in the snapshot year) we obtain a measure of the implicit GNP deflator in the model. For example GNP (from final demand side) = $163522m, (GNP from income side) = $37059m. Hence the GNP deflator = 4.41 .

4.4 Payments to Capital and to Labour

We can now use the deflator to arrive at estimates in 1971/72 prices of the projected payments to labour and capital. The actual payments to labour are the total of the wages and salaries row plus the total imputed labour payments from the gross operating surplus. The actual payments to capital represent the gross operating surplus accruing to the fixed capital stock.

The comparisons between estimated and actual payments to labour is shown in Table 4. The results indicate that SNAPSHOT is able to satisfactorily determine the split between capital and labour income in the economy given the exogenous specification of actual rates of return.