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A VARIANT OF THE ORANI MODEL FOR THE ANALYSIS OF SHORT-PERIOD RESPONSES

by

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NOTES TO ATTACHMENT 3

(a) This selected glossary includes only those ORANI-S variables which are either additional to ORANI-77 or which are used in ORANI-S with meanings which differ from their ORANI-77 interpretations. As such many of the variables appearing in the text and in the ORANI-S complete system of equations (Attachment 1) do not appear in this list. Details of these variables, common to both models, are contained in Table 2 of Volume 2.

Note also that not all the variables listed in this glossary appear explicitly in the structural equations of the ORANI-S system. They have been eliminated by substitution at an earlier stage.

ORANI-S contains a number of parameters additional to those of ORANI-77. Attachment 2 provides a glossary of these symbols.

(b) The equation numbers given as a reference for each variable are part of the equation numbering system used in the text. Note that the numbering system employed for the complete system of equations as set out in Attachment 1 is self-contained and does not correspond to that used in the text. The indicated equation in the text is that which defines, or at least contains, the given variable.

Equation	Variable	Subscript Range	Number	Description
(7.1)	$y^{(L)}$		1	Aggregate labour income.
(7.2)	$y^{(K)}$		1	Aggregate capital income.
(7.3)	$y^{(N)}$		1	Aggregate income accruing to land.
(7.4)	y		1	Total factor income (nominal value added).
(7.5)	x		1	Aggregate production (real value added).
(7.6)	p		1	Price deflator for aggregate production.
(7.7)	ℓ_m	$m=1,\ldots,M$	M	Total employment of labour in skill group m, in numbers employed.
(7.8)	ℓ		1	Aggregate employment, in numbers employed.
(7.9)	$d \log W$		1	Economy wide wage rate.

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1. INTRODUCTION

The purpose of this paper is to describe a variant of the ORANI inter-industry model designed specifically for the analysis of short-period responses (over, say, about one year). The variant, which we will refer to as ORANI-S, represents an elaboration of the structure of ORANI-77[1] to depict short-period adjustment processes more explicitly, particularly as reflected in industry selling prices, outputs and measured factor inputs.

In the complete IMPACT system, a number of the short-period adjustment processes at work will operate through 'macro' channels; for example, aggregate saving adjusts with a lag to changes in income, asset portfolios and asset prices set in financial markets adjust over time to changes in wealth and the structure of returns, and so on : these

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* This paper was drafted while the author was a member of the staff of the Industries Assistance Commission. He is now an officer of the Department of the Prime Minister and Cabinet. While the usual caveats about author's responsibility apply, the author wishes to record with appreciation the substantial conbributions to the work recorded here made by his colleagues at the Commission and the Australian Bureau of Statistics, among whom Philip Hagan, David Smith and John Spasojevic merit special mention.

1. See P. B. Dixon, B. R. Parmenter, G. J. Ryland and John 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, Volume 2 (Canberra : Australian Government Publishing Service, August 1977).

responses will be represented in the MACRO model. ORANI-S - - as a short-period model of 'micro' demand for and supply of commodities, and derived demands for factors - - is thus intended for use in conjunction with the IMPACT system's MACRO model, in line with the strategy for IMPACT development set out in the First Progress Report of the IMPACT Project, Volume 1.[1] Indeed the complete system will also incorporate the BACHUROO demographic/labour supply model, which will also have a role in depicting short-period labour supply responses. While this paper is concerned with ORANI-S itself, appropriate references are made to the mechanisms via which it will be linked to the other models of the system.

In a number of respects, ORANI-S represents a provisional approach to depicting short-period adjustment processes more explicitly; this is worth elaboration in a specific context. The labour-hoarding phenomenon, for example, is reflected in lagged adjustment of measured labour inputs to changes in outputs. It is recognised that these adjustments are the result of a rich variety of underlying economic behaviour : transactions costs in hiring and firing (and quitting), the accumulation of firm-specific human capital through experience and training, and so on.[2] For other reasons as well, labour input need not be adjusted immediately by increasing or reducing purchased units. Labour productivity can rise above (or fall below) customary 'norms' in the short term; indeed, particularly for salaried personnel, it is implicit in the ongoing employment relationship that this will occur as the

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1. Alan A. Powell, The IMPACT Project : An Overview, First Progress Report of the IMPACT Project, Volume 1 (Canberra : Australian Government Publishing Service, March 1977).

2. A further point is that some employees (research and development personnel, for example) may be engaged on tasks related not to current production levels but to investment in future productive capacity.

Equation	Variable	Subscript Range	Number	Description
(5.1)	$x_{(g+2)1mj}$	m=1,...,M j=1,...,g	Mg	Measured labour input of skill group m into industry j, in man-hours.
(4.5)	$x_{(g+2)1j}$	j=1,...,g	g	Demand for labour in general by industry j, in man-hours.
(5.3)	ℓ_{mj}	m=1,...,M j=1,...,g	Mg	Labour input of skill group m into industry j, in numbers employed.
(5.3)	n_{mj}	m=1,...,M j=1,...,g	Mg	Normal hours worked by skill group m in industry j.
(5.2)	f_{mj}	m=1,...,M j=1,...,g	Mg	Ratio of actual to normal hours worked by skill group m in industry j.
(5.8)	$\hat{x}_{(g+2)1mj}$	m=1,...,M j=1,...,g	Mg	Desired labour input of skill group m into industry j.
(7.9)	$p_{(g+2)1m}$	m=1,...,M	M	The economy wide 'ordinary-time' price of a man-hour of labour in skill category m.
(5.7)	$\bar{p}_{(g+2)1mj}$	m=1,...,M j=1,...,g	Mg	The average price per man-hour paid to skill group m in industry j.
(5.12)	$\hat{x}_{(g+2)3j}$	j=1,...,g	g	Desired input of agricultural land into industry j.
(6.3)	$p_{(g+2)2j}$	j=1,...,g	g	Ex post return to capital employed in industry j.
(6.4)	$\hat{p}_{(g+2)2j}$	j=1,...,g	g	'Shadow' rental price of capital employed in industry j.
(6.6)	k_j	j=1,...,g	g	The growth rate of the capital stock employed in industry j.
(6.7)	k^*_j	j=1,...,g	g	The component of k_j induced by the change in gross investment in industry j relative to the base period.

ATTACHMENT 3

SELECTED GLOSSARY OF SYMBOLS FOR VARIABLES IN ORANI - S[(a)]

Equation[(b)]	Variable	Subscript Range	Number	Description
				All variables are percentage changes with the exception of κ and Z.
(3.4)	u_j	j=1,...,g	g	The rate of user cost of capital in industry j.
(3.4)	r		1	Economy wide required real rate of return.
(3.4)	κ		1	The standard rate of investment allowance.
(3.4)	t		1	Economy wide tax rate on corporate income.
(3.4)	Z		1	Expected rate of inflation.
(3.5)	w_j	j=1,...,g	g	The user cost of capital in industry j, in nominal terms.
(3.8)	$\hat{p}_{j1}$	j=1,...,g	g	The 'normal' cost of domestic good j, at basic values.
(4.1)	$x_j^{(0)}$	j=1,...,g	g	Sales of the product of domestic industry j.
(4.2)	$\hat{v}_j$	j=1,...,g	g	Desired stock of inventories of industry j output.
(4.7)	v_j	j=1,...,g	g	Actual stock of inventories of industry j output.
(4.7)	$v_j^{(0)}$, $v_j^{(1)}$	j=1,...,g	2g	'Planned' and 'unplanned' components of v_j.
(4.4)	$\hat{x}_j$	j=1,...,g	g	'Normal' output of domestic industry j.

circumstances of the firm require. In fact for each category of labour, effective input (gross of short-term productivity movements) can deviate in the short term from measured input - - be it numbers of persons at standard hours or numbers of persons at actual (paid-for) hours.

ORANI-77 deals in effective inputs; ORANI-S is designed to dissect responses in these effective quantities so as to depict short-period responses in measured inputs as well. The ORANI-S approach is provisional in that it does not attempt to explain in detail the variety of economic behaviour, outlined above, which underlies the response lags observed in measured inputs - - the current state of relevant theory and the available data would not support a full-scale effort in that direction at present, although it may in the future. The present approach rather attempts to capture the measurable gross characteristics of the phenomena by representing the various response lags largely by partial adjustment mechanisms with constant speeds of adjustment, these augmenting the ORANI-77 general equilibrium structure. This and other aspects of the ORANI-S specification preserve linearity (in log differentials) and are carefully designed to preserve, as the states to which the ORANI-S system converges over time, the equilibrium states determined by the ORANI-77 structure. As a linear system, ORANI-S is designed to serve in two roles : either to yield directly the induced responses (at a given time horizon) to an incremental disturbance in some exogenous variable, relative to its 'control' path; or to yield the trajectories over time in the levels of model variables, given a complete scenario for exogenous variables.

2. SHORT-PERIOD ADJUSTMENT PROCESSES : A STYLIZED OVERVIEW

For present purposes, the best way to introduce the specification of ORANI-S is to present a stylized account, the gross features of which are emulated in that specification, of the behaviour in the short period of a typical firm which encounters an unexpected but sustained shift (upwards, say) in the level of demand for its product, measured at existing prices.

It is assumed that the firm is in equilibrium initially : it has the normal or 'desired' level of inventories corresponding to the initial level of demand, so that its output is also running at that level; it is using, at productivity norms, the cost-minimizing mix of inputs appropriate to the set of factor prices it faces; it has, in particular, a stock of fixed capital such that it is earning the (economy-wide) required rate of return on capital; thus its selling price equals normal cost.

The firm's reaction to the shift in demand is initially primarily through quantity, rather than price adjustments. The considerations underlying this are well summarized by Malinvaud[1] :

> "The immediate impact of changes in demand or supply is to be found in order books, waiting lists, inventories, delivery dates, output, hours of work, employment, ... Such quantitative adjustments are the first signals of changes in the demand-supply relationships. Shifts in relative prices come later and in a less apparent way.
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> . . . .
>
> "Quarterly changes in the prices of manufactured goods have a very good fit with a simple model stating a constant rate of mark-up above costs. In some cases, but by no means

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1. Edmond Malinvaud, The Theory of Unemployment Reconsidered, the Yrjo Jahnsson Lectures (Oxford : Basil Blackwell, 1977), pp. 9-10. Malinvaud cites (mainly in the footnotes to pp. 10-11) a selection of the more noteworthy recent references - - both empirical and theoretical - - on the question of short-term price determination, and related phenomena.

NOTES TO ATTACHMENT 2

(a) By far the majority of parameters contained in the list of structural equations for ORANI-S (see Attachment 1) are common to both ORANI-S and ORANI-77. Details of these parameters common to both models are contained in Table 4 of Volume 2. Only those ORANI-S parameters that are additional to the ORANI-77 parameter set are listed in this Attachment.

(b) The equation numbers used as a reference for each parameter are those used in the text of this note. They differ from those used in the complete listing of structural equations in ORANI-S (see Attachment 1).

(c) Many of the parameters listed do not explicitly appear in the structural equations of the ORANI-S system. However they are required to calculate those structural parameters that appear in Attachment 1.

(d) As mentioned in the text the ORANI-S parameters listed in this attachment can be divided into three general groups. The code used to identify these three groups is
   - (S) - These are the parameters that are essentially structural in nature and can be derived from available statistics in a straightforward manner.
   - (I) - These parameters represent the initial conditions of the model. Strictly speaking this class are not parameters at all since, although for one period solutions they are pre-determined, their value will change from period to period.
   - (A) - This last, and most important, class of parameters measure various aspects of the dynamic behaviour of economic agents in the model.

References

(1) H.N. Johnston, "Corporate Profitability and the User Cost of Capital for the Corporate Trading Enterprises Sector", ABS, December 1975 (mimeo).

(2) Evans, H.D., B. Moore and G. Horgan, "The Structure of the Australian Capital Stock and Depreciation", Econometric Analysis of Protection, Appendix 7 of Progress Report, Monash University, 1973 (mimeo).

(3) V.W. FitzGerald, "An Inter-Industry Pricing Model", RSSS Seminar, ANU, June 1977.

Equation	Parameter	Description	Status	Initial Values
(7.4)	$s^{(L)}$	The base period share of labour in total factor income (value added).	(S)	Derived from the ORANI-77 data base.
(7.4)	$s^{(K)}$	The base period share of capital in total factor income.	(S)	Derived from the ORANI-77 data base.
(7.4)	$s^{(N)}$	The base period share of agricultural land in total factor income.	(S)	Derived from the ORANI-77 data base.
(7.9)	$b_{w(m)}$	Logical switch between wages in each skill indexed to the ORANI CPI or set to move in line with some exogenous macro measure (m=1, ..., M).	(I)	This parameter should take a user selected value (either zero or one).

in all, the fit is somewhat improved when the possibility of an action of demand pressure on mark-up margins is introduced; but this influence appears to be weak.

. . . .

"The conclusion therefore emerges that short-term quantitative adjustments are much more apparent and influential than short-term price adjustments."

Bearing in mind that the time horizon relevant here ('about a year') may be a little longer than Malinvaud has in mind, the behaviour of the typical firm faced with a demand upshift can be stylized as follows. During the period, it may begin to raise its selling price - - with some restraining effect on the level of demand - - but this would not represent a major part of its response to the new situation of excess demand. The firm may also begin to adjust its rate of production, but the adjustment of output to the new level of demand is not completed within the period. Meanwhile, the increased demand is met to the remaining (substantial) extent from inventory (the stock of inventories thus acting as a buffer), so that sales equals ex ante demand.[1]

As the output of the typical firm rises, its factor inputs rise - except for its capital stock, which is assumed fixed.[2] However, for the kinds of reasons outlined above in respect of labour inputs, measured primary

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1. For simplicity, the specification of ORANI-S abstracts from the possibility that some form of queueing (e.g., via order books) or rationing also serves to mediate between ex ante demand and sales.

2. What is fixed is the measured capital stock (the stock in place). The transient productivity increases discussed here may be attributable, in part, to more intensive utilization of that stock.

factor inputs (other than capital) rise less than in proportion to output[1] (it is assumed that usage of materials rises in strict proportion to output). More precisely, allowing for the possibility that the demand shift is associated with changes in the factor prices faced by the typical firm, measured inputs of primary factors do not change by as much in the period as would be required to produce the increased output with a cost-minimizing mix of factors used at normal productivity levels. For hourly rated labour (measured in man-hours), the response in average hours worked is greater than in numbers of persons; however, since overtime hours are paid for at premium rates, there is no permanent increase in average hours : eventually the sustained new level of output will be reflected in increased numbers of employees working normal hours. Apart from premiums paid for overtime hours, the rents created by short-term productivity increases accrue to the firm.

As time passes, the firm completes the adjustment of its inputs to the new level of output, in part by investing in new capital equipment. The firm adjusts its capital stock to the level at which it can earn the (economy-wide) required rate of return, given the new level of output and the full set of factor prices it faces. Each step in the process of adjusting the capital stock involves a 'gestation' delay comparable to the time period in question - - say, about one year.

The firm also gradually replenishes its stock of inventories by diverting some of its increased output to that purpose. Eventually the stock is fully adjusted to the level appropriate to the firm's new output (and sales) level.

1. This expresses what is widely referred to as 'Okun's Law' : see A. M. Okun, "Potential GNP - - Its Measurement and Significance," Proceedings of the Business and Economic Statistics Section, American Statistical Association, 1962, pp. 98-104. See also E. Kuh, "Cyclical and Secular Labor Productivity in U.S. Manufacturing," Review of Economics and Statistics, 1965, pp. 1-12.

Equation	Parameter	Description	Status	Initial Values
(6.6)	b_{14j}	$= Y_j(0)/K_j(-1)$ (j=1, ..., g).	(I)	Derived from the expression given where $Y_j(0)$ and $K_j(-1)$ are gross investment in the base period and real capital stock in the period earlier, respectively, for industry j. These ratios could be estimated by the same method used to obtain values for the ORANI-77 parameter g_j, the ratio of annual gross investment, in future capital stocks (see Volume 2, p. 164). Note the similarity between g_j and b_{14j}. The difference being that the former is the ratio of gross investment to future capital stocks.
(7.7)	L_{mj}	The base period share of industry j in total employment (in numbers of persons) in occupation group m (j=1,...,g; m=1,...,M).	(S)	This share parameter can be calculated from the (M, g) 'persons employed' matrix used to create the wage bill matrix currently required by ORANI-77 (see Volume 2, p. 153).
(7.8)	L_m	The base period share of m-type labour (in persons) in total employment (m=1, ..., M).	(S)	This share parameter is equal to B_m in ORANI-77. It represents the share of the m^{th} row total in the sum at all entries in the 'persons employed' matrix.
(7.1)	$S^{(L)}_{mj}$	The base period share of aggregate labour income accruing to labour of type in industry j (j=1, ..., g; m=1, ..., M).	(S)	Derived from the ORANI-77 data base.
(7.2)	$S^{(K)}_j$	The base period share of j industry capital in aggregate capital income (j=1, ..., g).	(S)	Derived from the ORANI-77 data base.

Equation	Parameter	Description	Status	Initial Values
(5.6)	ζ_{mj}	$= \theta_{mj}(\upsilon_m - 1)$ (j=1, ..., g; m=1, ..., M).	(S)	Derived from the expression given, using the values estimated for θ_{mj} and υ_m.
(5.7)	$\lambda_{2(mj)}$	The extent to which the measured labour input of skill group m in industry j, in man-hours, responds to the gap between desired and existing employment in this skill and industry (j=1, ..., g; m=1, ..., M).	(A)	This parameter may, with some simplifying assumptions, be estimated from available time series/cross section data of industry outputs and employment levels, by skill groups.
(5.7)	$b_{11(mj)}$	$= (1-\lambda_{2(mj)}) x_{(g+2)1mj}(0)$, the influence of any existing disequilibrium in labour employment, measured as the gap between desired and existing employment in the previous period, on the employment of skill group m by industry j (j=1, ..., g; m=1, ..., M).		For solutions with specified initial conditions this parameter can be derived from the expression given. Its default (equilibrium) value will be zero. The base period value $x_{(g+2)1mj}(0)$ represents the observed change in the employment of skill m by industry j (measured in man-hours) in the base period.
(5.11)	λ_{3j}	The extent to which the demand for agricultural land in industry j adjusts to the gap between desired and existing usage of land (j=1, ..., g).	(A)	Because of the lack of appropriate data it is not expected that genuine estimates of this parameter can be made.
(5.11)	b_{12j}	$= (1-\lambda_{3j}) x_{(g+2)3j}(0)$, the influence of any existing gap between desired and existing usage of land by industry j on that industry's current demand for land (j=1, ..., g).	(I)	As for b_{11mj} this initial disequilibrium parameter can be derived from the expression given. Its default (equilibrium) value is zero.

Finally, with all factors again in use at normal productivity levels (and average hours restored to normal) and with stocks again at desired levels, the firm is again in (qualitatively) the same situation as it was initially, except that its scale of operations is larger. Possibly, however, the mix of factors it is using may have changed if there were some change in relative factor prices associated with the demand increase; if so, the weighting of factor prices in normal unit cost (and the firm's selling price) may also have changed.

3. SHORT-PERIOD PRICING BEHAVIOUR

In ORANI-S the typical industry adjusts its price in the short period in response to two factors : changes in normal unit cost and the level of excess demand.[1] Normal unit cost is defined as the cost per unit of output which would be incurred in steady production with factors used at normal levels of productivity and paid the going prices. For capital, this implies that the user cost passed on in the product selling price is

1. This model of pricing accords with the stylized account given above and has extensive empirical support. It is closely related to the target rate of return model of Eckstein and Fromm : see their paper "The Price Equation," American Economic Review, 1968, pp. 1159-1183. An extensive coverage of the applied theoretical and empirical work on pricing can be found in Otto Eckstein (ed). The Econometrics of Price Determination Conference (Washington, D.C. : The Board of Governors of the Federal Reserve System and the S.S.R.C., 1972). An important empirical study is reported in L. D. Taylor, S. J. Turnovsky and T. A. Wilson, The Inflationary Process in North American Manufacturing, Study prepared for the Prices and Incomes Commission (Ottawa : Information Canada, 1973). These authors superimpose a partial adjustment mechanism on the response to changes in normal costs; however, the results suggest that while this may enhance the explanation of observed quarterly price movements, it is a minor contributor to the explanation of year-to-year movements. Adopting the Taylor, Turnovsky and Wilson partial adjustment approach would, however, require only simple and obvious modifications to the equations set out here, involving an additional speed of response parameter and a constant representing any initial disequilibrium for each industry price equation.

based on the industry's capital, valued at replacement cost, earning the economy-wide required rate of return. The level of excess demand is measured in ORANI-S by the logarithmic gap between the actual level of output in the short period and the normal level of output, given the (measured) factor supplies; of course, other measures of excess demand are possible.

Before setting out the representative price equation, the concept of normal user cost for a unit of capital needs to be made explicit. The user cost W_j of a unit of j-industry capital is the product of its replacement price Π_j and the rate of user cost U_j. Measures of the latter for Australia are discussed by Johnston and by Kiernan and O'Shea.[1] In a variant of Johnston's notation, the rate of user cost in ORANI-S is defined as in equation (3.1), in which two classes of capital items, treated differently for tax purposes, are distinguished. For clarity, the industry subscript j is omitted :

$$U = \{R + gm + (1 - g)n - sT[ga(R + m)/(R + a) + g\kappa(R + m)/(R + 1) + hI]\}/(1 - sT) \quad (3.1)$$

where

U = industry rate of user cost (pre-tax basis) ;

1. See H. N. Johnston, "Corporate Profitability and the User Cost of Capital for the Corporate Trading Enterprises Sector," Australian Bureau of Statistics, 1975 (mimeo), and E. Kiernan and P. O'Shea, "An Analysis of Fixed Investment, Aggregate Production and the Cost of Capital in Australia," paper presented at the 48th ANZAAS Congress (Section 24), Melbourne, 1977. See also C. I. Higgins, H. N. Johnston and P. L. Coghlan, "Business Investment : The Recent Experience," in Conference in Applied Economic Research : Papers and Proceedings (Sydney : Reserve Bank of Australia, 1976), pp. 11-38.

Equation	Parameter	Description	Status	Initial Values
(4.7)	b_{6j}	$= \gamma_{5j}\{\hat{X}_j(0)/V_j(0)\}$ (j=1, ..., g).	(I)	$b_{6j} = \gamma_{5j}/e^{\gamma_{1j}}$
(4.7)	b_{7j}	$= \gamma_{5j} X_j^{(o)}(0)/V_j(0)$ (j=1, ..., g).	(I)	$b_{7j} = \gamma_{5j}/e^{\gamma_{1j}}$
(4.9)	b_{8j}	$= \{X_j^{(o)}(0)/X_j(0)\} -1$ (j=1, ..., g).	(I)	$b_{8j} = 0$
(4.9)	b_{9j}	$= X_j^{(o)}(0)/X_j(0)$ (j=1, ..., g).	(I)	$b_{9j} = 1.0$
(4.9)	b_{10j}	$= V_j(0)/X_j(0)$ (j=1, ..., g).	(I)	$b_{10j} = e^{\gamma_{1j}}$ where $e^{\gamma_{1j}}$ is the inventory to sales ratio for industry j in the base period.
(5.3)	θ_{mj}	The elasticity of changes in the ratio of average to normal hours worked by skill group m employed in industry j with respect to changes in demand pressure in its product market, measured as the ratio of actual to normal output (j=1, ..., g; m=1, ..., M).	(A)	This parameter may be estimated from available time series/cross section data of industry outputs and employment levels, by skill groups. A series of 'normal' outputs of each industry will also need to be constructed.
(5.4)	υ_m	Ratio of the overtime hourly wage rate to the ordinary-time hourly wage rate for skill group m - assumed to be industry independent (m=1, ..., M).	(S)	A value for this parameter can be derived from data on wages in each occupation.
(5.5)	$F_{mj}(0)$	Ratio of average to normal hours worked by skill group m in industry j in the base period (j=1, ..., g; m=1, ..., M).	(I)	A base-period value for this ratio may be obtained from data on hours worked by each skill in each occupation. Its default (equilibrium) value will be 1.0.
(5.5)	υ_{mj}	$= \upsilon_m / \{1-\upsilon_m + \upsilon_m F_{mj}(0)\}$ (j=1, ..., g; m=1, ..., M).	(S)	Derived from the expression given. Its default (equilibrium) value is υ_m (that is with $F_{mj}(0) = 1.0$).

Equation	Parameter	Description	Status	Initial Values
(4.6)	γ_{5j}	Buffering fraction. The extent to which the gap between planned output and demand (being sales plus planned inventory change) is met by unplanned inventory changes, for each industry j (j=1, ..., g).	(A)	This parameter could be estimated econometrically from time series data on industry outputs, sales and changes in inventories (at least one observation on the level of stocks is also needed).
(4.7)	$X_j(0)$	Output of industry j in the base period (j=1, ..., g).		) These base period values are pre-) determined for one period solutions) but will vary from period to period) in dynamic simulations. One source) of information on industry output and) sales in the base period are the I-O) tables in the ORANI-77 database. This) table will also provide data on the) change (absolute) in inventories in) 1968-69 in each industry but not) however on the level of inventories.) For the other base period values) required here the default (equilibrium)) assumptions can be made that) $\hat{X}_j(0) = X_j(0)$ and $v_j^{(0)} = 0$) Note that if these default options are) not exercised it is generally the) ratios, rather than the absolute) levels, of these base period values) that are required.
(4.7)	$\hat{X}_j(0)$	Normal output of industry j in the base period (j=1, ..., g).		
(4.7)	$X_j^{(0)}(0)$	Sales in industry j in the base period (j=1, ..., g).		
(4.7)	$V_j(0)$	Level of inventories held by industry j in the base period (j=1, ..., g).		
(4.7)	$v_j^{(0)}$	$= \Delta V_j^{(0)}/V_j(0)$, the planned percentage increase in inventories over the actual level in the base period (j=1, ..., g).		

The parameters ν_j and γ_{ij}, i=1, ..., 5 are not explicit structural parameters of the ORANI - S system as listed in Attachment 1. However, together with the base period values of sales, inventories, outputs, etc. above (or at least ratios of these values), they are used as follows to derive the explicit parameters:

Equation	Parameter	Description	Status	Initial Values
(4.7)	b_{5j}	$= v_j^{(0)}(1-\gamma_{5j}) + \gamma_{5j}\{\hat{X}_j(0) - X_j^{(0)}(0)\} / V_j(0)$ (j=1, ..., g)	(I)	For solutions with specific initial conditions, or for linked sequences of solutions, these disequilibrium parameters can be derived from the given formulae. The default (equilibrium) values are: $b_{5j} = 0$

R = economy-wide required real rate of return (a weighted average of rates on debt and equity)[1] ;

m = industry rate of depreciation for plant and equipment ;

a = ditto, for tax purposes ;

n = industry rate of depreciation for buildings and other construction investment (not generally tax-deductible) ;

κ = rate of investment allowance applicable to the industry (plant and equipment only; equals either a standard rate or zero) ;

g = proportion of plant and equipment in industry capital ;

h = proportion of debt finance in total financing of industry capital ;

I = nominal rate of interest on industry debt ;

T = economy-wide tax rate on corporate income (representative rate of tax on business income) ;

and

s = industry tax rate adjustment factor (to allow for the existence of unincorporated business, etc.).

The above expression for U is simplified as follows. Let $a = m$; write δ for $gm + (1 - g)n$; write M for gm . Assume that $I = f(R + Z)$, where f is a constant mark-up factor, for risk etc.,[2] and Z represents the expected rate of inflation (to be determined in the MACRO model); write H for hf . Then

1. Note that IMPACT's MACRO model at present explains only representative interest rates on debt.

2. Johnston gives a value of 1.25 for the ratio of the rate of interest paid on the debt of the corporate trading enterprises sector (as a whole) to the Government bond rate.

$$(3.2) \qquad U = \{R + \delta - sT[M + g\kappa \frac{(R+m)}{(R+1)} + H(R+Z)]\}/(1 - sT) .$$

Treating U as a function of R , Z , κ and T , the proportional change in U is

$$d \log U = \{R + \delta - sT[M + g\kappa \frac{(R+m)}{(R+1)} + H(R+Z)]\}^{-1}$$

$$(3.3) \qquad \{R(1 - sTH + sTg\kappa \frac{(m-1)}{(R+1)^2}) \, d \log R - sTHdZ$$
$$- sTg \frac{(R+m)}{(R+1)} d\kappa + \frac{sT}{(1-sT)} [R + \delta - M$$
$$- g\kappa \frac{(R+m)}{(R+1)} - H(R+Z)] \, d \log T\} .$$

Note that dZ and dκ appear, rather than (Z d log Z) and (κ d log κ), since Z and κ are not guaranteed positive.

In ORANI-S, the expression for d log U is represented as follows; the industry subscript j is restored and the ORANI convention of using lower case letters to represent the log differentials of variables symbolized by upper case letters (e.g., u for d log U) is adopted:

$$(3.4) \qquad u_j = b_{0j} \, d\kappa + b_{1j} \, r + b_{2j} \, t + b_{3j} \, dZ ,$$

where the coefficients b_{ij} (i = 0, 1, 2, 3) are predetermined for the current period and depend as set out above on the industry structural parameters δ_j , s_j , H_j , g_j and m_j , and on the initial values of κ , R , T and Z ; here κ represents the standard rate of investment allowance and b_{0j} is zero for industries not eligible for the allowance.

Equation	Parameter	Description	Status	Initial Values
(3.7)	b_{4j}	$= \lambda_{1j}(\log X_j(0) - \log\hat{X}_j(0))$, the influence of any initial excess demand in the product market on the selling price of industry j (j=1, ..., g).	(I)	For solutions with specific initial conditions, or for linked sequences of solutions, this initial disequilibrium parameter can be derived from the expression given. Its default (equilibrium) value is zero.
(4.2)	ν_j	The weight given to current sales as compared to last period sales in the composite sales variable, for industry j (j=1, ..., g).	(S)	Scope for obtaining a value for this parameter is limited. Although it could take any value between zero and unity its default value will be set at 1.0; composite sales equal current sales.
(4.2)	γ_{1j}	Logarithm of the proportionality factor between desired level of inventories in industry j and the level of composite sales (if γ_{2j} = 1.0), or some specified power of composite sales (if γ_{2j} < 1), in each industry (j=1, ..., g).	(S)	In the absence of any other information a default value for this parameter could be calculated as the logarithm of the ratio of inventories to sales in each industry. Observed values of this ratio could be obtained from manufacturing censuses, etc.
(4.2)	γ_{2j}	The elasticity of changes in the desired inventory level with respect to changes in composite sales, in industry j, (j=1, ..., g).	(S)	This parameter must take a value between zero and one. Scope for its estimation is limited. A default value of 1.0 is chosen: desired inventories are proportional to composite sales (equal current sales with ν_j = 1.0).
(4.2)	γ_{3j}	$= \nu_j \cdot \gamma_{2j}$ (j=1, ..., g).	(S)	Derived from above. Its implied default value is 1.0.
(4.3)	γ_{4j}	The speed of adjustment of the actual level of inventories in industry j to the desired level (j=1, ..., g).	(A)	A value for this parameter could be obtained by estimation (see γ_{5j}). Its value does not affect one period solutions; however it should be kept relatively small in keeping with the notion of buffering.

Equation	Parameter	Description	Status	Initial Values
(3.2)	M_j	$= g_j \cdot m_j \quad (j=1, \ldots, g)$.		Derived from the expressions given.
(3.2)	H_j	$= h_j \cdot f_j \quad (j=1, \ldots, g)$.		Derived from the expressions given.
(3.2)	δ_j	$= g_j m_j + (1-g_j)n_j$, a weighted average of the depreciation rates for the two broad classes of capital $(j=1, \ldots, g)$.		Derived from the expressions given.
(3.3)	R(0)	Economy wide required real rate of return in the base period.		To be obtained from the MACRO module.
(3.3)	T(0)	Economy wide tax rate on corporate income in the base period.		To be obtained from the Australian Taxation Office.
(3.3)	K(0)	Standard rate of investment allowance in the base period. This will be zero for industries not eligible for the allowance.		Ditto
(3.3)	Z(0)	Expected economy wide rate of inflation.		To be obtained from the MACRO module.
	All these parameters are combined in the manner implied by the equation (3.3) of the text to give the four structural parameters:			
(3.4)	of equation (29) in Attachment 1.	b_{0j}, b_{1j}, b_{2j} and b_{3j} ,	(S)	Derived from the expressions implied by equations (3.3) and (3.4) of the text.
(3.7)	λ_{1j}	The extent to which the selling price of industry j responds to excess demand in the market for this industry's product $(j=1, \ldots, g)$.	(A)	To be econometrically estimated from time series data on actual output, 'normal' output and 'normal' unit costs. While the first can be observed the last two will have to be constructed series.

Note that all of the variables on the r.h.s. of (3.4) are macro variables exogenous to ORANI-S.

Now user cost in nominal terms, denoted W_j , is the product of the replacement price Π_j of an average unit of j-industry capital and the rate of user cost U_j ; thus

(3.5) $$w_j = \pi_j + u_j .$$ [1]

The ORANI-S pricing model can now be set out explicitly. The notation follows Dixon, Parmenter, Ryland and Sutton.[2] The specification for the adjustment of prices (measured at basic values) is as follows :

(3.6) $$d \log P_{j1} = d \log \hat{P}_{j1} + \lambda_{1j}(\log X_j - \log \hat{X}_j) ,$$

where $\hat{P}_{j1}$ and $\hat{X}_j$ represent normal cost (including the normal capital user cost component) and normal output, respectively : see below.

The logarithms of the current levels of X_j and $\hat{X}_j$ in (3.6) can be replaced by the log differentials plus the initial values. Thus

(3.7)
$$p_{j1} = \hat{p}_{j1} + \lambda_{1j}(x_j - \hat{x}_j) + \lambda_{1j}(\log X_j(0) - \log \hat{X}_j(0))$$
$$= \hat{p}_{j1} + \lambda_{1j}(x_j - \hat{x}_j) + b_{4j} .$$

1. Substituting (3.4) into (3.5) enables u_j to be dropped out of the ORANI-S equations; then only w_j appears.

2. Op. cit., hereafter referred to simply as "Volume 2."

The specification of $\hat{p}_{j1}$ is the same as the r.h.s. of of ORANI-77 equation (9.2) (see Volume 2), except in respect of capital costs :

$$\hat{p}_{j1} = \sum_{i=1}^{g} \sum_{s=1}^{2} a^{(1)}_{isj}\, p^{(1)}_{isj} + a^{(1)}_{(g+1)j}\, p^{(1)}_{(g+1)j}$$

$$(3.8) \qquad + \sum_{m=1}^{M} a^{(1)}_{(g+2)1mj}\, p_{(g+2)(1m)} + a^{(1)}_{(g+2)2j}\, w_j$$

$$+ a^{(1)}_{(g+2)3j}\, p_{(g+2)3} + a^{(1)}_{(g+3)j}\, p_{(g+3)j} \ .$$

In the implementation of ORANI-S, (3.8) is substituted into (3.7), so that $\hat{p}_{j1}$ does not appear explicitly.

It will be apparent that if λ_{1j} and b_{4j} are set at zero, the ORANI-S pricing model differs from the ORANI-77 model only in the treatment of capital costs : in place of w_j in (3.8) above, ORANI-77 (see Volume 2) has an ex post returns to capital concept $p_{(g+2)2j}$ [1]. ORANI-S also incorporates such a concept, but, in consequence of the emergence in ORANI-S of rents generated by short-term deviations of productivity from normal levels, its derivation is different from that in

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1. In the implementation of ORANI-S, an industry-by-industry logical switch w_{1j} is in fact provided to allow the user to revert to the ORANI-77 pricing model (with λ_{1j} and b_{4j} set at zero); details will be found in the ORANI-S computing manual (forthcoming). It might also be noted that, consistent with an earlier line of enquiry which is not being pursued at present, the representative price equation actually implemented contains an additional term $b_{15j}\, dZ$ in the change in the expected economy-wide inflation rate dZ, defined above (exogenous to ORANI-S) ; b_{15j} is at present set at zero, giving the ORANI-S specification described in this paper.

ATTACHMENT 2

ADDITIONAL PARAMETERS SPECIFIC TO ORANI - S[(a)]

Equation[(b)]	Parameter[(c)]	Description	Status[(d)]	Initial Values
(3.1)	s_j	Industry tax rate adjustment factor. The proportion of industry j that is covered by the general tax rate on corporate income (j=1, ..., g).		An economy wide value may be obtained from Johnston (1975)[1]; industry specific values may be obtained from data published by the Australian Taxation Office.
(3.1)	$1-g_j$	The proportion of building and construction in a unit of capital in industry j (j=1, ..., g).		) These may be obtained from the Monash) capital matrix[2] (used in the data) bases of ORANI-77 and the FitzGerald) pricing model[3]). For ($1-g_j$) the) relevant entries are those for the two) I-O industries (41.01 and 41.02)) supplying building and construction;) g_j then follows as a residual.
(3.1)	g_j	The proportion of plant and equipment in a unit of capital in industry j (j=1, ..., g).		
(3.1)	m_j	Depreciation rate on plant and equipment in industry j (j=1, ..., g).		A weighted average, with weights taken from the Monash capital matrix, of values in the appropriate column of the Monash depreciation rate matrix for rows other than those corresponding to I-O industries 41.01 and 41.02.
(3.1)	n_j	Depreciation rate on building and construction in industry j (j=1, ..., g).		As for m_j except only using the rows corresponding to I-O industries 41.01 and 41.02.
(3.1)	a_j	Depreciation rate allowed for tax purposes on plant and equipment in industry j (j=1, ..., g).		Assumed equal to m_j.
(3.1)	h_j	Proportion of debt finance in total finance in industry j (j=1, ..., g).		An economy wide value may be obtained from Johnston[1]: industry figures may be obtained from stock exchange data.
(3.2)	f_j	Constant mark up factor to raise the economy wide required rate of return to the rate of interest paid on debt by industry j (j=1, ..., g).		Economy wide value from Johnston[1]; data for each industry may be more difficult to obtain.

NOTES TO ATTACHMENT 1

(a) The presentation of the structural equations of ORANI-S used here mirrors that used for ORANI-77 in Table 1 of Volume 2. In fact, many of the equations presented above are duplicates of equations in Table 1.

(b) The ordering and numbering of equations in this attachment bears no relation to that used in either the text of this note or in Table 1 of Volume 2.

(c) J is the subset of $\{1,2,\ldots g\}$ which contains the numbers of those industries whose investment is treated as endogenous within ORANI. See Volume 2, Section 10.

ORANI-77 (see below) and it does not directly influence short-period pricing.

In order that the ORANI-S explanation of price converges over time to the ORANI-77 general equilibrium explanation, it is necessary that X_j and $\hat{X}_j$ converge (and hence b_{4j} disappear), and that the normal and ex post concepts w_j and $p_{(g+2)2j}$ converge. Satisfying these conditions depends on aspects of the ORANI-S specification other than pricing - - indeed, on aspects of the other models of the system, particularly of MACRO - - and is addressed further below.

4. INVENTORIES AND OUTPUT

In ORANI-S, buffering of short-term fluctuations in the demand for the product of the representative industry is provided by stocks of inventories.[1] Variations in inventory carrying costs are ignored in the model, so that either the industry itself or some other participant in the market for its product can be thought of as holding the inventories.

It is assumed that there is a 'desired' stock of inventories which is a slowly changing function of sales. That is, the desired stock adjusts with a 'recognition lag' to changes in the level of sales. Since there is no rationing in product markets in ORANI-S, the change in sales, denoted $x_r^{(0)}$, is defined by the r.h.s. of ORANI-77 equation (11.5), defining demand in that model (see Volume 2) :

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1. Given the focus on supply relationships for domestic products, inter-relationships between short-period import movements and inventory change are not represented in ORANI-S; it is thus implied that imported goods are in elastic supply from abroad at the going prices.

$$x_r^{(0)} = \sum_j x_{r1j}^{(1)} B_{r1j}^{(1)} + \sum_j x_{r1j}^{(2)} B_{r1j}^{(2)} + x_{r1}^{(3)} B_{r1}^{(3)} + x_r^{(4)} B_{r1}^{(4)}$$

$$+ x_{r1}^{(5)} B_{r1}^{(5)} + \sum_{i=1}^{g} \sum_{s=1}^{2} \sum_{j=1}^{g} \sum_{k=1}^{2} x_r(isjk)\; B_r(isjk)$$

(4.1)

$$+ \sum_{j=1}^{g} \sum_{k=1}^{2} x_r(g+1jk)\; B_r(g+1jk) + \sum_{k=3,5} x_r(g+1k)\; B_r(g+1k)$$

$$+ \sum_{i=1}^{g} \sum_{s=1}^{2} \sum_{k=3,5} x_r(isk)\; B_r(isk) + \sum_{i=1}^{g} x_r(i4)\; B_r(i4) \; .$$

The current level of the desired inventory stock, denoted $\hat{V}_j$, is specified as a log-linear function of current sales $X_j^{(0)}$ and lagged sales $X_j^{(0)}(0)$:

$$\hat{V}_j = e^{\gamma_{1j}} \left\{ (X_j^{(0)})^{\nu_j} (X_j^{(0)}(0))^{1-\nu_j} \right\}^{\gamma_{2j}} ,$$

or

(4.2) $$\log \hat{V}_j = \gamma_{1j} + \gamma_{2j} \log X_j^{(0)}(0) + \gamma_{3j} x_j^{(0)} ,$$

where

$$\gamma_{2j} , \nu_j \leqslant 1 ,$$

and

$$\gamma_{3j} = \nu_j \gamma_{2j} .$$

Eqn No	Equation	Subscript Range	No	Description
(59)	$p_{(g+3)j} = h_{(g+3)j}\, \xi^{(3)} + f_{(g+3)j}$	j=1,...,g	g	Indexing of the prices of 'other cost tickets'
(60)	$\mu = \sum_{m=1}^{M} B_m x_{(g+2)1m}$		1	Aggregate employment, measured in man-hours
(61)	$\ell = \sum_{m=1}^{M} \bar{I}_m \ell_m$		1	Aggregate employment, measured in numbers of persons
(62)	$i_R = c_R + f_R$		1	Ratio of real private investment to real consumption expenditure
(63)	$y^{(L)} = \sum_{m=1}^{M} \sum_{j=1}^{g} S_{mj}^{(L)} \; (x_{(g+2)1mj} + \bar{p}_{(g+2)1mj})$		1	Aggregate labour income
(64)	$y^{(K)} = \sum_{j=1}^{g} S_j^{(K)} \; (p_{(g+2)2j} + k_j(o))$		1	Aggregate capital income
(65)	$y^{(N)} = n + p_{(g+2)3}$		1	Aggregate income accruing to land
(66)	$y = S^{(L)}.y^{(L)} + S^{(K)}.y^{(K)} + S^{(N)}.y^{(N)}$		1	Aggregate factor income (value-added)
(67)	$x = \sum_{j=1}^{g} S_j^{(x)} x_j$		1	Aggregate production (real value added)
(68)	$p = y - x$		1	Price deflator for aggregate production

Eqn No	Equation	Subscript Range	No	Description
(49)	$x_{r2} = \sum_{k=1}^{2} \sum_{j=1}^{g} x_{r2j}^{(k)} B_{r2j}^{(k)} + \sum_{k=3,5} x_{r2}^{(k)} B_{r2}^{(k)}$	r=1,...,g	g	Competitive import volumes
(50)	$x_{(g+1)} = \sum_{k=1}^{z} \sum_{j=1}^{g} x_{(g+1)j}^{(k)} + B_{(g+1)j}^{(k)} + \sum_{k=3,5} x_{(g+1)}^{(k)} B_{(g+1}^{(k)}$		1	Non-competitive import volume
(51)	$m = \sum_{r=1}^{g} (p_{r2}^{m} + x_{r2}) M_{r2} + (p_{(g+1)}^{m} + x_{(g+1)}) M_{(g+1)}$		1	Foreign currency value of imports
(52)	$e = \sum_{r=1}^{g} (p_r^{e} + x_r^{(4)}) E_r$		1	Foreign currency value of exports
(53)	$100\ \Delta B = E.e - M.m$		1	Balance of trade
(54)	$\xi^{(3)} = \sum_{s=1}^{2} \sum_{i=1}^{g} w_{is}^{(3)} p_{is}^{(3)} + w_{(g+1)}^{(3)} p_{(g+1)}^{(3)}$		1	ORANI consumer price index
(55)	$\xi^{(2)} = \sum_{j \varepsilon J} Z_j \pi_j$		1	ORANI capital price index
(56)	$i_R = i - \xi^{(2)}$		1	Real private investment expenditure
(57)	$y_j = i_R h_j^{(2)} + f_j^{(2)}$	$j \not\in J$	g-J*	'Exogenous' investment
(58)	$p_{(g+2)1m} = b_{w(m)} (h_{(g+2)1m} \xi^{(3)} + f_{(g+2)1m}) + (1-b_{w(m)})\ d \log W$	m=1,...,M	M	Wage rate movements determined by indexation or in line with an exogenous macro wage measure

The actual stock of inventories is denoted V_j . The total change in the stock, denoted dV_j , is made up of two components, 'planned' inventory change $dV_j^{(0)}$ and 'unplanned' inventory change $dV_j^{(1)}$. Planned inventory change has the function of gradually replenishing (or running down) the actual stock to the desired level; it thus represents an internal addition to (or subtraction from) the external demand for the industry's product. In the long run, planned inventory change falls to zero (or perhaps to a constant growth rate if sales are growing steadily) as stocks reach the desired relationship to sales. Planned inventory change in ORANI-S is specified as a constant fraction of any gap (in the logarithms) existing at the beginning of the period between the desired and actual levels of the inventory stock; it is therefore predetermined for the current period :

$$v_j^{(0)} = dV_j^{(0)}/V_j(0) = \gamma_{4j}\{\log \hat{V}_j(0) - \log V_j(0)\}, \quad (\gamma_{4j} < 1)$$

$$\approx \gamma_{4j}\{\hat{V}_j(0)/V_j(0) - 1\} \quad , \qquad (4.3)$$

in which $\hat{V}_j(0)$ is the value of inventories as desired in the last period j for the end of that period, and $V_j(0)$ is the actual level of inventories at the end of that period (i.e., at the beginning of the current period).

Unplanned inventory change represents the buffering role proper, and takes up part of the gap between demand and normal output. Adjustment of actual output during the period takes up the remainder of the gap, so that the quantitative characteristics of the buffering process and the output adjustment process are in a sense measures of the same thing. Normal output $\hat{X}_j$ was introduced earlier; it is the level of output which would be produced with the available factor supplies used at normal, sustainable levels of productivity - - in other words, on the long-run production function. Since the ORANI-77 assumption that inputs of materials and 'other cost tickets' remain in proportion to output is maintained, normal output in ORANI-S is proportional to an index $X^{(1)}_{(g+2)j}$ based on the measured input of primary factors. Thus

$$(4.4) \qquad \hat{x}_j = x^{(1)}_{(g+2)j} = \sum_{s=1}^{3} S_{(g+2)sj}\, x_{(g+2)sj} ,$$

where

$$(4.5) \qquad x_{(g+2)1j} = \sum_{m=1}^{M} S_{(g+2)1mj}\, x_{(g+2)1mj} .$$

Unplanned inventory change is assumed to be proportional to the gap between normal output and actual demand, where the latter term is broadly defined so as to include planned accumulation of inventories. That is ,

$$(4.6) \qquad dV_j^{(1)} = \gamma_{5j}\left\{ \hat{X}_j - X_j^{(0)} - dV_j^{(0)} \right\} , \qquad (0 < \gamma_{5j} < 1)$$

$$= \gamma_{5j}\left\{ \hat{X}_j(0)(1 + \hat{x}_j) - X_j^{(0)}(0)(1 + x_j^{(0)}) - dV_j^{(0)} \right\} .$$

Now

$$dV_j = dV_j^{(0)} + dV_j^{(1)}$$

$$= (1 - \gamma_{5j})dV_j^{(0)} + \gamma_{5j}\left\{ \hat{X}_j(0) - X_j^{(0)}(0) \right\}$$

$$+ \gamma_{5j}\left\{ \hat{X}_j(0)\, \hat{x}_j - X_j^{(0)}(0)\, x_j^{(0)} \right\} .$$

Eqn No	Equation	Subscript Range	No	Description
(41) cont.	$+ \sum_{j=1}^{g}\sum_{k=1}^{2} x_r(g+1jk)\, B_r(g+1jk) + \sum_{k=3,5} x_r(g+1k) B_r(g+1k)$			
	$+ \sum_{i=1}^{g}\sum_{s=1}^{2}\sum_{k=3,5} x_r(isk) B_r(isk) + \sum_{i=1}^{g} x_r(i4) B_r(i4)$			
(42)	$\hat{x}_j = \sum_{s=1}^{3} S_{(g+2)sj} x_{(g+2)sj}$	j=1,...,g	g	Normal output is production function output with measured primary factor inputs
(43)	$v_j = b_{5j} + b_{6j}\hat{x}_j - b_{7j}x_j^{(0)}$	j=1,...,g	g	Inventory changes, planned and unplanned, depend on normal output and sales
(44)	$x_j = b_{8j} \quad b_{9j}x_j^{(0)} + b_{10j}v_j$	j=1,...,g	g	Actual industry output equals sales plus inventory changes
(45)	$x_{(g+2)1m} = \sum_{j=1}^{g} L_{mj} x_{(g+2)1mj}$	m=1,...,M	M	Demand and supply for labour by skill, measured in man-hours
(46)	$\ell_m = \sum_{j=1}^{g} \bar{L}_{mj}\, \ell_{mj}$	m=1,...,M	M	Aggregate employment of labour by skill group, measured in numbers of persons
(47)	$k_j(0) = x_{(g+2)2j}$	j=1,...g	g	Demand equals supply for capital in each industry
(48)	$n = \sum_{j=1}^{g} N_j x_{(g+2)3j}$		1	Demand and supply for agricultural land

Eqn No	Equation	Subscript Range	No	Description
(34)	$p^{(k)}_{isj} = m\ (isjk) \begin{Bmatrix} p_1 \\ p_2 \end{Bmatrix}$	i,j=1,...,g k,s=1,2	$4g^2$	Purchasers' prices of inputs into production and capital creation
(35)	$p^{(k)}_{is} = m\ (isk) \begin{Bmatrix} p_1 \\ p_2 \end{Bmatrix}$	i,1,...,g k=3,5; 4=1,2	4g	Purchasers' prices paid by households and 'other' demands
(36)	$p^{(k)}_{(g+1)j} = m(g+1jk) \begin{Bmatrix} p_1 \\ p_2 \end{Bmatrix}$	j=1,...,g k=1,2	2g	Purchasers' prices for non-competitive imports
(37)	$p^{(k)}_{(g+1)} = m\ (g+1k) \begin{Bmatrix} p_1 \\ p_2 \end{Bmatrix}$	k=3,5	2	
(38)	$-\beta_j\ k^*_j + (\hat{p}_{(g+2)2j} - w_j)/b_{1j} = \lambda - r$	$j\varepsilon J^{(c)}$	J*	Equality of MEC's
(39)	$k^*_j = b_{14j}(y_j - k_j(0))$	j=1,...g	g	Induced change in the rate of net investment
(40)	$\sum\limits_{j\varepsilon J} (\pi_j + y_j)Z_j = (\sum\limits_{j\varepsilon J} Z_j)\ i$		1	Investment budget
(41)	$x^{(0)}_r = \sum\limits_{j=1}^{g} x^{(1)}_{r1j}\ b^{(1)}_{r1j} + \sum\limits_{j=1}^{g} x^{(2)}_{r1j}\ B^{(2)}_{r1j} + x^{(3)}_{r1}\ B^{(3)}_{r1}$ $+ x^{(4)}_r\ B^{(4)}_{r1} + x^{(5)}_{r1}\ B^{(5)}_{r1}$ $+ \sum\limits_{i=1}^{g} \sum\limits_{s=1}^{2} \sum\limits_{j=1}^{g} \sum\limits_{k=1}^{2} x_r(isjk)\ B_r(isjk)$ (41) continued	r=1,...,g	g	Sales equals demand for domestically produced goods

$$v_j = (1 - \gamma_{5j})v^{(0)}_j + \gamma_{5j}\left\{\hat{X}_j(0) - X^{(0)}_j(0)\right\} / V_j(0)$$

$$+ \gamma_{5j}\left\{\hat{X}_j(0)/V_j(0)\right\} \hat{x}_j - \gamma_{5j}\left\{X^{(0)}_j/V_j(0)\right\} x^{(0)}_j$$

(4.7) $$= b_{5j} + b_{6j}\ \hat{x}_j - b_{7j}\ x^{(0)}_j\ .$$

Now actual output is determined by

$$X_j = X^{(0)}_j + dV_j\ .$$

$$x_j = \left\{X^{(0)}_j(0)/X_j(0)\right\} - 1 + \left\{X^{(0)}_j(0)/X_j(0)\right\} x^{(0)}_j$$

$$+ \left\{V_j(0)/X_j(0)\right\} v_j$$

(4.8) $$= b_{8j} + b_{9j}\ x^{(0)}_j + b_{10j}\ v_j$$

(4.9) $$= (b_{8j} + b_{10j}b_{5j}) + (b_{9j} - b_{10j}b_{7j})\ x^{(0)}_j + b_{10j}b_{6j}\ \hat{x}_j\ .$$

Note that if the industry had been in equilibrium in the initial period, the b_{ij} appearing in equation (4.9) above would become simple functions of the relevant γ_{ij} .

5. EMPLOYMENT

In ORANI-S, the quantities $X_{(g+2)1mj}$ are interpreted as measured labour inputs by skill and industry, in man-hours - - either numbers of persons by standard hours (for non-hourly rated labour) or numbers of persons by actual, paid for hours (for hourly rated labour). Equation (4.5) above then defines (in percentage change terms) a composite measured labour input $X_{(g+2)1j}$ for industry j .

The case of hourly rated labour is the more general, subsuming the case of non-hourly rated labour. The short-period relationship between man-hours and numbers employed is dealt with first. Let F_{mj} be defined by

(5.1) $$X_{(g+2)1mj} = L_{mj} H_{mj} = L_{mj} N_{mj} F_{mj} ,$$

where

L_{mj} = numbers of persons ;

H_{mj} = average hours ;

N_{mj} = normal hours .

Let F_{mj} be determined by

(5.2) $$F_{mj} = (X_j/\hat{X}_j)^{\Theta_{mj}} ;$$

that is, actual hours respond log-linearly to demand pressure, measured as the gap between actual and normal output.[1] Thus

1. In practice, Θ_{mj} is made the product of skill-specific and industry-specific components.

Eqn No	Equation	Subscript Range	No	Description
(26)	$x_r(isk) = x_{is}^{(k)}$	i,r=1,...,g k=3,5; ℓ=1,2	$4g^2$	Demands for margins to facilitate the flow of goods to households, exports and 'other' demands
(27)	$x_r(i4) = x_i^{(4)}$	i,r=1,...,g	g^2	
(28)	$p_{j1} = \sum_{i=1}^{g}\sum_{s=1}^{2} a^{(1)}_{isj} p^{(1)}_{isj} + a^{(1)}_{(g+1)j} p^{(1)}_{(g+1)j}$ $+ \sum_{m=1}^{n} a_{(g+2)1mj} p_{(g+2)im} + a^{(1)}_{(g+2)2j} w_j$ $+ a^{(1)}_{(g+2)3j} p_{(g+2)3} + a^{(1)}_{(g+3)j} p_{(g+3)j}$ $+ \lambda_{1j}(x_j - \hat{x}_j) + b_{4j}$	j=1,...,g	g	Basic value output price responds to normal unit costs of production and the pressure of product demand
(29)	$\pi_j = \sum_{i=1}^{g}\sum_{s=1}^{2} a^{(2)}_{isj} p^{(2)}_{isj} + a^{(2)}_{(g+1)j} p^{(2)}_{(g+1)j}$	j=1,...,g	g	Price of capital units equals cost of their production
(30)	$w_j = \pi_j + b_{0j} dk + b_{1j} r + b_{2j} t + b_{3j} dZ$	j=1,...,g	g	User cost of a unit of capital in industry j
(31)	$p_{j2} = p^m_{j2} + \phi + t_j$	j=1,...,g	g	) Basic prices of imports
(32)	$p_{g+1} = p^m_{(g+1)} + \phi + t_{(g+1)}$		1	)
(33)	$p^e_j + \phi + S_j = \sum_{r=1}^{g} m_r(j4)\, p_{r1}$	j=1,...,g,	g	'At port' export prices

Eqn No	Equation	Subscript Range	No	Description
(16)	$x_{is}^{(3)} = x_i^{(3)} - \sigma_i^{(3)} (p_{is}^{(3)} - \sum_{s=1}^{2} S_{is}^{(3)} p_{is}^{(3)})$	i=1,...,g s=1,2	2g	Household demands for goods by type and source
(17)	$p_i^{(3)} = \sum_{s=1}^{2} S_{is}^{(3)} p_{is}^{(3)}$	i=1,...,g	g	General price of each good to households
(18)	$x_i^{(3)} = \varepsilon_i c + \sum_{j=1}^{g+1} \eta_{ij} p_j^{(3)} + (1-\varepsilon_i) q$	i=1,...,g+1	g+1	Household demands for 'effective' consumption levels
(19)	$p_i^{e} = \gamma_i x_i^{(4)} + f_i^{e}$	i=1,...,g	g	Export demand functions
(20)	$x_{is}^{(5)} = c_R h_{is}^{(5)} + f_{is}^{(5)}$	i=1,...,g s=1,2	2g	'Other' demands for goods by type and source
(21)	$x_{(g+1)}^{(5)} = c_R h_{(g+1)}^{(5)} + f_{(g+1)}^{(5)}$		1	'Other' demands for non-competitive imports
(22)	$c_R = c - \xi^{(3)}$		1	Real household expenditure
(23)	$x_r\ (isjk) = x_{isj}^{(k)}$	i,j,r=1,...,g k,s=1,2	$4g^3$	Demands for margins to facilitate commodity flows to production and capital creation
(24)	$x_r\ (g+1jk) = x_{(g+1)j}^{(k)}$	r,j=1,...,g k=1,2	$2g^2$	Demands for margins to facilitate the flow of non-competitive imports to producers, capital creators households and other.
(25)	$x_r\ (g+1k) = x_{(g+1)}^{(k)}$	r=1,...,g k=3,5	2g	

$$x_{(g+2)1mj} = \ell_{mj} + n_{mj} + f_{mj}$$

$$= \ell_{mj} + n_{mj} + \Theta_{mj}(x_j - \hat{x}_j) ,$$

or

(5.3) $$\ell_{mj} = x_{(g+2)1mj} - n_{mj} - \Theta_{mj}(x_j - \hat{x}_j) .$$

Note that N_{mj} may reasonably be treated as a constant, so that n_{mj} could be dropped from (5.3).

Now let $P_{(g+2)(1m)}$ represent the going price for an ordinary-time man-hour for skill group m . Because of overtime premiums, the average price per man-hour paid to skill group m in industry j may deviate from $P_{(g+2)(1m)}$; denote it $\bar{P}_{(g+2)1mj}$. Then the wage bill for skill m in industry j is made up as follows :

(5.4) $$\bar{P}_{(g+2)1mj} X_{(g+2)1mj} = P_{(g+2)(1m)} L_{mj} N_{mj}\left\{1 + \upsilon_m(F_{mj} - 1)\right\} ,$$

where υ_m is the ratio of the overtime hourly wage rate to the ordinary-time hourly wage rate for skill group m - - assumed to be industry-independent and stable over time. Thus, using (5.1) ,

$$\bar{P}_{(g+2)1mj} F_{mj} = P_{(g+2)(1m)}\left\{1 - \upsilon_m + \upsilon_m F_{mj}\right\} ,$$

or

$$\bar{P}_{(g+2)1mj} = P_{(g+2)(1m)} + f_{mj}\left\{\frac{\upsilon_m F_{mj}(0)}{1 - \upsilon_m + \upsilon_m F_{mj}(0)} - 1\right\}$$

(5.5) $$= P_{(g+2)(1m)} + f_{mj} (\upsilon_{mj} - 1) ;$$

in which υ_{mj} , the ratio of the overtime hourly wage rate to the average hourly wage rate in the base period, is equal to

$$\frac{\upsilon_m F_{mj}(0)}{1 + (F_{mj}(0) - 1)\upsilon_m} .$$

Note that υ_{mj} reduces to υ_m if $F_{mj}(0) = 1$. Using (5.2), (5.5) becomes

$$\bar{P}_{(g+2)1mj} = P_{(g+2)(1m)} + \zeta_{mj}(x_j - \hat{x}_j) , \tag{5.6}$$

where

$$\zeta_{mj} = \Theta_{mj}(\upsilon_{mj} - 1) .$$

The next step is to specify the representative industry's demand for measured labour inputs by skill. Desired labour input in ORANI-S, denoted $\hat{X}_{(g+2)1mj}$, is determined along the lines used in ORANI-77 for actual labour demand. In ORANI-S, actual measured labour inputs, $X_{(g+2)1mj}$, adjust towards their desired levels via a partial adjustment mechanism in the logarithms.[1] Thus

$$x_{(g+2)1mj} = \lambda_{2(mj)}(\log \hat{X}_{(g+2)1mj} - \log X_{(g+2)1mj}(0))$$

$$= \lambda_{2(mj)}\hat{x}_{(g+2)1mj} + \lambda_{2(mj)}(\log \hat{X}_{(g+2)1mj}(0) - \log X_{(g+2)1mj}(0))$$

$$= \lambda_{2(mj)}\hat{x}_{(g+2)1mj} + b_{11(mj)} . \tag{5.7}$$

1. This can be shown to represent profit-maximizing behaviour if adjustment costs are quadratic : see M. R. Wickens, "Towards a Theory of the Labour Market," Economica, 41 (1974), pp. 278-94.

Eqn No	Equation	Subscript Range	No	Description
(8)	$\ell_{mj} = x_{(g+2)1mj} - \theta_{mj}(x_j - \hat{x}_j)$	j=1,...,g m=1,...,M	Mg	Demands for labour by industry and skill group, in numbers employed
(9)	$\bar{p}_{(g+2)1mj} = p_{(g+2)1m} + \zeta_{mj}(x_j - \hat{x}_j)$	j=1,...,g m=1,...,M	Mg	Average price per man-hour paid to skill group m in industry j
(10)	$x_{(g+2)3j} = \lambda_{3j}\hat{x}_{(g+2)3j} + b_{12j}$	j=1,...,g	g	Measured industry demands for agricultural land as a primary factor
(11)	$\hat{x}_{(g+2)3j} = x_j - \sigma_{(g+2)j}(p_{(g+2)3}(1-S_{(g+2)3j}) - S_{(g+2)1j}p_{(g+2)1j} - S_{(g+2)2j}w_j)$	j=1,...,g	g	Desired industry demands for agricultural land
(12)	$a^{(1)}_{(g+2)2j}(p_{(g+2)2j} - w_j) = (a^{(1)}_{(g+2)j} + \lambda_{1j} - \zeta_j)\cdot(x_j - \hat{x}_j) + b_{4j}$	j=1,...,g	g	Ex post return to capital in each industry
(13)	$x_{(g+2)2j} = x_j - \sigma_{(g+2)j}(\hat{p}_{(g+2)2j}(1-S_{(g+2)2j}) - S_{(g+2)1j}p_{(g+2)1j} - S_{(g+2)3j}p_{(g+2)3})$	j=1,...,g	g	Shadow price of capital in each industry
(14)	$x^{(2)}_{isj} = y_j - \sigma^{(2)}_{ij}(p^{(2)}_{isj} - \sum_{s-1}^{2} S^{(2)}_{isj}p^{(2)}_{isj})$	i,j=1,...,g s=1,2	$2g^2$	Demands for inputs to capital creation
(15)	$x^{(2)}_{(g+1)j} = y_j$	j=1,...,g	g	Demands for non-competitive imports in capital creation

ATTACHMENT 1

ORANI - S : COMPLETE SYSTEM OF STRUCTURAL EQUATIONS[(a)]

Eqn No [(b)]	Equation	Subscript Range	No	Description
(1)	$x_{isj}^{(1)} = x_j - \sigma_{ij}^{(1)} (p_{isj}^{(1)} - \sum_{s=1}^{2} p_{isj}^{(1)} S_{isj}^{(1)})$	i,j=1,...,g s=1,2	$2g^2$	Demands for produced intermediate inputs, imported and domestic
(2)	$x_{(g+1)j}^{(1)} = x_j$	j=1,...,g	g	Demands for intermediate use of non-competitive imports
(3)	$x_{(g+3)j}^{(1)} = x_j$	j=1,...,g	g	Demands for 'other cost tickets'
(4)	$x_{(g+2)1mj} = \lambda_{2(mj)} \hat{x}_{(g+2)1mj} + b_{11(mj)}$	j=1,...,g m=1,...,M	Mg	Industry demands for measured labour inputs by skill, in man-hours
(5)	$\hat{x}_{(g+2)1mj} = x_j - \sigma_{(g+2)j} (p_{(g+2)1j}(1-S_{(g+2)1j}) - S_{(g+2)2j} w_j - S_{(g+2)3j} p_{(g+2)3}) - \sigma_{(g+2)1j} (p_{(g+2)1m} - p_{(g+2)1j})$	j=1,...,g m=1,...,M	Mg	Desired labour input by industry and skill group
(6)	$x_{(g+2)1j} = \sum_{m=1}^{M} S_{(g+2)1mj} x_{(g+2)1mj}$	j=1,...,g	g	Composite measured labour input for each industry, in man-hours
(7)	$p_{(g+2)1j} = \sum_{m=1}^{M} S_{(g+2)1mj} p_{(g+2)1m}$	j=1,...,g	g	General normal price of labour, per man-hour, to each industry

Note that since

$$x_{(g+2)1mj}(0) = \lambda_{2(mj)} \{\log \hat{X}_{(g+2)1mj}(0) - \log X_{(g+2)1mj}(-1)\}$$

$$= b_{11(mj)} + \lambda_{2(mj)} \{\log X_{(g+2)1mj}(0) - \log X_{(g+2)1mj}(-1)\}$$

$$= b_{11(mj)} + \lambda_{2(mj)} x_{(g+2)1mj}(0) ,$$

it follows that

$$b_{11(mj)} = (1 - \lambda_{2(mj)}) x_{(g+2)1mj}(0) .$$

Note also that in the implementation of ORANI-S, $\lambda_{2(mj)}$ is made the product of an m-specific quantity $\lambda_{2(m)}$ and a j-specific quantity $\lambda_{2(j)}$. This simplifying assumption is made with a view to preserving degrees of freedom in estimation. It implies that the ratio of the speeds of adjustment of each pair of skill groups is the same in every industry.

The change in desired labour input in ORANI-S is derived along the same lines as labour demand in ORANI-77, except for the treatment of capital costs.[1] The expression is as follows :

1. As in the case of pricing, the implementation of ORANI-S provides an industry-by-industry set of logical switches w_{3j} to allow the user to select an ex post returns to capital concept in the factor demand equations. This means that the ORANI-77 factor demand model can be selected instead of the ORANI-S version. Also, as a relic of an earlier approach, a switch w_{2j} (now switched OFF) allows the selection of a simple employment model with the change in employment determined solely by pressure of product demand :

$$x_{(g+2)1mj} = b_{11(mj)} + \lambda_{2(mj)} (x_j - \hat{x}_j) .$$

$$\hat{x}_{(g+2)1mj} = x_j - \sigma_{(g+2)j}(p_{(g+2)1j} - p_{(g+2)(j)}) - \sigma_{(g+2)1j}(p_{(g+2)(1m)} - p_{(g+2)1j}) \quad (5.8)$$

where, as in ORANI-77 ,

$$p_{(g+2)1j} = \sum_{m=1}^{M} S_{(g+2)1mj}\, p_{(g+2)(1m)} \quad (5.9)$$

and where, similar to ORANI-77 ,

$$p_{(g+2)(j)} = S_{(g+2)1j}\, p_{(g+2)1j} + S_{(g+2)2j}\, w_j + S_{(g+2)3j}\, p_{(g+2)3} . \quad (5.10)$$

Note that $\hat{x}_{(g+2)1mj}$ (and a corresponding $\hat{x}_{(g+2)1j}$ derived along the lines of equation (4.5) above) are only implicit in ORANI-S, as (5.8) is in practice substituted into (5.7).

For completeness, ORANI-S also imposes a partial adjustment mechanism on the demand for agricultural land.[1] This is treated in the same way as labour; thus

$$x_{(g+2)3j} = \lambda_{3j}\, \hat{x}_{(g+2)3j} + b_{12j} , \quad (5.11)$$

and

$$\hat{x}_{(g+2)3j} = x_j - \sigma_{(g+2)j}\, (p_{(g+2)3} - p_{(g+2)(j)}) . \quad (5.12)$$

1. Problems of measurement may be greater for λ_{3j} than for other parameters introduced in ORANI-S; as a default option, however, one can revert to the ORANI-77 specification. Data and estimation problems for ORANI-S are discussed further below.

The data need to be at constant prices; thus appropriate price indexes are used to deflate current price data. The simplifying assumption made in obtaining initial estimates of these parameters is the following : in equation (4.2), the desired inventory stock is assumed to be strictly proportional to current sales. Substituting into (4.3) and thence, with (4.6), into an equation for the total change in inventories yields a straightforward estimating equation for γ_{5j} and γ_{4j} (and γ_{1j} as well). With sufficient data, γ_{2j} and γ_{3j} could also be estimated.

The last group of 'key' parameters is the set of λ_{ij} , the elasticities of changes in selling prices to excess demand levels. To estimate these it is necessary to have time-series data on actual and 'normal' outputs (constructed as mentioned above) and 'normal' unit costs. The major task is the preparation of the cost series. In this it is assumed that normal unit total cost differs from normal unit variable cost by a simple mark-up -- i.e., one which is either constant or representable by a simple time trend chosen so as to force the constructed unit total cost series to have approximately the same trend as the corresponding selling price series. Equation (3.7) above is then used as the estimating equation to yield values for the λ_{1j} .

are slow and can be represented by time trends. For sample periods ending early in the 1970's, at least, this assumption is well supported by Australian data. During recent years, however, there have been appreciable changes in certain relative factor prices, although much of the relative wage structure has remained remarkably stable. The main changes in relative wage rates have been in respect of females (with the move to equal pay) and juniors. However, with the currently available data (generally not extending beyond 1975-76) it appears difficult to find any significant effects of these changes in relative wage rates on relative employment levels.[1] There have also been difficulties in measuring the effects on employment of the shifts observed in the relative factor price of composite labour vis-à-vis capital. Indeed there has even been considerable dispute as to how to measure the appropriate relative price.[2] In this light it is not proposed to take explicit account of the effects of relative factor price changes on desired employment levels in making initial estimates of the $\lambda_{2(mj)}$; however, it may be worthwhile to do so in the future.

The inventory parameters γ_{5j} and γ_{4j} are estimated in fairly straightforward fashion for those industries (those covered by the Economic Censuses, plus certain others) for which time-series statistics are available or can be constructed on output and sales or changes in stocks; at least one observation on the level of stocks is also needed.

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1. See R. G. Gregory and R. C. Duncan, "The Relevance of Segmented Labour Market Theories : the Australian Experience of the Achievement of Equal Pay for Women," paper presented to the Seventh Conference of Economists, Macquarie University, 1978.
2. For a recent survey in these areas, see W. M. Corden, "Wages and Unemployment in Australia," paper presented to the Seventh Conference of Economists, Macquarie University, 1978. See also M. R. Fisher, F. H. Gruen, P. J. Sheehan and D. W. Stammer, Real Wages and Unemployment, C.A.E.R. Papers No. 4, Centre for Applied Economic Research, University of N.S.W., 1978.

6. RETURNS TO CAPITAL; INVESTMENT

An ex post return to capital is implied by the models of pricing, output and factor usage set out above. If the typical industry operated a strict normal cost pricing rule in the short run, then the ex post return would be equal to the level of output multiplied by the difference between normal unit costs (for all inputs) and actual unit costs (other than for capital itself), and divided by the quantity of capital. Thus, apart from explicit overtime payments, the transient rents - - positive or negative - - generated by short-term deviations of factor productivity from normal levels accrue to the fixed factor, capital. Where there is an additional component in the industry selling price reflecting current excess demand, this augments the ex post return. Thus

$$P_{(g+2)2j}\, K_j(0) = X_j \Bigg\{ P_{j1} - \sum_{i=1}^{g} \sum_{s=1}^{2} a^{(1)}_{isj}\, p^{(1)}_{isj} - a^{(1)}_{(g+1)j}\, p^{(1)}_{(g+1)j} - \sum_{m=1}^{M} (X_{(g+2)1mj}/X_j)\, \bar{P}_{(g+2)1mj} - (X_{(g+2)3j}/X_j)\, P_{(g+2)3} - a^{(1)}_{(g+3)j}\, p^{(1)}_{(g+3)j} \Bigg\}. \tag{6.1}$$

Assuming normal cost shares for primary factors in the base period[1] and taking log differentials, this, with (3.8) and (5.6), leads to

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1. This is correct to first order in any case; there is, however, a general issue of updating cost shares in ORANI (in a dynamic context), of which the assumption here is just one aspect.

$$a^{(1)}_{(g+2)2j}(p_{(g+2)2j} - w_j) = \lambda_{1j}(x_j - \hat{x}_j) + b_{4j}$$

(6.2)
$$+ a^{(1)}_{(g+2)2j}(x_j - k_j(0))$$
$$+ \sum_{m=1}^{M} a^{(1)}_{(g+2)1mj}[x_j - x_{(g+2)1mj} - \zeta_{mj}(x_j - \hat{x}_j)]$$
$$+ a^{(1)}_{(g+2)3j}(x_j - x_{(g+2)3j}) \quad .$$

Now let

$$\zeta_j = \sum_{m=1}^{M} a^{(1)}_{(g+2)1mj}\, \zeta_{mj} \quad ,$$

so that, using (4.4) ,

(6.3) $$a^{(1)}_{(g+2)2j}(p_{(g+2)2j} - w_j) = (a^{(1)}_{(g+2)j} + \lambda_{1j} - \zeta_j)(x_j - \hat{x}_j) + b_{4j} \quad ,$$

where

$$a^{(1)}_{(g+2)j} = \sum_{m=1}^{M} a^{(1)}_{(g+2)1mj} + a^{(1)}_{(g+2)2j} + a^{(1)}_{(g+2)3j} \quad .$$

Equation (6.3) then determines $p_{(g+2)2j}$. In the long run, as the gap between actual and normal output closes (and b_{4j} disappears), equation (6.3) shows that the gap between $p_{(g+2)2j}$ and w_j also closes.

The ex post return to capital concept specified above is clearly the appropriate one for explaining short-period changes in factor incomes; however, it is a less straightforward matter to specify the rate of return concept on which industry investment decisions are based. Investment decisions are the outcome of a complex process of expectations formation

Provided that some simplifying assumptions are made, the $\lambda_{2(mj)}$ parameters may be estimated from available time series/cross section data of industry outputs and employment levels, by skill groups. The Θ_{mj} parameters are estimated from the same data, augmented by constructed series for 'normal' outputs $\hat{X}_j$ (these are the predicted values from regression, in the logarithms, of actual outputs on time and composite employment). Relevant data are obtainable from the Economic Censuses and the Labour Force Surveys. The Census data are for a more disaggregated set of industries than the Survey data, but do not provide regular time-series information on hours or the skill composition of employment; the Survey data do cover these. Since there is likely to be most interest in the behaviour of total numbers employed in each industry, the deficiencies of the Census data with respect to hours and skill patterns are not critical.

The estimation approach is based on that of Smyth and Ireland,[1] extended to skill groups by assuming that the speed of adjustment for composite employment in each industry is an exact employment-weighted average of skill-specific adjustment speeds (which is approximately true in any case). A similar relationship is taken to hold for the Θ_{mj} . The major simplifying assumption made in the approach is that relative factor prices[2] do not change significantly over the period of estimation - - or, alternatively, that any movements

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1. See D. J. Smyth and N. J. Ireland, "Short-term Employment Functions in Australian Manufacturing," Review of Economics and Statistics, 49 (1967), pp. 537-44.
2. The relevant relative prices are not necessarily the observed 'spot' prices, but possibly some slowly varying function of these, representing average relative prices expected to obtain over an appropriate planning period.

It is this last group of parameters which capture the major dynamic adjustments in ORANI-S, particularly in one-period solutions. The discussion below focuses on these.

The main dynamic behavioural parameters of ORANI-S are as follows :

λ_{1j} : elasticity of selling price with respect to excess demand (i.e., with respect to the ratio of actual to normal output); see equation (3.7) ;

γ_{4j} : 'speed of replenishment' of the inventory stock; see equation (4.3) ;

γ_{5j} : buffering parameter; see equation (4.6) ;

Θ_{mj} : elasticity of overtime hours to excess demand; see equation (5.2) ;

$\lambda_{2(mj)}$: speed of adjustment of m-type labour in the j^{th} industry; see equation (5.7) ;

λ_{3j} : speed of adjustment of land use; see equation (5.11).

γ_{4j} is not important for one-period solutions, but is estimated along with γ_{5j} . It is not expected that 'genuine' estimates for λ_{3j} can be readily obtained. Θ_{mj} may be important for some types of labour in some industries, but probably not particularly important generally, given the one-year time horizon. The key ORANI-S parameters are thus $\lambda_{2(mj)}$, γ_{5j} and λ_{1j} , roughly in that order of importance.

encompassing future movements in demand and factor prices; any model such as ORANI - - particularly a short-run model - - can do no more than provide a greatly simplified representation of that expectations process.

In common with ORANI-77, ORANI-S assumes that in making investment decisions, the firms in an industry (and potential new investors in the industry) look at the prospective returns to the existing stock of industry capital, given that the current level of demand and the going factor prices persist, but they are cautious about expanding the stock too fast : they behave as if prospective returns are a decreasing (constant elasticity) function of increases in the capital stock; see Volume 2, pp. 75-76.

The question then is what to specify as the appropriate measure of the prospective rate of return entering the investment decision. Partly this is an empirical matter, but the choice is restricted to measures generated in the model and is constrained by the need to preserve the long-run properties of the system.[1] Effectively, the choices are two : $p_{(g+2)2j}$ as specified above, or an alternative concept, denoted $\hat{p}_{(g+2)2j}$, determined as in ORANI-77. While the former does incorporate certain rents attributable to the short-period fixity of the capital stock, it does not fully reflect short-period rents potentially exploitable through a full adjustment of product selling prices in response to current (ex ante) demand. Therefore, the latter measure is chosen as the basis of investment decisions in ORANI-S, although in the version implemented a logical switch (w_{4j} , by default switched OFF) does permit experiments with the former measure influencing investment.

1. Note that, as in ORANI-77, capital is assumed to take one period ('about one year') to instal, although capital goods industries face the relevant demand in the current period.

$\hat{p}_{(g+2)2j}$ is thus determined as follows :

$$k_j(0) = x_j - \sigma_{(g+2)j}\left\{(1 - S_{(g+2)2j})\,\hat{p}_{(g+2)2j} - \sum_{s=1,3} S_{(g+2)sj}\, p_{(g+2)sj}\right\} . \qquad (6.4)$$

Concerning the model of investment itself, no fundamental changes are proposed to the treatment in ORANI-77. There are two minor changes, however. First, given the ORANI-S treatment of the user cost of capital,[1] rates of return on a gross, before business tax basis are converted to a net after business tax basis in a slightly more complicated way than in ORANI-77. Referring to equation (10.8) of Volume 2, the term representing the rates of change of the industry-specific rates of return to capital needs modification; in particular $Q_j(p_{(g+2)2j} - \pi_j)$ is replaced by

$$(\hat{p}_{(g+2)2j} - \pi_j - b_{0j}\, d\kappa - b_{2j}\, t - b_{3j}\, dZ)/b_{1j} \;;$$

that is, by

$$r + (\hat{p}_{(g+2)2j} - w_j)/b_{1j} \;.$$

Second, ORANI-S deals directly in changes in the rate of net investment rather than in initial and final capital stocks, as does ORANI-77 (the approaches are equivalent; the ORANI-S approach was seen as more convenient in the context of a linked MACRO/ORANI system, as MACRO deals in net investment).

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1. The relevant equations are (3.4) and (3.5) above.

Perhaps the major task in implementing ORANI-S is the estimation of its parameters. The treatment of this topic in deptth is best left for a separate paper. However, a brief discussion is provided below, while Attachment 2 describes and briefly indicates sources, estimation methods, etc., for all of the parameters of ORANI-S which are additional to those of ORANI-77. Generally, Attachment 2 does not show actual values. These are to be tabulated (and their derivation described more fully) in the planned separate paper. Full details of the ORANI-77 structural and behavioural parameters may be found in Volume 2, and are not repeated; the value of a parameter is common to the two versions of ORANI wherever the same symbol is used, unless an explicit exception is made.[1]

The parameters covered in Attachment 2 fall into three groups. There are those which are essentially structural (e.g., industry depreciation rates); these are derived straightforwardly from available statistics - - often after interpolating, aggregating, etc., to achieve the required set of industries. Next, there are a group of the 'b_{ij}' parameters which represent transient disequilibria at particular points of time;[2] while these will play an important dynamic role in linked sequences of solutions, they can ordinarily be set at default values (usually zero or unity - - see Attachment 2) for one-period solutions. Finally there are dynamic behavioural parameters which have to be estimated by econometric techniques from data with a time dimension.

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1. One instance is the case of the industry elasticities of substitution among primary factors. In ORANI-S, these take their long-run values (see Volume 2, pp. 159-63), so that only the speed-of-adjustment parameters in the factor demand equations reflect the 'one-year' time horizon.
2. Strictly speaking, these are not 'parameters' at all, but quantities which are time-varying but are predetermined for any particular period.

and the equation reverts to ORANI-77 equation (13.5). A slightly more elaborate scheme involving the r.h.s. of the MACRO wage rate equation could permit a reverse link (from ORANI to MACRO) - - if that were desired.

8. IMPLEMENTATION OF ORANI-S

The structural equations of ORANI-S are set out in full in Attachment 1 - - including those equations of ORANI-77 which are included unmodified in ORANI-S. The system is condensed before solution in the same way as ORANI-77, by substituting out variables which are not expected to be of interest.[1] The final condensed system is a set of equations such that the number of variables exceeds the number of equations; solutions can then be computed by declaring the required number of variables to be exogenous. Alternative allocations of the system's variables to the endogenous and exogenous groups are of course possible, facilitating the solution of a variety of problems.

It is planned that details of the mechanisms by which the condensed form of ORANI-S is linked to the IMPACT system's MACRO model will be set out in a separate paper. In brief, what is done is that the annualized MACRO equations in the log differentials of MACRO variables are appended to the ORANI-S condensed form; identities are then added to impose equality between corresponding MACRO and ORANI-S aggregates.[2] The combined system can then be solved in the same way as stand-alone versions of ORANI.

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1. See John Sutton, "The Solution Method for the ORANI Module," IMPACT Preliminary Working Paper No. OP-03, Industries Assistance Commission, Melbourne, June 1976.
2. Generally speaking, the addition of such an identity means that a variable which had been exogenous to one of the models becomes endogenous to the combined system.

As in ORANI-77, it is necessary to account for the continuing existence of positive gross investment; this is assumed to be the case by industry - - so that the possibility of scrappage or sale of industry capital items is ignored - - as well as in the aggregate. The approach is to take as the base the rate of gross investment in the initial period; induced changes in the rate of net investment are then to be interpreted relative to the rate implied by the base rate of gross investment. The growth rate k_j of the capital stock in industry j is defined by

$$k_j = \{K_j(1) - K_j(0)\} / K_j(0)$$

$$= \{Y_j - \delta_j K_j(0)\} / K_j(0)$$

$$= Y_j / K_j(0) - \delta_j \quad . \qquad (6.5)$$

Allowing for the possibility of treating $K_j(0)$ as a variable (with $k_j(0)$ denoting the corresponding log differential), this leads to

$$k_j = \{Y_j(0) / K_j(-1) - \delta_j\} + \{Y_j(0) / K_j(-1)\}\{y_j - k_j(0)\}$$

$$= k_j(0) + b_{14j}\{y_j - k_j(0)\} \quad , \qquad (6.6)$$

so that the rate of growth of the capital stock k_j can be partitioned into a part (equal to $k_j(0)$) which would be consistent with gross investment in the current period remaining equal to base period gross investment $Y_j(0)$, and a part k_j^* which is induced by the change $(Y_j - Y_j(0))$ in gross investment relative to the base. Then

$$k_j^* = k_j - k_j(0) = b_{14j}(y_j - k_j(0)) \quad . \qquad (6.7)$$

Equations (10.8) through (10.10) of ORANI-77 are thus represented in ORANI-S as follows :

$$- \beta_j k_j^* + (\hat{p}_{(g+2)2j} - w_j) / b_{1j} = \lambda - r \; ; \qquad (6.8)$$

$$k_j^* = b_{14j}\{y_j - k_j(0)\} \quad \text{[restatement of (6.7)]} \; ; \qquad (6.9)$$

$$\sum_{j \in J} (\pi_j + y_j) Z_j = (\sum_{j \in J} Z_j) \, i \; . \qquad (6.10)$$

Note that (6.8) applies to 'endogenous investment industries' only, as in ORANI-77.[1]

One issue which the foregoing treatment of investment raises relates to the long-run convergence of $\hat{p}_{(g+2)2j}$ and w_j (and hence $\hat{p}_{(g+2)2j}$ and $p_{(g+2)2j}$), given that there is nothing in ORANI-S itself to ensure that λ and r converge.[2] The ORANI economy-wide MEC λ reflects both real prospective returns across industries and the short-term funds constraint on aggregate investment, which is given exogenously to ORANI independently of the required real rate of return r (reflecting, in part, conditions in financial markets). However, the MACRO model should encompass mechanisms which, by generating investment expenditure so long as the MEC is above r, drive the MEC to r in the long run. The

1. In the normal use of ORANI, there is an approximate correspondence between investment in 'endogenous investment industries' and private investment, except that in dwellings which is in the exogenous group, along with most public investment. This may require attention in the context of the linked MACRO-ORANI system.

2. It would be a straightforward matter to make r endogenous to ORANI-S and set it equal to λ in the short-period, but it does not appear to be the best course to cut off direct macro influences on r in this way.

The aggregates defined above allow the responses of ORANI-S to be monitored at the aggregate level and represent potential channels for linkage, particularly with MACRO. Thus, if - - as seems likely - - it is established that ORANI has a comparative advantage over MACRO in explaining price aggregates, movements in the MACRO measure(s) can readily be forced to equal those in the corresponding ORANI measure(s), simply by replacing the relevant MACRO structural equation(s) by an appropriate identity (or identities); in the implemented version of the linked system, this replacement will operate via logical switches. Similar devices will provide forward linkages from MACRO demand aggregates to the corresponding concepts in ORANI.[1] Additional forward linkages planned for early versions of the linked system relate to wage rates (given that MACRO will represent centralized determination of movements in award wages) and the exchange rate (movements in which will, in MACRO, reflect conditions in financial markets and the reactions of the authorities, as well as the balance of trade).

As an example, the following equation effects a forward linkage between the MACRO and ORANI wage rates :

$$p_{(g+2)m} = b_{W(m)} (h_{(g+2)1m} \xi^{(3)} + f_{(g+2)1m}) + (1 - b_{W(m)}) \, d \log W \; , \qquad (7.9)$$

where d log W is the change in the MACRO wage rate and $b_{W(m)}$ is a logical switch. When $b_{W(m)}$ is set at unity the link is disabled

1. It might be noted here that ORANI-S accepts the MACRO determination of the aggregate consumption budget, but does not at present impose any lags on the process of changing the allocation of that budget across commodities. Simple partial adjustment schemes designed for this purpose may be examined in the future - - particularly if the model is to be used to analyse responses to 'micro'-induced changes in the relative prices of consumer goods.

The change in aggregate production (i.e., in real value added, X) may be readily derived if it is noted that in each industry, all non-primary factor inputs are proportional to gross output, so that composite primary factor input (i.e., real value added for the industry) is also proportional to gross output. Aggregate production is then given by

$$x = d \log X = \sum_{j=1}^{g} S_j^{(x)} x_j \quad , \tag{7.5}$$

where the $S_j^{(x)}$ are base-period shares in aggregate production (note that X and Y would normally be the same in the base period, with all price indexes then set at unity).

The price deflator for aggregate production is then defined by

$$p = d \log P = y - x \quad . \tag{7.6}$$

The employment aggregates are derived straightforwardly as follows. For numbers of persons :

$$\ell_m = \sum_{j=1}^{g} \bar{L}_{mj} \ell_{mj} \quad , \tag{7.7}$$

where $\bar{L}_{mj}$ is the base-period share of industry j in total employment (in numbers of persons) in occupation group m . Then

$$\ell = \sum_{m=1}^{M} \bar{L}_m \ell_m \quad , \tag{7.8}$$

where $\bar{L}_m$ is the base-period share of m-type labour (in persons) in total employment ($\bar{L}_m$ corresponds to 'B_m' in ORANI-77 , and ℓ here corresponds approximately to μ in that version of the model).

RBA76 model[1] on which MACRO may be based contains this sort of mechanism;[2] a linked MACRO-ORANI system could then readily be set up with equality of the ORANI MEC (λ) and the MACRO MEC imposed by identity, in order to achieve the desired long-run convergence of λ and r .

7. AGGREGATES; CHANNELS FOR LINKAGES

A number of equations are included in ORANI-S to provide explanations of aggregates corresponding to the industry-specific, occupation-specific, etc., quantities in which the model deals. Some of these 'summary equations' have their counterparts in ORANI-77, but, with a view to providing for linkages with the MACRO model (and, later, with BACHUROO), there are several more of these in ORANI-S - - and more still could be added in the future as the need arises, to monitor more conveniently aggregate movements in ORANI quantities and/or to provide for additional channels of linkage in the complete system.

In the present version of ORANI-S, summary equations are included for the following :

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1. See Conference in Applied Economic Research : Papers and Proceedings (Sydney : Reserve Bank of Australia, 1977).
2. That model also contains mechanisms driving domestic interest rates towards world rates in the long run, so that the economy faces a horizontal supply curve for foreign investment funds in the long run.

(i) aggregate incomes accruing to labour, land and capital, and total factor income (value added) ;

(ii) aggregate domestic production (real value added) ;

(iii) the deflator for aggregate domestic production ;

(iv) aggregate employment across industries (in numbers of persons) by occupation group and in total.

Summary equations planned for later versions of ORANI-S include the following :

(a) aggregate employment in man-hours, and average hours worked ;

(b) aggregate inventory change ;

(c) aggregate export and import quantities and corresponding price deflators ;

(d) the average rate of tariff on aggregate competing imports and average rates of sales tax and excise.[1]

The change in aggregate labour income is determined as follows :

$$y^{(L)} = d \log Y^{(L)} = \sum_{m=1}^{M} \sum_{j=1}^{g} S_{mj}^{(L)} (x_{(g+2)1mj} + \bar{p}_{(g+2)1mj}) ,$$

where $S_{mj}^{(L)}$ is the base-period share of j-industry, m-type labour in aggregate labour income; then

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1. These will require reintroducing these latter rates as variables (rather than structural parameters), as is foreshadowed in Volume 2, chapter 9. Some modifications may be required to represent ad valorem taxes.

$$y^{(L)} = \sum_{m=1}^{M} S_m^{(L)} p_{(g+2)1m} + \sum_{m=1}^{M} \sum_{j=1}^{g} S_{mj}^{(L)} x_{(g+2)1mj}$$

$$(7.1) \qquad + \sum_{m=1}^{M} \sum_{j=1}^{g} S_{mj}^{(L)} \zeta_{mj} (x_j - \hat{x}_j) ,$$

where

$$S_m^{(L)} = \sum_{j=1}^{g} S_{mj}^{(L)} .$$

The change in aggregate capital income is given by

$$(7.2) \qquad y^{(K)} = d \log Y^{(K)} = \sum_{j=1}^{g} S_j^{(K)} [p_{(g+2)2j} + k_j(0)] ,$$

where $S_j^{(K)}$ is the base-period share of j-industry capital in aggregate capital income.

Aggregate income accruing to land is given by

$$(7.3) \qquad y^{(N)} = d \log Y^{(N)} = n + p_{(g+2)3} ,$$

where n is as derived by equation (11.8) of ORANI-77. Total factor income is then given by

$$(7.4) \qquad y = d \log Y = S^{(L)} d \log Y^{(L)} + S^{(K)} d \log Y^{(K)} + S^{(N)} d \log Y^{(N)} ,$$

where $S^{(L)}$, $S^{(K)}$ and $S^{(N)}$ are the respective shares in total base-period factor income (value added).