IMPACT OF DEMOGRAPHIC CHANGE ON INDUSTRY STRUCTURE IN AUSTRALIA

A joint study by the Australian Bureau of Statistics, the Department of Employment and Industrial Relations, the Department of Environment, Housing and Community Development, the Department of Industry and Commerce and the Industries Assistance Commission

COMPUTING MANUAL FOR THE ORANI MODEL

FIRST EDITION

by

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Industries Assistance Commission

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by John Sutton*

1. INTRODUCTION

This manual is a first attempt at explaining how to compute solutions to the ORANI model of the Australian economy, which has been described in Volume 2 of the First Progress Report of the IMPACT Project[1] (hereafter referred to as Volume 2). Users are now encouraged to develop the expertise to use programs and to interpret the results. It is assumed that readers of this manual are already familiar with Volume 2. It is also assumed that they have the services of someone who is familiar with the CSIRONET computing system. In fact much of this manual is addressed to the persons who will be running the programs. It must be emphasized that it would be dangerous to run the ORANI programs as a "black box" by referring to this manual alone. To obtain sensible results it is necessary to appreciate the structure of the model.

Although the programs are now operational, work on them is continuing so as to reduce computing times and computing costs, to simplify the usage and to increase their versatility and range of

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* I am indebted to Allan Mikkelsen for his efforts in reducing the computing costs and in making the programs less difficult to use, and also helpful criticisms of this text from the user's point of view.

1. P.B. Dixon, B.R. Parmenter, G.J. Ryland and J. Sutton, ORANI, A General Equilibrium Model of the Australian Economy : Current Specification and Illustrations of Use for Policy Analysis - First Progress Report of the Impact Project, Vol. 2 (Canberra : Australian Government Publishing Service, 1977).

application. Appendix 1 lists some of the changes which are under consideration. The programs have been developed from the point of view of the IMPACT team, and it is to be expected that other users will have other requirements. Comments, criticisms, and suggested modifications are most welcome, particularly from users who have studied Volume 2 carefully and who have tried out the programs. Feedback should be directed to John Sutton at the IAC, Melbourne. Queries about running the programs should also be addressed to John Sutton in Melbourne (telephone (03) 518611) or to Allan Mikkelsen at the IAC, Canberra (telephone (062) 730 415).

In summary, the function of the ORANI model from a computational point of view is to calculate, for a specified economic environment, the percentage changes in endogenous variables which would result from given changes in certain exogenous variables. The model can be run for a large variety of environments, where each is defined by a particular separation of the variables into endogenous and exogenous. Results can be printed for any arbitrary set of assumptions about the magnitudes of the autonomous changes (if any) in the exogenous variables. The structure of the ORANI model implies that, for small changes in the exogenous variables, the resultant percentage effects on any particular endogenous variable can simply be added to one another. This is a consequence of the linearity of the ORANI reduced form in logarithmic differentials. This linearity implies for example, that the effects produced by a 6 per cent change in an exogenous variable will be twice those for a 3 per cent change.

These assumptions should be kept in mind when interpreting the results.

The starting point for the calculations consists of 5 data files which contain a modified version of the input-output table and a set of parameters. These files are IOTABLES6869, MARGINS6869, PARAMS6869, R1R2 and PDIMPORTS6869. The computations then consist of running several programs in sequence (see the flow diagram in figure 1) :

(1) EQNS, which forms numerous matrices from the data files in preparation for the basic solution.

(2) ORANI, the basic solution program.

(3) BACK and SANDX4, which compute the back solutions.

(4) PIE, which prints results (which were computed in ORANI, BACK and SANDX4) for selected combinations of endogenous and exogenous variables.

At present PARAMS6869 is the only data file which can be changed by users. However, users will often find that the standard version used by the IMPACT team (see Appendix 2 - PARAMS) is suitable for their purposes and thus there is no need to re-run the jobs PARAMS and EQNS. Indeed, the standard ORANI solution (see Appendix 2 - ORANI) will be adequate for many purposes : it is necessary then to run only the job PIE. For these reasons it may be best to study the notes for individual programs in the sequence ORANI, PIE, SANDX4, BACK, PARAMS, EQNS.

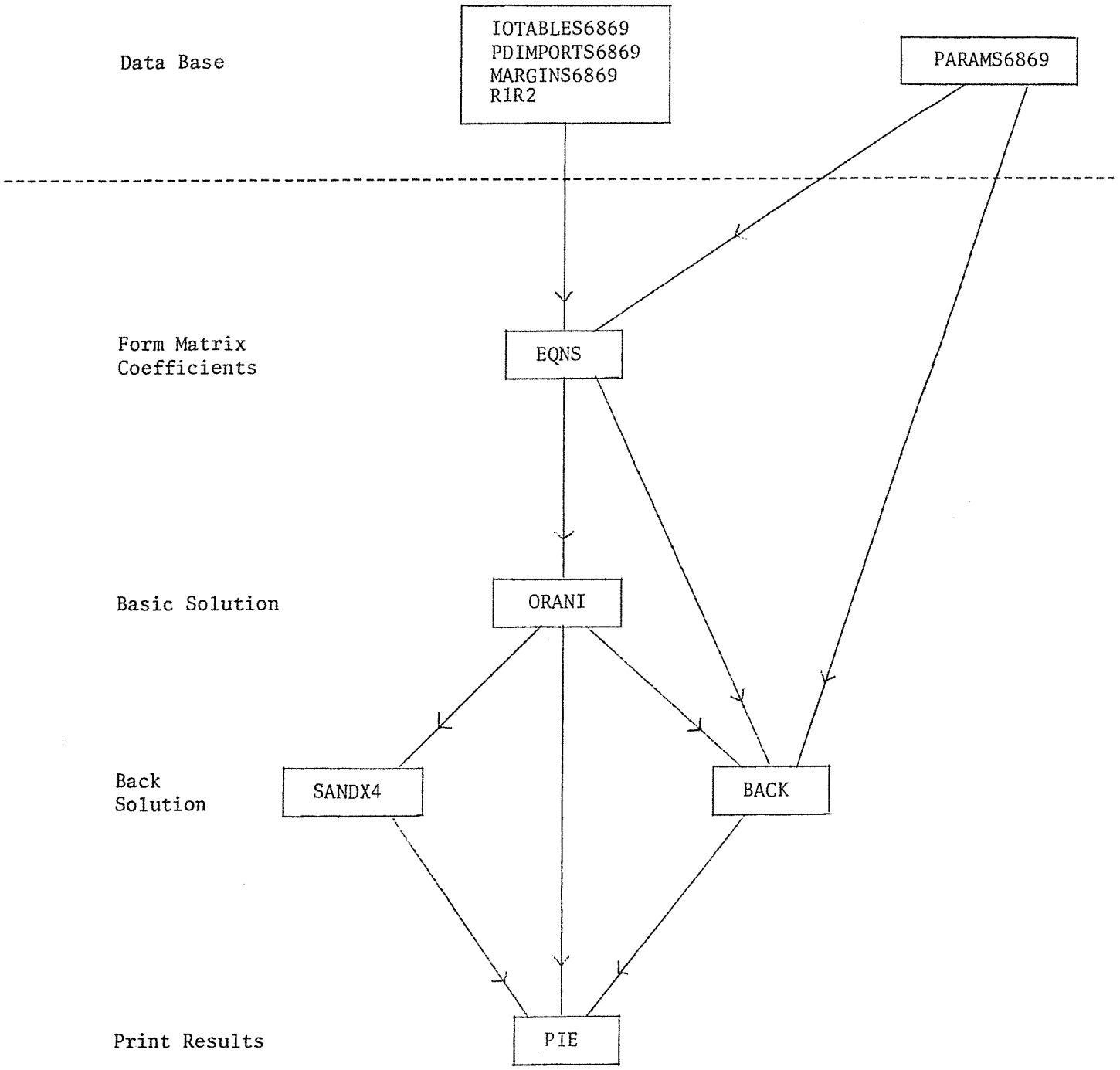

Figure 1 : Flow Diagram for ORANI Solutions

Computations are performed on the CSIRO's CYBER 76. The programs and data files are all stored on the permanently mounted IAC disc. Data files are available at present only for the year 1968/9. It is intended to introduce files for other years at a later date. Some of the programs make use of the matrix manipulation package SUPERPASSION.[1] The remaining programs are written in FORTRAN.

The computer programs correspond to the ORANI model as described in Volume 2,[2] although the notation is somewhat different. The correspondence between the two sets of symbols can be obtained from Table 1 of this manual. The occasional references in the text to undefined lower case variables, e.g. p_1 and p_2, are direct usage of Volume 2 notation. The general principles of the method of solution have been described in OP-03[3] and Volume 2, Section 17. However, Volume 2 contains no material on the specifics of the computer programs and the material in OP-03 is now largely out-dated.

2. GENERAL DESCRIPTION OF THE SET OF PROGRAMS

The Mathematical Method

The ORANI model can be considered as a set of approximately 10g linear equations in approximately 19g variables, where g is the

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1. SUPERPASSION was originally developed at Harvard University and has been adapted by the IAC for use on the CSIRO Computer Network.

2. The current implementation does not include the number of households, q (see Volume 2, equation 5.7).

3. John Sutton, "The Solution Method for the ORANI Module", Impact of Demographic Change on Industry Structure in Australia, Preliminary Working Paper No. OP-03, Industries Assistance Commission, Melbourne, June, 1976 (mimeo), pp. 51.

number of industries (see Vol. 2, Section 17). The chosen method of solution involves reducing the number of equations to approximately 2g by the elimination of 8g variables which are assumed to be always endogenous. More precisely, there are then (2g + 2M + 10) equations in (11g + 3M + 17) variables, where M is the number of occupations and M is small relative to g. Selecting (2g + 2M + 10) variables as endogenous and the remaining (9g + M + 7) as exogenous,[1] the system of equations can be written as :

$$Ay + Bz = 0$$

where y represents the vector of endogenous variables and z the vector of exogenous variables. Then $y = Cz$ where $C = -A^{-1}B$. The basic solution is given by the matrix C , where element C_{ij} is the elasticity of endogenous variable i with respect to exogenous variable j .

Solutions for the previously eliminated variables are then obtained by back-solving. Usually the back solution to a system of linear equations is performed sequentially. For example, given the equations

$$\begin{aligned} x + 2y + z &= 10 \\ x + y &= 4 \\ x &= 1 \end{aligned}$$

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1. The corresponding number of exogenous variables in Vol. 2 (p. 185) is $8g + (g - J^*) + M + 8$. The different value in the current computer implementation is due to the omission of one variable, q , and the use of g in place of $(g - J^*)$ for computing convenience.

once the (obvious) solution for x is available, the next step is to solve for y, and finally to solve for z. Alternatively, by writing the first equation as $-x + 2(x + y) + z = 10$ it is possible to solve for z without explicitly solving first for y. In the ORANI model there are several vector variables which are to be obtained via back solution. It is expected that only one or two of these will be of interest in a particular experiment. For this reason we use the alternative method of back solution just described, and solve directly for each of the variables in the back solution.

The set of programs

The overall computing task is broken into several separate jobs whose relationships to one another are shown in the flow diagram in Figure 1. The data consists of two parts :

(1) an extensively modified version of the input-output tables. We anticipate that most users would opt to use the version compiled by the ORANI team.

(2) a parameter file PARAMS6869 which can be recreated by users if they wish to change it.

PARAMS6869 contains parameters such as the elasticity of substitution between imported and domestic goods, and the elasticity of substitution between primary factors (labour, capital and land). It also contains, among other things, investment parameters for the various industries, and a vector which specifies the industries that have exogenous investment.

EQNS forms the matrix coefficients for the basic set of equations and also performs the elimination of 4g variables, namely X3 (household consumption of domestically produced goods, by industry), PI (price of capital by industry), I (investment by industry[1]) and $x_2^{(3)}$.

The solution program ORANI eliminates a further 4g variables, namely p_1, p_2, p^e and a composite vector of S (export subsidies) and X4 (exports). The choice of export industries is not made until the ORANI program. Once an industry is defined as an "export" industry the level of its exports is endogenous and the level of its export subsidy is exogenous. Conversely, all other industries have endogenous export subsidies and exogenous exports. They are sometimes referred to as "non-export" industries.

The data input to ORANI consists not only of the choice of export industries, but also the specification of the economic environment by means of the division of variables into endogenous and exogenous. Other data include export price elasticities, and wage indexation as a percentage of the ORANI index of consumer prices.

SANDX4 computes the back solutions[2] for PN and XN, the eliminated endogenous components of S and X4 . Approximate

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1. For certain industries, which were specified on the parameter file, investment is not endogenous. Investment in these industries is described by the exogenous variable F1 and the parameter H1.

2. The program computes solutions for all components of one or more of the endogenous variables. It is not possible to compute results for only a selection of components of some variable. Similarly, the program does not compute elasticities for a selection of exogenous variables, but computes elasticities with respect to all exogenous variables. On the other hand PIE can print results for selections of components and variables.

solutions for domestic prices p_1 can be obtained from S (see Section 5.4).

BACK computes the back solutions[1] for the eliminated endogenous variables X3, PI and I (see page 8). It also computes results for other endogenous variables, namely N4 (employment by industry), MP (imports by industry), and K1 (capital stocks for next year), which were eliminated prior to reaching the system of approximately 10g equations which is mentioned on page 5.

PIE prints results selected from those computed by ORANI, SANDX4, and BACK. The user specifies the endogenous variables of interest, the exogenous variables to be changed, and the magnitudes of the exogenous changes. Specification of the lists of variables includes the selection of individual components of vector variables.

3. EFFICIENT USE OF THE CSIRONET SYSTEM

The CSIRONET system, together with its scales of computing charges, is subject to frequent changes. This section suggests some procedures which would seem appropriate for efficient usage, given the computing system and computing charges as at present. Although the costs will change with time it is expected that the relative costs, and hence the computing strategy, will experience only minor changes.

Some of the jobs in the ORANI suite of programs cost more than $50 to run at present, so that repeated use of these programs can generate large computing bills. There are also significant costs for file storage. Users should be familiar with the scale of computing charges for the CSIRONET system, as described in SERVICES NOTES for Accounting, Computer Charges and Crediting.

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1. See footnote 2 on previous page.

For large jobs, considerable money savings can be achieved by use of priorities P1000 (0.8 times normal charge), P0000 (0.6 times normal charge) and "unattended operating mode", although these will be at the expense of longer turnaround times. Conversely, turnaround times can be decreased by using priorities such as P3000 (1.2 times normal charge). For long jobs it is also necessary to use the time limit parameter, e.g. T177 for 177_8 or 127 seconds.

For the jobs described in this manual, the computing costs in dollars are approximately equal to the CPU times in seconds when operating on the default priority P2000.[1]

There are considerable costs involved in storing the large files which are produced in the ORANI solutions. Consider files with a total size of 5 million characters (500,000 "words" or numbers).

Storage on SYSTEM costs	\$14	per calendar day.
Storage on COMMON costs	\$ 4.25	per calendar day.
Storage on 2 magnetic tapes costs	30¢	per working day.

It is recommended that backup tapes be created in pairs, as a precaution against tape errors. The cost of writing such files on to 2 backup tapes would be approximately \$10, and the cost of retrieving one or more files from a backup tape would be approximately \$4. Due to these overheads it is best to backup and get back files in bulk rather than one at a time.

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1. This and other computing costs mentioned in this manual are based on rates for government users of the CSIRO computing system as at October, 1977.

The disadvantage of using COMMON, as opposed to SYSTEM, is that CSIRO does not maintain copies of the COMMON files; this is the user's responsibility. As there are occasional accidental wipeouts of the entire COMMON set and occasional systematic purges of large files on COMMON, users are advised to backup important files on to magnetic tape as soon as possible.

It is suggested that users catalogue any large files on COMMON rather than SYSTEM so as to minimize daily file storage charges. The number of days of storage, and also the probability of a wipeout, will be minimized if the whole computing operation is planned carefully so that all the jobs are run in as short a time as possible, the files backed up, and then all but the immediately relevant files purged.

In principle all the programs could be linked together in one large job. However, such a procedure would greatly increase the complexity of the job and, due to the increased turnaround time and increased probability of failure due to both machine errors and data errors, may take even longer to compute the solution. It would also usually involve unnecessary duplication of calculations and cataloguing of files. We have found it convenient to run a separate computing job for each of the blocks in Figure 1, i.e., to have a separate card deck for each of EQNS, ORANI, PIE, etc. Each job can then be checked for success before proceeding to the next. It is usually not necessary to run all the programs. The files produced by one run of EQNS will

often be suitable for numerous runs of ORANI; for example, with different selections of export industries, and different amounts of wage indexation. Similarly, one run of ORANI can produce results which are of interest to several different users. Rather than print all these results in one run, it is more convenient for individual users to print them in separate jobs as required.

The total amount of file space required for a complete ORANI solution, starting from programs PARAMS and EQNS, is approximately 20 million characters. As IMPACT has access to only 45 million characters on the IAC disc, and most of this is normally occupied, it is not practical for users to catalogue any files on the IAC disc. The ORANI files are large and numerous, and there would be too great a danger of exceeding the capacity of the disc, at which stage all files on it would be lost. There is no problem about attaching files from the IAC disc. The ORANI team will keep on the disc all the necessary programs and data files, together with a complete set of files created by EQNS and the files ZC1, ZS1 and ZX1 for the "standard solution" (see Appendix 4). A convention for naming new files is described at the beginning of Appendix 2.

4. HOW TO COMPUTE A SOLUTION

Experience has shown that an efficient method of using ORANI for a particular problem is to work systematically through a checklist. Such a procedure was described in Volume 2, Section 19. A similar procedure will now be described from the point of view of using the programs.

(1) Select the 246 endogenous variables required for the basic solution. See below for further details about the selection.

(2) Are the parameters used in file PARAMS6869 (or an equivalent file in the catalogue of ORANI solutions) appropriate? If so, as is usually the case, proceed to (3). If not, it will be necessary to re-run jobs PARAMS and EQNS before proceeding with program ORANI.

(3) Select the "export industries."

(4) Select values for parameters which are supplied to program ORANI; in particular, the wage indexation parameters.

(5) Check if a solution to the problem defined by (1) to (4) already exists.[1] If it does, skip program ORANI and use the available files. (Appendix 2 contains an example of how to recover files from a backed up magnetic tape.) If not, ORANI must be re-run.

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1. It is intended to institute a catalogue of ORANI solutions where each solution will be summarized on one page (see Appendix 4).

in the world price would be necessary to increase domestic production in industry i by 10 per cent?"

From the second group the major choice is between (a) setting wage relativities between occupations, and (b) allowing wage relativities to adjust according to supply and demand. For (a), declare N1 and Q1 to be endogenous. Wage relativities can then be set by using the components of the exogenous variable FW , and also by the indexation of wages to CP , the ORANI index of consumer prices. If all components of FW are zero and all components of the wage indexation parameters H_W have equal values, e.g., 1.0 for 100 per cent wage indexation, 0.7 for 70 per cent wage indexation, 0.0 for fixed money wages, then wage relativities are maintained. On the other hand, wage relativities can be changed by using different values for different components of H_W . For (b) , declare Q1 and FW to be endogenous.

From the third group the object is to select 9 from the following 12 variables as endogenous :

ER, IM, CM, M, E, BT, IP, CP, IR, CR, FR, LT (See Table 1) .

Looked at another way, three of these twelve are to be chosen as exogenous. There are some restrictions :

(i) One of the equations is FR = IR - CR . Obviously no more than two of these three variables can be exogenous. For all solutions computed to date, FR has been exogenous and equal to zero, which implies that

the percentage increases in aggregate real private investment and aggregate real consumption are equal. If this is the case then at least one of IR and CR must be endogenous.

(ii) In a similar manner :

at least one of BT, M, E must be endogenous,

at least one of CR, CM, CP must be endogenous,

at least one of IR, IM, IP must be endogenous.

(iii) It is to be expected that there are similarities in the relative weightings of industries in the formulae for the consumption and investment price indices. If these weightings are the same, or very nearly equal, and both these variables were exogenous , then matrix A could not be inverted. To avoid this possibility, no more than one of IP and CP should be exogenous.

In addition it is expected that M and E will usually be endogenous. They were introduced explicitly only for the purpose of dealing with the problem of percentage changes in the balance of trade when the balance of trade was zero. It should be mentioned that although IM and CM will be exogenous to ORANI when the MACRO and ORANI modules interact, they will frequently be endogenous when ORANI is used in a stand-alone mode.

5. NOTES FOR INDIVIDUAL PROGRAMS

Sample deck structures for all programs are given in Appendix 2. Attention is drawn to the convention for naming new files.

5.1 Data Base (Program PARAMS)

At the current state of development of the programs it is expected that those data files which are derived from the 1968/9 input-output tables (i.e., IOTABLES6869, MARGINS6869, R1R2, PDIMPORTS6869) can be modified only by the ORANI team. They are formed for $g = 109$ industries,[1] $M = 9$ occupations[2] and a particular set of "markup" industries[3] (retail, wholesale, transport, etc.). However, individual users will be able to modify the parameter file PARAMS6869 for their own purposes. This is done with a separate program PARAMS which recreates the file. The contents of the file are 15 SUPERPASSION matrices, namely :

Investment parameters

1. (dimensions 109×1) β_j, elasticity of rate of return with respect to the ratio of planned capital stock to current capital stock.
2. (109×1) g_j, rate of growth of capital stock.
3. (109×1) Q_j, gross rate of return/net rate of return.

Elasticities of substitution between imported and domestically produced goods

4. (109×1) $\sigma^{(1)}$, for intermediate usage.
5. (109×1) $\sigma^{(2)}$, for formation of capital.
6. (109×1) $\sigma^{(3)}$, for household consumption.

1. See Volume 2, Table 13(b), page 210.
2. See Volume 2, Table 5, page 154.
3. See Volume 2, page 137.

Elasticities for household consumption

7. (110 × 110) η, "outside elasticity" of demand.

8. (110 × 1) ε, expenditure elasticity.

9. (110 × 1) "outside" elasticity for complementary imports (equals last column of η).

10. (109 × 1) σ_{KL}, elasticity of substitution between primary factors (labour, capital, land).

11. (109 × 1) σ_{LL}, elasticity of substitution between occupations.

12. (109 × 1) H1, indexation of exogenous investment to aggregate real private investment.

13. (109 × 1) H2, indexation of domestic components of other usage (i.e. government expenditure excluding capital investment) to aggregate real consumption CR .

14. (109 × 1) H3, indexation of imported components of other usage to CR .

15. (109 × 1) type of investment (0.0 = exogenous, 1.0 = endogenous).

Program PARAMS

Approximate CPU time 1 second Approximate cost $1.00

Files to be attached : None

Files to be catalogued : TAPE14 = PARAMS6869, 0.14 million characters, used in EQNS and BACK.

Data Cards :

A complete set of data cards is required. It is recommended that the same values be used as in the example in Appendix 2, except for those variables and values that the user is particularly interested in changing, i.e., if indifferent or uncertain, then follow the example.

(a) Investment parameters. One card for each industry, each containing I,β,g,Q, in format (I3, 22X, F5.1, 2F5.3), where I is the industry number. The cards must be in the sequence I = 1 to 109.

(b) Name cards for parameters 1, 2, 3. One card for each parameter in format F5.0, 12A6 . The F5.0 is the parameter number, i.e., 1, 2, or 3 in this case. The 12A6 is available for the user to specify a name if desired.

(c) Number of export industries, followed on the same card by the industry numbers of the export industries. Format 16I5. This in no way restricts the choice of export industries used in the solution program ORANI. This specification is only for the purposes of setting values for σ_I (see (d) following).

(d) Import substitution elasticities $\sigma_I^{(1)}$. 109 values in format 16F5.1 . The same values are also used for $\sigma_I^{(2)}$ and $\sigma_I^{(3)}$. If σ_I equals 0.0 or is left blank, then σ_I is set to the default value of 2.0 for that industry.[1] For the export industries which were read in (c) σ_I is set equal to 0.5 .

(e) Name cards for parameters 4, 5, 6 .

(f) Marginal budget shares for household consumption, β . 110 values in format 10F8.6

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1. This means that if users really wish to set an element of σ_I at zero, then they should use some small positive number, e.g., 0.001.

(g) Average budget shares for household consumption, α . 110 values in format 10F8.6 .

(h) Name cards for parameters 7 to 15 .

(i) Types of investment. 109 values in format 16F5.0 .

(0 or blank = exogenous , 1 = "private," i.e., endogenous.)

Investment in industries 14 and 109 must always be exogenous (see Volume 2, p. 144).

The following parameters do not involve data input but are set within the program :

σ_{KL} (currently set at 0.5 for all industries).

σ_{LL} (currently set at 1.0 for all industries)

H_1, H_2, H_3 (currently set at 1.0 for all industries).

Frisch parameter ω (used for computing η, set at -2.18).

5.2 Program EQNS (forms matrix coefficients)

Approximate CPU time 125 seconds

Approximate cost (using P1000) $90

This job consists of 11 SUPERPASSION jobs, most of which are linked to other jobs in EQNS and hence have to be done in the correct sequence.

Files to be attached :

TAPE1 = IOTABLES6869

TAPE2 = MARGINS6869

TAPE3 = PARAMS6869

TAPE4 = R1R2

TAPE50 = PDIMPORTS6869

JIM = SUPERP , compiled version of program SUPERPASSION

OLDPL = CZDATA , update file which contains all necessary data cards.

Files to be catalogued :

Tape	Current name	No. chars. (million)	Where used (apart from EQNS re-run)
12	EQN12	0.85	BACK, SANDX4
13	EQN13	0.48	BACK (for I and K1 only)
14	EQN14	0.24	BACK (for X3 only)
15	EQN567	0.29	ORANI, BACK (for N4 only)
18	EQN18	0.96	EQNS rerun only
22	ALGEBRA2	1.70	ORANI
51	SPIDER	0.49	BACK (for MP only)
53	ALGEBRA3	0.02	ORANI

Appendix 2 lists the cards required to completely re-run job EQNS.

Partial Re-runs of EQNS

Which parts of EQNS need to be re-run after changing only parts of the parameter file? A complete run of EQNS takes approximately 125 seconds of CPU, and costs approximately $90. EQNS consists of 11 SUPERPASSION jobs which need to be executed in the correct sequence. The following table summarizes the component SUPERPASSION jobs, CPU times, input files required and files catalogued.

SUPERPASSION jobs in EQNS (in correct sequence of execution)

name	CPU time (seconds)	file catalogued	tape no.	input files required (excluding the data base)
GCAPITAL *	3.8	-	-	--
GPRICE *	12.1	EQN12	12	--
GINVEST	10.5	EQN13	13	--
GCONSUME	10.4	EQN14	14	--
GBETA	19.1	EQN18	18	--
ALGEBRA1 *	17.3	-	-	EQN12, EQN13, EQN14, EQN18
ALGEBRA2 *	14.1	ALGEBRA2	22	EQN12, EQN13, EQN14, EQN18
FACTOR	5.0	EQN567	15	--
IMPORTS	20.3	SPIDER	51	--
UPFLY *	4.5	-		EQN12, EQN13, SPIDER
UPGEB3 *	7.7	ALGEBRA3	53	EQN12, EQN13, SPIDER

* These jobs must be run in pairs as indicated.

If any changes were made to PARAMS6869, then one response would be to completely re-run EQNS. However, changing a single set of parameters will usually effect only a subset of the SUPERPASSION jobs in EQNS. Thus costs are minimized by re-computing only those files which will be changed. The following table shows which SUPER-PASSION jobs need to be re-run if a parameter is changed, and the associated CPU time. This time is to be compared with 125 seconds for a full run of EQNS. At a later date it is intended to rewrite EQNS in such a way that most of these times will be reduced considerably.

Parameter changed	SUPERPASSION jobs to be re-run	CPU time (seconds)
β_j, G_j, Q_j, H_1 type of invest	GINVEST, ALGEBRA1, ALGEBRA2, UPFLY, UPGEB3	54.1
σ_1, σ_2, H_3	GBETA, ALGEBRA1, ALGEBRA2, IMPORTS, UPFLY, UPGEB3	83.0
σ_3, η_1, ϵ	GCONSUME, ALGEBRA1, ALGEBRA2, IMPORTS, UPFLY, UPGEB3	74.3
σ_{KL}, σ_{LL}	FACTOR	5.0
H_2	GBETA, ALGEBRA1, ALGEBRA2	50.5

The procedure for running such a job is :

(1) Attach file CZDATA and compile the required SUPERPASSION decks.

(2) Attach IOTABLES6869, MARGINS6869, PDIMPORTS6869, RIR2, PARAMS6869, SUPERP.

(3) Attach all files which were previously catalogued by EQNS and are now required as inputs to the current job.

(4) Run the SUPERPASSION jobs, cataloguing files where necessary.

Appendix 2 shows the deck of cards required to re-run EQNS after only the investment parameters have been changed on the parameter file.

5.3 Program ORANI (basic ORANI solution)

Approximate CPU time 85 seconds

Approximate cost (using P1000) $65

Files to be attached :

TAPE15 = EQN567

TAPE22 = ALGEBRA2

TAPE53 = ALGEBRA3

Files to be catalogued :

Tape	Current name	No. chars. (million)	Contents	Where used
24	ZC1	3.07	Elasticities for basic solution. Also, lists of export industries, endogenous variables etc.	SANDX4, BACK, PIE
25	ZS1	1.22	Data used to form elasticities for PN	SANDX4
26	ZX1	0.14	Data used to form elasticities for XN	SANDX4

Error messages for program ORANI are described in Appendix 3.

Data Cards

A complete set of data cards is required. It is recommended that the same values be used as in the example in Appendix 2, except for those variables and values that the user is particularly interested in changing, i.e., if indifferent or uncertain, then follow the

example. It should be pointed out that all results will depend on the choices of export industries, wage indexation, etc., even if the user is not specifically interested in say exports or wages. At the current stage of development, the values for NG, NH and NN must not be changed from 109, 9 and 1.

(a) NG,NH,NN,NEX,NB,NSV in the format 6I5 where

NG = number of industries, currently 109

NH = number of occupations, currently 9

NN = number of types of land, currently 1

NEX = number of export industries, e.g., 11

NB = number of vector variables used in the calculation (= 25 or 29). 29 means include all variables in the basic solution. 25 is a shortened form which omits Q4, F1, F2, F3.

NSV = must be zero or blank. It is concerned with an option which is still under development.

(b) Specification of export industries

NEX + 1 industry numbers in format 16I5. These are the NEX export industries which must be followed by a dummy industry - 1 .

(c) Specification of endogenous variables

All vector variables in the reduced form of the ORANI equations are listed in Table 1 (see the first 29 positions only). The division of variables into endogenous and exogenous is made by specifying the endogenous variables, of which there must be 2NG + 2NH + NN + 9. By implication the remaining variables are exogenous.

There are one or more cards for each endogenous variable. Ignoring omitted variables, the cards must be in the sequence given in Table 1. The first card for each variable contains in format A2, 8X, 2I5 the symbolic name for the variable (see Table 1), the number of components to be declared endogenous, and a "code number." The "code number" controls the format for the cards immediately following. These specify which components are to be endogenous. Rules for the code numbers are as follows. See Appendix 2, program PIE, for examples.

If all components are declared endogenous then the "code number" is ignored, and the next card should refer to a new variable.

1 means that component numbers will be read one at a time in format 16I5, with the last followed by a component - 1.[1]

N (not equal to 0 or 1) means that components will be read in N sets in format 8(2X, 2I4). Two numbers are read for each set - the first and last numbers of the set. The last set is followed by a dummy set - 1 - 1.[1] For example, 10 14 60 60 - 1 - 1 would declare components 10, 11, 12, 13, 14, 60 to be endogenous. It is not possible to read a single set as this would have N = 1 ; instead, break the single set into two sets.

The last card in the endogenous set is blank.

(d) Wage indexation parameters (H_w)

NH values in format 10F8.0 . These numbers describe how the wage rate in each occupation is indexed to CP , the ORANI

---

1. The program uses the "- 1's" to check that the correct number of components or sets has been read. Omission of relevant "- 1's" will stop the program.

version of the consumer price index. Typical values are 1.0 for 100 per cent wage indexation and 0.0 for fixed money wages.

(e) Employment weights

NH values in format 10F8.0 . These are proportions of the workforce (measured in numbers of persons) employed in each occupation. They are used in the calculation of LT (total employment). The sum of the proportions should equal 1.0.

(f) Export demand parameters, γ

NG values in format 10F5.2 . These values are reciprocals of export demand elasticities. The program requires values for all industries. The values for "non-export" industries are relevant only for calculations in which exogenous changes in exports are made. We have arbitrarily used $\gamma = 0.05$ for such industries.

(g) Indexation of other costs (H_6)

1 value in format F8.0 . This scalar is expanded within the program to a vector of length NG . H_6 describes how other costs are indexed to CP . Normally 1.0 .

5.4 Program SANDX4 (back solution for PN and XN, the endogenous components of S and X4)

Approximate CPU time 11 seconds for PN, 3 seconds for XN

Approximate cost $11 for PN, $3 for XN

Files to be attached :

TAPE24 = ZC1

TAPE25 = ZS1 (for PN only)

TAPE26 = ZX1 (for XN only)

Files to be catalogued :

The output files consist of elasticities which can be printed by program PIE.

Tape	Current name	No. chars. (million)	Contents
31	ES1	1.22*	Endogenous components of export subsidies PN
32	EX1	0.14*	Endogenous components of exports XN

* The numbers of characters in these two files depend on the number of export industries. The sum of these two numbers will always be approximately 1.36 million characters.

Data cards :

Two cards only. Each reads NR,LE,LN in format 3I5 where

NR = number of endogenous components, which depends on the value of NEX used in ORANI. For example, NR = 98 for PN, NR = 11 for XN.

LE = tape number for input file (25 or 26).

LN = tape number for output file (31 or 32).

If a back solution is required for only one of these two variables then put NR = 0 on the second card.

The back solution for domestic prices is given approximately by

$p_1 = PM + ER + S - \gamma x_1^{(4)}$

(see Vol. 2, equations (6.2 and (9.12). The matrix coefficient of p_1, $m_r(j4)$, is an identity matrix except for small perturbations in the margins columns.)

5.5 Program BACK (back solution for X3, PI, I, K1, N4, MP)

Approximate computing times and costs are summarized in the table below.

Files to be attached :

TAPE3 = PARAMS6869 (for K1 only)

TAPE12 = EQN12

TAPE13 = EQN13 (for I and K1 only)

TAPE14 = EQN14 (for X3 only)

TAPE15 = EQN567 (for N4 only)

TAPE24 = ZC1

TAPE51 = SPIDER (for MP only)

Files to be catalogued :

The output files consist of elasticities which can be printed by program PIE.

Tape	Current name	Contents	CPU time* (seconds)
33	ZX3	X3 (consumption, by industry)	12
34	ZPI	PI (price of capital)	11
35	ZIN	I (investment, by industry)	14
36	ZK1	K1 (capital stocks for next year)	14+1
37	ZN4	N4 (employment, by industry)	9
38	ZMP	MP (imports, by industry)	20

* Cost in dollars (for priority P2000) is approximately equal to the time in seconds.

The size of each file is approximately 1.36 million characters. Hence the total size for six files is approximately 8.16 million characters. The back solution for K1 must be run in conjunction with the back solution for I ; the additional computing time is less than one second. Apart from this the back solutions can be run independently of one another. In fact is is recommended to run them separately so as to avoid the possibility of the job terminating before the earlier back solutions have been catalogued.

Data Cards 1 card (in format 1X, F9.0) which specifies the value of H6 (see page 28(g)). Normally 1.0.

6 cards, one for each variable in the back solution in the order X3, PI, I, K1, N4, MP. Format 2X, I3. If the number on the card is zero, then the back solution for that variable is omitted. If the number is non-zero, then the back solution is carried out.

5.6 Program PIE (print impact elasticities)

CPU time is typically a few seconds

Cost is typically a few dollars.

Times and costs will vary greatly with the selection of results to be printed.

Files to be attached :

File ZC1 is required for all PIE jobs. The other files are attached only if they are to be printed.

TAPE24 = ZC1 (basic solution, required for all PIE jobs)
TAPE31 = ES1 (for PN)
TAPE32 = EX1 (for XN)
TAPE33 = ZX3 (for X3)
TAPE34 = ZPI (for PI)
TAPE35 = ZIN (for I)
TAPE36 = ZK1 (for K1)
TAPE37 = ZN4 (for N4)
TAPE38 = ZMP (for MP)

The output is on the line printer.

To obtain multiple copies use control cards :

```
:
PIE(,OUT)
REWIND(OUT)
COPYSP(OUT,OUTPUT)
REWIND(OUT)
COPYSP(OUT,OUTPUT)
:
```

In the tables of results each row refers to an endogenous variable, and each column refers to an exogenous variable. The results are printed in format F10.4, 12 columns across the page, and with labelled row and column headings. Row and column totals across the printed results are printed after the last column and below the last row.

Each result is the percentage change in the endogenous variable which would arise from the specified increase in the exogenous variable (with all other exogenous variables being held constant). In the case of BT (balance of trade) the changes are expressed not as percentage changes, but as changes in units of $1 billion (1,000 million).

Error messages for program PIE are described in Appendix 3.

Data cards (see Appendix 2 for an example) :

The data input consists of one or more sets of elasticities, where each set consists of the following four parts :

(1) Summary card

Read NTX, NTN(I) where I equals 1 to 9, NSW,NST in format (1X,I4,9I5,5X,2I5) where

NTX is the total number of exogenous variables. NTX=0 or blank is used to indicate the end of data.

NTN(I) is the total number of endogenous variables of type I . The 9 components of NTN correspond to the endogenous variables from the basic solution (I=1), and 8 variables obtained from the back solutions, namely PN, XN, X3, PI, I, K1, N4 and MP. The maximum numbers of components allowed for these variables are 246, (109-NEX), NEX, 109, 109, 109, 109, 110 respectively. For each set, only one of the NTN(I) on the summary card can be non-zero. If the endogenous variables are to be the same as for the preceding set, then use - NTN(I) and omit part (3).

NSW non-zero means that only the row total of the specified elasticities (i.e., the total across the specified exogenous variables) will be printed. This is useful for across-the-board changes in tariffs.

NST=1 means that elasticities which were computed with respect to (1+T) as the exogenous variable, where T is the tariff rate, will be converted to elasticities with respect to T. In order to do this a set of tariff rates will be read in part (4). The option is desirable for most tariff calculations.

(2) Specification of exogenous variables

The formats and options are similar to the specifications of endogenous variables in ORANI. However, on the first card for each variable, column 25 is now used to indicate whether or not values for the exogenous changes are to be read after the exogenous components have been specified. 0 or blank means set all changes to 1.0 , i.e., the results will be elasticities.

1 means that one number will be read in format F5.0 and all changes will have this value. 2 means that values will be read for all relevant components in format 16F5.0 .

If the number of exogenous components is set equal to the total number of components for a variable, then the program will select only all those components which are exogenous, and use these. For example, if 109 exogenous components were specified for X4 the program would automatically omit the export industries because they are endogenous.

After specifying all the exogenous variables and their values there must be a blank card.

(3) Specification of endogenous variables
This sequence of cards is omitted if NTN(I) on the summary card is negative. The formats and options are the same as for the specification of endogenous variables in ORANI. The last card in this sequence must be a blank.

For variables outside the basic solution, results can be printed for only one vector variable at a time. For the variables PN and XN, if the numbers of components are specified as 109-NEX and NEX respectively then the program will automatically select all those components which are endogenous. (NEX is the number of export industries.)

(4) These cards are included only if NST=1 . Read 110 tariff rates in format 10F5.2 , even if not all 110 are needed.

The end of data is indicated by a single blank card, i.e. a summary card with NTX=0 or blank.

Appendix 1 - Changes to the ORANI Programs

Following is a list of changes to the current versions of the programs which are either in progress or under consideration. Many of the changes are concerned with computing efficiency and the ease of using the programs; others are concerned with minor changes to the theoretical structure of the model. The latter are mostly within the scope of the model as described in Volume 2.

1. Restrict the computations and cataloguing of files to only those exogenous variables which are of interest to the user. This will reduce computing times and computing costs appreciably.

2. Efficient re-computation of results when the A matrix is altered slightly.

3. Efficient re-computation of results when a small number of variables is interchanged between the endogenous and exogenous sets.

4. Incorporate into the model the number of households (q), or some other appropriate measure which relates consumption to the size and structure of the population.

5. Allow for technological change.

6. Model 18 occupations so as to allow for male employment and female employment separately.[1]

7. Rewrite program EQNS so that re-computation of matrices as a consequence of changes to the parameter file is more efficient.

---

1. Eighteen occupations were used for a paper by Peter B. Dixon, B. R. Parmenter and John Sutton, "Some Causes of Structural Maladjustment in the Australian Economy," presented at the Winter School of the N.S.W. Branch of the Economic Society of Australia and New Zealand, July 29, 1977. This option is not yet available for general use.

8. Compute the exact back solutions for p_1. These will replace the fairly good approximation described in Section 5.4.

9. Read the indexation parameters H1, H2 and H3 into program ORANI rather than set them in file PARAMS6869. The user will then be able to adjust them easily without the need to re-run programs PARAMS and EQNS.

10. Include the rate of return variable λ (see Volume 2, equation 10.8) in the basic solution rather than eliminating it in the algebra as at present. This means that λ can be set exogenously if required.

11. Use the CRETH[1] formulation for rural industries.

It is intended to issue supplements to the manual from time to time as the programs are changed. As far as possible the changes will be such that existing files and data decks are compatible with the revised programs.

---

1. See Peter B. Dixon, D. P. Vincent and Alan A. Powell, "Factor Demand and Product Supply Relations in Australian Agriculture : The CRESH/CRETH Production System," Impact of Demographic Change on Industry Structure in Australia, Preliminary Working Paper No. OP-08, Industries Assistance Commission, Melbourne, November, 1976.

Appendix 2 - Sample Deck Structures

Sample decks, including both control cards and data cards, are given for the programs in the order ORANI, PIE, SANDX4, BACK, PARAMS, EQNS, and EQNS (partial re-run). There are also examples of how to backup files on to magnetic tape and how to retrieve such files. The jobs for ORANI and SANDX4 also include usage of PIE, which is normal practice. These sample decks are stored as card images on one file, JSMANUAL, which can be accessed by

```
ATTACH(A,JSMANUAL,ID=DIAXOR,MR=1) .
```

The decks are in the sequence given above, and are separated by end-of-section cards. Within each deck the cards are stored exactly as printed, e.g., *EOS is stored as 4 characters (*,E,O,S) not as an end-of-section card. Users may find it convenient to modify these decks for their own purposes via interactive terminals. On the other hand, IMPACT files, i.e., those on ID=DIAXOR,SN=DTB2344, must not be altered.

It is important to check every option on each control card, and every item on each data card. In these examples the newly created files are catalogued on COMMON under the user's charge code. The file names are the same as those used throughout this manual, except that they are now preceded by a mnemonic (provision is made for two additional characters in these examples) which identifies the user and perhaps the application. To avoid book-keeping problems we must insist that file names be different from those used by the IMPACT team for the "standard" solution. The system just described gives every file a unique name, and also retains the standard nomenclature. It is important to use the retention period option RP ; otherwise the files will be lost within one day.

ORANI

This example computes the "standard" solution, which includes full indexation of wages to CP, slack labour market, exchange rate exogenous, CR and FR exogenous (for FR = 0, this implies $i_R = c_R = g_R$ where g_R denotes real government expenditure. g_R is fully indexed to c_R).

The same job also prints the effects of a 7 per cent devaluation (ER = +7) on outputs, wages, demands for labour by occupation and the macroeconomic variables.

```
*CYJ
ORANI(T177,P1000)
COMMON,
MOUNT(VSN=PMC513,SN=DTB2344)
ATTACH(OLIB,AMORANILIB,ID=DIAXOR,SN=DTB2344,MR=1)
LIBRARY(OLIB)
ATTACH(TAPE15,EQN567,ID=DIAXOR,SN=DTB2344,MR=1)
ATTACH(TAPE22,ALGEBRA2,ID=DIAXOR,SN=DTB2344,MR=1)
ATTACH(TAPE53,ALGEBRA3,ID=DIAXOR,SN=DTB2344,MR=1)
REQUEST(TAPE24,*PF,SN=COMMON)
REQUEST(TAPE25,*PF,SN=COMMON)
REQUEST(TAPE26,*PF,SN=COMMON)
ORANI,
CATALOG(TAPE24,..ZC1,ID=......,RP=..)
CATALOG(TAPE25,..ZS1,ID=......,RP=..)
CATALOG(TAPE26,..ZX1,ID=......,RP=..)
REWIND(TAPE24)
PIE.
*EOS
  109     9     1    11    29     0
    1     2     9    10    11    12    15    22    27    60    61    -1
X             109
Q1              9
Q2            109
Q3              1
N1              9
IM              1
CM              1
M               1
E               1
BT              1
IP              1
CP              1
IR              1
```

```
LT                1

      1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
   0.0528    0.1290    0.2726    0.1019    0.0423    0.0269    0.2963    0.0813    0.0169
     0.40      0.10      0.05      0.05      0.05      0.05      0.05      0.05      0.10      0.10
     0.20      0.05      0.05      0.05      0.10      0.05      0.05      0.05      0.05      0.05
     0.05      0.10      0.05      0.05      0.05      0.05      0.30      0.05      0.05      0.05
     0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05
     0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05
     0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05
     0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05
     0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05
     0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05
     0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05      0.05
      1.0

*EOS
    1   136
ER                1           1
   7.0

X               109
Q1                9
N1                9
IM                1
CM                1
M                 1
E                 1
BT                1
IP                1
CP                1
IR                1
LT                1


*EOI
```

PIE

This is a rather artificial example which illustrates the usage of the various options. It uses files for the basic solution (ZC1) and the back solution for exports (EX1). The data is labelled in 5 blocks A to E for the purposes of description. If EX1 didn't exist, then part D would have to be omitted.

A The effects of specified changes in the exchange rate and selected world prices on selected outputs, all wages, selected rental prices for capital, and the ORANI index of consumer prices. The specification of exogenous changes and the selection of components are done in a variety of ways for the purposes of illustration.

B The effects of reducing all tariff rates by 10 per cent, i.e., to 90 per cent of their original values. The endogenous variables are the same as for A . Note the entries for NSW and NST in columns 60 and 65 of the first card. NSW = 1 means that only total effects are printed; the effects due to individual industries are not printed. For NST = 1, which means that the 10 per cent reduction applies to the tariff rate and not to 1+tariff rate, it is necessary to read all the tariff rates, even if only a subset of them is to be used.

C A repeat of A but with different values for the exogenous variables.

D Back solutions for exports with respect to the same exogenous changes as A . This uses files ZC1 and EX1 .

E Elasticities of selected outputs with respect to exogenous wage changes.

```
*CYJ
PIE.
MOUNT(VSN=PMC513,SN=DTB2344)
ATTACH(OLIB,AMORANILIB,ID=DIAXOR,SN=DTB2344,MR=1)
LIBRARY(OLIB)
ATTACH(TAPE24,ZC1,ID=DIAXOR,SN=DTB2344,MR=1)
ATTACH(TAPE26,EX1,ID=DIAXOR,SN=DTB2344)
PIE.
*EOS
```

```
   7    26
PM                 6     1     2
   10    11    12    60    61    65    -1
  7.6   7.6  13.2   8.8   8.8   4.0
ER                 1           1
  7.0
                                                                        A
X                  8     1
   10    11    12    13    14    60    61    65    -1
Q1                 9
Q2                 8     3
    10    14     60    61    65    65    -1    -1
CP                 1
```

```
  110   -26                                                             1     1
T                110           1
-10.0

    0     0     0     0     0    39     0     0     3     0
    0     0     0     0     2     5    19    15     7     4
   40    27    42    27    54    31     1    25    33    27
   36    23    25    44    58    51    10    29    24    33
   12    46    34     5    42    10    19    34    29    24
   39    23     4    14    25     9     0     5    20    17
    8    39    40    37    35    37    32    15    17    48
   39    28    23    31    35    27    29    29    33    34
    0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0
```

```
   7   -26
PM                 6     1     1
   10    11    12    60    61    65    -1
 10.0
ER                 1           1                                        C
  3.5
```

```
   7                      11
PM                 6     1     2
   10    11    12    60    61    65    -1
  7.6   7.6  13.2   8.8   8.8   4.0                                      D
ER                 1           1
  7.0

XN                11
```

```
   9     8
FW                 9

                                                                        E
X                  8     1
   10    11    12    13    14    60    61    65    -1
```

```
*EOS
```

SANDX4

This example computes the back solution for exports, and then prints the effects of 3 per cent revaluation of the Australian dollar (ER = -3) on the exports in the 11 exporting industries.

Back solutions for subsidies require the time limit parameter T17 ; it can be omitted for back solutions for exports.

```
*CYJ
SANDX4(T17)
MOUNT(VSN=PMC513,SN=OTB2344)
COMMON.
ATTACH(OLIB,AMORANILIB,ID=OIAXOR,SN=OTB2344,MR=1)
LIBRARY(OLIB)
ATTACH(TAPE24,ZC1,ID=OIAXOR,SN=OTB2344,MR=1)
ATTACH(TAPE26,ZX1,ID=OIAXOR,SN=OTB2344)
REQUEST(TAPE32,*PF,SN=COMMON)
SANDX4.
CATALOG(TAPE32,..EX1,ID=......,RP=..)
REWIND(TAPE32)
PIE.
*EOS
   11    26    32
    0
*EOS
    1                11
ER              1            1
 -3.0

XN              11

*EOI
```

BACK

This particular example computes the back solution for investment. Although the program can be used to compute several back solutions with one set of data cards, it is inadvisable to do so as an error in the later back solutions (including time limit) will stop the program before the earlier back solutions are catalogued. The only back solution which needs to be combined with another is K1 . The times taken for the different back solutions vary considerably.

```
*CYJ
BACK(T37,P1000)
MOUNT(VSN=PMC513,SN=DTB2344)
COMMON.
ATTACH(OLIB,AMORANILIB,ID=DIAXOR,SN=DTB2344,MR=1)
LIBRARY(OLIB)
ATTACH(TAPE24,ZC1,ID=DIAXOR,SN=DTB2344,MR=1)
ATTACH(TAPE12,EQN12,ID=DIAXOR,SN=DTB2344)
ATTACH(TAPE13,EQN13,ID=DIAXOR,SN=DTB2344)
REQUEST(TAPE35,*PF,SN=COMMON)
BACK.
CATALOG(TAPE35,,,ZIN,ID=......,RP=..)
*EOS
        1.2

    1



*EOI
```

PARAMS

This example recomputes file PARAMS6869 as it has been used for most of the solutions to date, including the "standard solution" described in the ORANI example above. The parameters are the same as those described in Volume 2.

```
*CYJ
PARAMS.
MOUNT(VSN=PMC513,SN=UTB2344)
COMMON.
ATTACH(OLIB,ANORANILIB,ID=DIAXUR,SN=UTB2344,MR=1)
LIBRARY(OLIB)
REQUEST(TAPE14,*PF,SN=COMMON)
PARAMS.
CATALOG(TAPE14,,,PARAMS6869,ID=......,RP=,,)
*EOS
  1    1223   141 1583 1869   301   086 1630
  2    1357   108 1699 1206   336   120 1500
  3     484    56  603  886   231   090 1636
  4     985   144 1309  856   280   091 1800
  5      40    16          301   189   115 2035
  6     720   513 1199  910   299   119 1604
  7    45.5  10.0      20.0    304   087 1756
  8     264    83                234   115 2600
  9     108     5          156   150   082 2900
 10    1087   307                080   200 1711
 11    1203   339                080   200 1711
 12     705   199                080   200 1711
 13     458   129                080   200 1711
 14     100                      080   200 1711
 15     379   206                489   100 2379
 16     440   167                372   106 2379
 17     111   115                259   117 2379
 18      32    19                150   111 2304
 19     137    45                186   131 2379
 20     297   104                489   100 2379
 21      68    46                542   090 2077
 22     376   146                349   108 2379
 23     113    39                150   143 2379
 24     381   131                329   080 1500
 25      27    92                329   080 1500
 26     153   142                600   138 1803
 27      33    31                272   115 2379
 28     146   134                150   143 2379
 29      96    89                150   143 2379
 30      57    53                150   143 2379
 31      23    21                600   096 2379
 32      37    36                600   102 1952
 33      72    68                600   085 1594
 34      99   114                600   096 2379
 35     150   172                453   110 1879
 36      46    50                600   094 1753
 37     234   230                600   110 2216
```

38	30	29	600	086	1550
39	156	105	195	138	1550
40	140	106	230	130	1513
41	130	50	268	134	1800
42	193	73	268	134	1800
43	107	41	268	134	1800
44	401	186	312	126	1800
45	306	142	312	126	1800
46	190	84	161	136	2957
47	493	218	150	139	2957
48	84	81	406	102	1833
49	202	210	316	142	1692
50	88	72	263	175	2091
51	81	84	362	136	1692
52	94	106	150	139	2957
53	682	101	150	150	2607
54	112	92	248	124	2194
55	278	63	324	105	1619
56	186	68	313	152	2196
57	94	34	313	152	2196
58	197	72	313	152	2196
59	128	47	313	152	2196
60	1555	428	213	120	2569
61	886	244	213	120	2569
62	240	200	465	100	2455
63	248	207	465	100	2455
64	402	336	465	100	2455
65	1237	1059	577	140	2330
66	138	58	276	109	2633
67	54	23	276	109	2633
68	49	20	276	109	2633
69	1	1	304	137	1909
70	119	156	214	122	2029
71	107	149	225	119	2029
72	233	325	414	097	2029
73	61	76	600	086	2167
74	97	121	555	088	2167
75	269	337	600	086	2167
76	33	41	600	078	1909
77	140	187	304	116	2875
78	231	171	262	201	2023
79	34	46	304	128	1784
80	47	64	304	128	1784
81	3260	836	092	064	2875
82	167	43	092	064	2875
83	939	241	092	064	2875
84	592	962	138	196	1570
85	1404	2282	138	196	1570
86	4421	5404	217	105	1575
87	3563	2580	307	089	1561
88	756	483	320	085	1590
89	247	158	124	153	1529
90	1895	1674	124	155	1563
91	289	256	124	155	1563
92	584	515	124	155	1563
93	413	364	124	155	1563
94	1975	322	146	145	1667
95	1262	807	122	147	1471
96	946	605	122	147	1471
97	385	246	122	147	1471
98	1373	21200	122	140	1376

```
 99    1038 1602                 122   147 1471
100   13880    0                 122   147 1471
101                              161   124 1667
102                              161   124 1667
103     627  401       1117      161   124 1667
104     346  222                 161   124 1667
105     132   85                 161   124 1667
106     586  445                 320   094 1465
107    1518  268                 129   095 2205
108     397  253                 320   100 1446
109                              161   124 1667
    1  BETA(I) = ELASTICITY OF ROR WITH RESPECT TO K(1)/K(0)
    2  G(I) = GROSS ROR / NET ROR
    3  G(I) = RATE OF GROWTH OF CAPITAL STOCK
   11     1     2     9    10    11    12    15    22    27    60    61
    0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
   11    17    21    21     0    07     0    21  210.001     5    24    24     5     0     0
   24    29    34    65     0     0     0    19    11    11    11     0     0    14    17    20
    0    12     0     0  0.34    14    14     6    13    13    13    15    14    15    15     0
   50     5     5     5     5     0    21    13     5     5     5    20    13    13     0    12
    0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
    4  SIGMA1(I)    = IMPORT ELASTICITY
    5  SIGMA2(I)    = IMPORT ELASTICITY
    6  SIGMA3(I)    = IMPORT ELASTICITY
  614          0       280       111      4375     18519      2126      1277      1992         0
    0        502       387         0     42097      3736     10393      1295       629      5611
 7521       7996      4457     26726      6485     17521         0      3220      5557      3951
    0       4385      2547     12029     27156     10258       729       409      1777     15263
    0          0      1021      4647      3932       303      2052        91      6737      6086
 2761       3188     44086      2399      2525         0         0         0       352        15
  271        635      7064      7378     94865       487         0        67      4185     17755
28178       3864        16       109       278      3424      9322      7705       541      5223
18937       6490       532         0         0       430     11511     32939       816       214
  140         65        46     12697      9213      3948      8975      9290     11698    197750
 5543          0     42116     16723      4808     12620     37858     19293         0
 1038          0       504      1626     13763     25871      2990      1152      2911         0
```

```
      0      853      420        0    57696    35035    14408     2079     3114    29928
  10841    13934     8431    48053    14162    31748        0     4151     6588     5058
    103     5439     2693    19464    43941    14842      946      432     1813    11919
      0        0     2242    10616     7911      433     2653      164    13134    11682
   5427     3650    29188     2224     2388        0        0        0      707        0
    400      696     4863     6734    47576      856        0      166     7236    12309
  18417     2593        0      125      292     6035     7285     6986      593     7606
  17229     5822      567        0        0      588     9774    19451      453    14229
   9279     4330     3093     9115     6781     2906     6233     6296     8126   125271
   3798        0    32052    12024     3283     7060    21180    13268        0     4489
7  OWN AND CROSS PRICE ELASTICITIES, 0 = OUTSIDE ELASTICITIES, ETA
8  VECTOR OF EXPENDITURE ELASTICITIES, EPSILON
9  OUTSIDE ELASTICITIES FOR COMPLEMENTARY IMPORTS
10 ALPHA(I),  PRODUCTION FUNCTION ELASTICITIES
11 DELTA(I),  OCCUPATION ELASTICITIES
12 H1
13 H2
14 H3
15 EXOG, INVESTMENT VECTOR (1=ENDOG, 0=EXOG)
   1     1     1     1     1     1     1     1     1     1     1     1     0     1     1
   1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
   1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
   1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
   0     0     0     1     1     1     1     1     1     1     1     1     1     1     1
   1     1     1     0     0     0     0     0     0     1     1     1     0
*EOI
```

BACKUP

This example backs up files ZC1, ZS1 and ZX1 on COMMON on to magnetic tape, and also on to a duplicate magnetic tape. The tape label is BACKUP211077 ; the dayfile will specify the tape numbers. All files to be backed up should be on only one set, i.e., on only one of COMMON, SYSTEM and IAC disc.

```
*CYJ
BACKUP(T17,NL2)
STAGE(TAPEA,PE,POST,N)
STAGE(TAPEB,PE,POST,N)
LABEL(TAPEA,W,T=999,L=$BACKUP211077$)
LABEL(TAPEB,W,T=999,L=$BACKUP211077$)
ATTACH(FUSE,FUSE,MR=1)
LIBRARY(*,FUSE)
COMMENT. THIS IS FOR BACKUP FROM COMMON
COMMENT.  OMIT THE NEXT 2 CARDS FOR BACKUP FROM SYSTEM
COMMON.
SETNAME(COMMON)
KEEP(TAPEA)
REWIND(TAPEA)
COPY(TAPEA,TAPEB)
*EOS
ZC1(ID=......,CY=2)
ZS1(ID=......,CY=1)
Zx1(ID=......,CY=1)
*EOI
```

GETBACK

This example retrieves files ZC1 and ZX1 from a backup tape and puts them on set COMMON. The tape number (VSN) and tape label (L) must be the same as those used in the corresponding backup job. The retention periods are 10 days. Note that the default value for RP is 999. If a file with the same name and cycle number is already on the set there will be no retrieval and the job will skip to the next file.

```
*CYJ
GETBACK(NL1)
STAGE(TAPE1,PE,VSN=....,E)
LABEL(TAPE1,R,L=$............$)
ATTACH(FUSE,FUSE,MR=1)
LIBRARY(*,FUSE)
COMMENT.  THIS IS FOR GETBACK TO COMMON
COMMENT.  OMIT NEXT 2 CARDS FOR GETBACK TO SYSTEM
COMMON.
SETNAME(COMMON)
FETCH(TAPE1)
*EOS
ZC1(ID=......,CY=2,RP=10)
Zx1(ID=......,CY=1,RP=10)
*EOI
```

Appendix 3 - Error Messages for programs ORANI and PIE

The programs are designed to stop when certain errors or inconsistencies are detected in the data. The errors are indicated by "STOPxx" near the end of the listing of control cards. In some cases there is also a message at the end of the usual lineprinter output. The true error will often not be the error indicated. Due to the omission or inclusion of data cards the program can get out of step. It is then a matter of working back through the data cards to find the error.

The programs do include some other STOPs and messages which are concerned with programming errors rather than data errors. They might occur if the data makes the program get out of step. In all cases the data card formats and contents should be checked thoroughly. Contact John Sutton if all else fails.

STOP's for program ORANI

STOP10 with message "error found at vector .., check number of components in vector, and also total number of endogenous components". This can be caused by

(a) total number of components read exceeds the total number of endogenous components (in the basic solution),

(b) set of individual components (e.g. industries) or strings of components not terminated with -1 .

(c) component number equals 0 or blank,

(d) number of components read in a string not equal to the total number specified for that variable.

(e) incorrect number of strings.

STOP11 unrecognised variable name.

STOP13 no blank card at the end of specifying all endogenous variables.

STOP14 with message "0.00000" . Matrix A is singular; the division of variables between endogenous and exogenous is probably not sensible in an economic sense.

STOP15 with message "all zeros in row (STOP15)/col(STOP16).. of Matrix A", i.e. all zeros in specified row of A . Probably not a meaningful choice of endogenous variables.

STOP16 (without a message). The set of export industries is not terminated with -1 . Perhaps an incorrect number of export industries has been specified.

STOP16 with a message. As for STOP15, except for columns instead of rows. If this happens, contact John Sutton.

STOPS for program PIE

STOP10 with message. Error in endogenous variables. See STOP10 for ORANI for details, except that "total number of endogenous components" now refers to total to be included in printout.

STOP11 unrecognised variable name in reading exogenous variables.

STOP12 unrecognised variable name in reading endogenous variables for back solution.

STOP13 no blank card at the end of specifying all exogenous variables.

STOP14 no blank card at the end of specifying all endogenous variables.

Catalogue of Computed ORANI Solutions - Page Number

(Use ✓ to indicate the same as for the standard solution)

1. Separation of variables into endogenous and exogenous
   (Some solutions may not conform to this division, or to these particular numbers of variables in each category.)

   (a) 2g + 1 endogenous "industry" variables all X, all Q2, Q3
   (b) 2M endogenous "labour" variables all Q1, all N1
   (c) 3 exogenous "macro" variables ER, CR, FR

2. Parameter file See ORANI Computing Manual, Program PARAMS, example in Appendix 2

3. Export industries 1 2 9 10 11 12 15 22 27 60 61

4. Parameters supplied to program ORANI (a) wage indexation 1.0

   (b) other See ORANI Computing Manual, Program ORANI, example in Appendix 2

5. Computer Files

Default File Name	Tape No.	File Name used	Cycle No.	Date Created	ID & SN	Details of backup (tape nos., label, date)
IOTABLES6869	1	IOTABLES6869	7	15.3.77		6247 $ORANI770317$ 17.3.77
MARGINS6869	2	MARGINS6869	4	4.3.77		
R1R2	4	R1R2	1	25.2.77		
PDIMPORTS6869	50	PDIMPORTS6869	2	22.2.77		
PARAMS6869	3	PARAMS6869	7	7.6.77		
EQN12	12	EQN12	3	30.5.77	all ID = DIAXOR and	8091 $BACKUP230677$ 24.6.77
EQN13	13	EQN13	1	8.6.77		
EQN14	14	EQN14	1	30.5.77		
EQN18	18	EQN18	2	30.5.77		
EQN567	15	EQN567	1	31.5.77	all SN = (DTB2344) (IAC disc)	
ALGEBRA2	22	ALGEBRA2	1	8.6.77		
SPIDER	51	SPIDER	1	8.6.77		
ALGEBRA3	53	ALGEBRA3	1	8.6.77		
ZC1	24	ZC1	2	9.6.77		8091 $BACKUP230677$ 24.6.77
ZS1	25	ZS1	2			
ZX1	26	ZX1	2			
ES1	31					
EX1	32					
ZX3	33					
ZP1	34					
ZIN	35					
ZK1	36					
ZN4	37					
ZMP	38					

6. NOTES This is the STANDARD solution. It was used for the tariff experiment reported in Volume 2 and also in a paper presented at the ANZAAS Conference, Melbourne, August, 1977 (Dixon, Parmenter and Sutton)

Slack labour market.

Name : John Sutton

Department : IMPACT

Date : 12 October 1977

Catalogue of Computed ORANI Solutions - Page Number

(Use ✓ to indicate the same as for the standard solution)

1. Separation of variables into endogenous and exogenous
   (Some solutions may not conform to this division, or to these particular numbers of variables in each category.)
   (a) 2g + 1 endogenous "industry" variables ✓
   (b) 2M endogenous "labour" variables all Q1, all N1 (except occ.4),
   (c) 3 exogenous "macro" variables ER, CR, FR FW(occ.4 only)
2. Parameter file ✓
3. Export industries ✓
4. Parameters supplied to program ORANI (a) wage indexation 0.7
   (b) other ✓
5. Computer Files

Default File Name	Tape No.	File Name used	Cycle No.	Date Created	ID & SN	Details of backup (tape nos., label, date)
IOTABLES6869	1					
MARGINS6869	2					
R1R2	4					
PDIMPORTS6869	50					
PARAMS6869	3					
EQN12	12	✓				
EQN13	13					
EQN14	14					
EQN18	18					
EQN567	15					
ALGEBRA2	22					
SPIDER	51					
ALGEBRA3	53					
ZC1	24	ANZAASZC1	4	16.8.77	DIAXOR	2626
ZS1	25	ANZAASZS1	3		DTB2344	$BACKUP240877$
ZX1	26	ANZAASZX1	3			24.8.77
ES1	31					
EX1	32					
ZX3	33					
ZP1	34					
ZIN	35					
ZK1	36					
ZN4	37					
ZMP	38					

6. NOTES Used for a paper presented at the ANZAAS Conference, Melbourne, August 1977 (Dixon, Parmenter, Sutton).

Slack labour market for all occupations except skilled blue collar (metal and electrical).

Name : John Sutton

Department : IMPACT

Date : 12 October 1977

Catalogue of Computed ORANI Solutions - Page Number

(Use ✓ to indicate the same as for the standard solution)

1. Separation of variables into endogenous and exogenous
   (Some solutions may not conform to this division, or to these particular numbers of variables in each category.)
   (a) 2g + 1 endogenous "industry" variables ✓
   (b) 2M endogenous "labour" variables ✓ with M = 18
   (c) 3 exogenous "macro" variables ER, BT, FR
2. Parameter file ✓
3. Export industries ✓
4. Parameters supplied to program ORANI (a) wage indexation all 1.0
   (b) other weights for LT modified to allow for 18 occupations
5. Computer Files

Default File Name	Tape No.	File Name used	Cycle No.	Date Created	ID & SN	Details of backup (tape nos., label, date)
IOTABLES6869	1	IOTABLEAG	1	19.9.77	† DIAXOR DTB2344	* 8306 $BACKUP171077$ 17.10.77
MARGINS6869	2	✓				
R1R2	4	✓				
PDIMPORTS6869	50	✓				
PARAMS6869	3	✓				
EQN12	12	AGN12	1	19.9.77	†	*
EQN13	13	✓				
EQN14	14	✓				
EQN18	18	✓				
EQN567	15	AGN567	1	19.9.77	†	*
ALGEBRA2	22	AGGEBRA2	1			*
SPIDER	51	✓				
ALGEBRA3	53	✓				
ZC1	24	AG	2	21.9.77	†	*
ZS1	25					
ZX1	26	AGX	2	21.9.77	†	*
ES1	31					
EX1	32					
ZX3	33					
ZP1	34					
ZIN	35					
ZK1	36					
ZN4	37					
ZMP	38					

6. NOTES

This was used as background material for Mr. Parmenter's contribution to a panel discussion, Ag. Economics Soc., Melbourne, 28 Sept. 1977.

Data base and programs modified as needed to allow for 18 occupations - male and female treated separately in each occupation.

Wage bills for industries 1 to 9 modified by removing imputed wages and adding them to fixed capital.

Name : John Dutton

Department : IMPACT

Date : 12 October 1977

Table 1 : Variables Used in ORANI Solutions

Lists of Endogenous and Exogenous Variables must be Input in the following sequence :

		No. of components	Description and Volume 2 Notation
1.	X	g	domestic output, x_i
2.	X4	g	exports, $x_i^{(4)}$
3.	FE	g	shift term for world price ($US) for exports, f_i^e
4.	S	g	subsidies (S = 1 + rate of export subsidy), s_i
5.	PM	g+1	world price ($US) for imports, p_{j2}^m and p_{g+1}^m
6.	T	g+1	tariffs (T = 1 + tariff rate), t_j
7.	ER	1	exchange rate (= $A/$US), ϕ
8.	Q1	M	wages ($), $p_{(g+2)(1m)}$
9.	Q2	g	rental price of capital ($), $p_{(g+2)2j}$
10.	Q3	n	rental price of land ($), $p_{(g+2)3}$
11.	N1	M	demand for labour (man-hours), ℓ_m
12.	N2	g	demand for capital, $k_j(0)$
13.	N3	n	demand for land, n
14.	IM	1	aggregate investment ($), i
15.	CM	1	aggregate consumption ($), c
16.	M	1	aggregate imports, m
17.	E	1	aggregate exports, e
18.	BT	1	balance of trade (exports - imports) in $ billions, ΔB
19.	IP	1	investment price index, $\xi^{(2)}$
20.	CP	1	consumer price index, $\xi^{(3)}$
21.	IR	1	real investment, i_R
22.	CR	1	real consumption, c_R
23.	FR	1	FR = IR - CR, f_R
24.	LT	1	aggregate employment, i.e., aggregate demand for labour (man-hours), μ
25.	FW	M	shift terms for wages, $f_{(g+2)1m}$
26.	Q4	g	shift term for other costs ($), $f_{(g+3)j}$
27.	F1	g	shift terms for exogenous investment*, $f_j^{(2)}$
28.	F2	g	shift terms for other usge (domestic components), $f_{i1}^{(5)}$
29.	F3	g+1	shift terms for other usage (imported components), $f_{i2}^{(5)}$ and $f_{g+1}^{(5)}$
30.	S1	1	
31.	S2	1	variables 30 to 33
32.	S3	1	not yet in operation
33.	S4	1	
34.	PN	g	endogenous components of export subsidies S
35.	XN	g	endogenous components of exports X4
36.	X3	g	consumption (of domestically produced goods), $x_i^{(3)}$
37.	PI	g	price of capital, π_j
38.	I	g	investment, y_j
39.	K1	g	capital stock for next year, $k_j(1)$
40.	N4	g	demand for labour, by industry, $x_{(g+2)1j}$
41.	MP	g+1	imports

NOTE : An increase in the exchange rate means a devaluation of $A with respect to $US.

* Meaningful only for industries with exogenous investment, as specified on parameter file.