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By

AND INTERNATIONAL TRADE

CHANGES IN ECONOMY, TECHNOLOGY, ECONOMY WIND EFFECTS OF LONG RUN

September 4 - 6, 1978

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SIMULATION CONFERENCE

Paper Presented to

IMPACT OF DEMOGRAPHIC CHANGE ON INDUSTRY STRUCTURE IN AUSTRALIA
ABSTRACT

1971-72.

performed using historic data over the period 1965-69 to
are satisfied. A detailed validation exercise is then
preliminary solution recurred until the communication costs
 AAPM e-AAPM approximations are revised and the inner
approximate solution satisfying the approximate solution, if the
approximate communication costs are applied to the
approximate solution obtained. Transcommunication costs are applied to the
approximate program to then solved and an approximate
inner approximate approximations to the non-linear objective function
The solution algorithm is solved by making pseudo-wake
inner approximate solutions are presented and linear and economics discussed.
inner approximate solutions to the extent of the assistance
shock, the presented are approximate and the patience of
In the longer term, changes in demand.

APPENDIX
5. CONCLUSION

The results demonstrate that the SNAPSHOT model is capable of projecting to a high degree of accuracy economic variables at an economy and individual industry level as well as employment by occupation. However this level of accuracy has been demonstrated only when the exogenous data inputs concerned with trade, technology and demography are known with certainty. While the test described here validates the economics of the model, further tests are required to evaluate the model's forecasting potential. For the model to be used in forecasting mode, that is, to generate solutions for a snapshot year beyond the present, the user must formulate the technology, trade and demography scenarios for the chosen snapshot year. Further testing is required to establish the relative contribution each of the components of the exogenous data base makes to the projection accuracy of the model.
### Table IV

The data occupational groups distributed by the model.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>2000,000</th>
<th>2001,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>83.5</td>
<td>50.1</td>
</tr>
<tr>
<td>Lunch</td>
<td>43.9</td>
<td>24.2</td>
</tr>
<tr>
<td>Dinner</td>
<td>156.5</td>
<td>94.2</td>
</tr>
<tr>
<td>Snack</td>
<td>69.7</td>
<td>43.5</td>
</tr>
<tr>
<td>Total</td>
<td>430.7</td>
<td>253.7</td>
</tr>
</tbody>
</table>
An important task of SNAPSHOT is to identify the longrun consequences of changes in technology, demography and trade on the performance of individual industries in the economy. The projection accuracy for key endogenous variables at an individual industry level is shown in Table III.

**TABLE III**

**PROJECTION OF ECONOMIC VARIABLES AT AN INDUSTRY LEVEL**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Projection Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Projected ± 5% of Actual</td>
</tr>
<tr>
<td>industry output</td>
<td>102</td>
</tr>
<tr>
<td>industry consumption</td>
<td>88</td>
</tr>
<tr>
<td>industry investment</td>
<td>86</td>
</tr>
<tr>
<td>industry imports</td>
<td>96</td>
</tr>
<tr>
<td>industry growth rate</td>
<td>86</td>
</tr>
</tbody>
</table>

Figures in the table refer to the number of industries for which the projection of the economic variable in question lies within each accuracy range. The Australian economy is divided for the purpose of inter-industry analysis into 109 industries. The table indicates that the model is also able to project economic variables at an industry level to a high degree of accuracy.
1. INTRODUCTION

Table I. Comparison of Economic Aggregates

| Year | Actual | Projection
|------|--------|-------------
| 1971 | 1970   | 1971/72    |
| 1972 |        | 1978/79    |
| 1973 |        | 1979/80    |

2. ECONOMIC PERFORMANCE

SNAPSHOT: The economic performance has been evaluated by...

3. TECHNOLOGY AND INTERNATIONAL TRADE

ECONOMY WITH EFFECTS OF LONG RUN CHANGES IN DEMAND...
2. MODEL SPECIFICATION

Table 1 lists the SNAPSHOT equations. A brief description of the underlying economics is as follows:

2.1 Consumption

Households are divided into nine groups chosen to reflect different consumption patterns on the basis of socio-economic characteristics such as age of household head and number of children. Consumption preferences of groups are represented by different utility functions of the Klein-Rubin functional form, with demand behaviour obtained by maximising the utility functions subject to group budget constraints. The real after-tax proportional distribution of disposable income across demographic groups in the snapshot year is set exogenously.

2.2 Capital Stocks, Investment and Rates of Return

Capital stocks in the snapshot year are obtained by multiplying base year stocks (exogenous) in each industry by an endogenously determined average growth factor over the snapshot period. Investment by each industry in the snapshot year is assumed to be sufficient to maintain the snapshot period growth rates. Relative rates of return on capital to induce investment in each industry are set exogenously. The relativities account for such factors as risk and industry concentration. This formulation does allow industries to be affected by changes in productivity caused by demographic and technological change, by changes in world prices or by changes in

(j) Calculate final solution variables. When an acceptable solution is finally found, various extra quantities based on the solution values are calculated and printed out.

Each of the above steps was chosen to be a single problem step. For model and program debugging, an extra printing step was added after each of the calculation steps. All of the steps were then coded as separate subroutines, and a main program was written to control the step execution of the problem. A simple set of commands was defined to represent each of the steps, and a main program was written to read in the commands one by one and execute them. This command structure gave the flexibility during debugging to execute as little or as much as was required without disturbance to the program code.

The computing strategy incorporated ideas from modular programming. Use of these ideas simplified the program coding and debugging. The main program does no mathematical work whatsoever. Its only task is to read a command, decide which command it is, and to call the appropriate subroutine to do the mathematics for that step. Each of the individual "worker" subroutines was deliberately coded to handle the mathematics for only one simple step of the algorithm. In this way, its function was clear and it could be easily identified if an error occurred. If a single step was complicated, some of the subtasks were coded into "helper" subroutines which were then called by the "worker" when needed. Thus the trap of writing large, hard to understand sections of code was avoided. Details of the simulation facilities are contained in Appendix 1.
Lipoteestion of an appropriate export tax or subsidy

With the export tariffs, competitiveness is affected by the monopolistic
National average of foreign and non-foreign of monopolistic firms. A competitive
domestic market, as it is the monopolistic market that is most
affected. In the light of the
above, it is clear that firms are not necessarily
post-tariff domestic market share. If a firm
wishes to continue to domestic market share, it needs to
provide a post-tariff price that is competitive with the
domestic price of the foreign imports. In order to
maintain a competitive price, the costs of the
foreign imports must be competitive with the
domestic price of the foreign imports. In
particular, the effects of the
post- and pre-tariff prices need to be
considered. When the price of the
foreign imports is lower than the
domestic price, the domestic
market is likely to be
affected. In order to
continue to domestic market share, the
firm must be able to compete
in the foreign import market.

Also see: Export

Export policies are effective when they enhance the competitiveness of the
exports and reduce the effective rate of exchange.

2.3 International Trade and Commodity Policies

The effects of protection on employment and competitiveness are
of considerable importance. The effects of protection policies, however,
are

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2.4 Balance of Trade and Exchange Rate

The balance of trade is set exogenously according to an assessment of the net inflow or outflow of capital likely to occur. The exchange rate, which is endogenous, adjusts to ensure that the SNAPSHOT solution is consistent with this assessment about international capital movements.

2.5 Cost Structure of Commodities

The cost of producing a commodity is made up of purchased materials, wages and salaries, the return on capital and taxes levied on inputs. Should the cost of production of a commodity exceed its price, then that commodity is not produced in the snapshot year.

2.6 Clearing of Commodity Markets

SNAPSHOT is a general equilibrium model which matches the demand and supplies. For each commodity, the sum of domestic production and the net balance of imports over exports must equal the demands generated by consumers plus investors plus government.

2.7 Labour Market and Wages

The size of the workforce in the snapshot year is specified exogenously. The distribution of employment over nine occupational groups is endogenous and demand determined. That is, SNAPSHOT indicates which occupational composition of the labour force would be consistent with the projected structure of the economy in the snapshot year, given an exogenously set total workforce.

The main computing task was to develop a system which makes it easy to; (i) transfer input data required for the basic program (LP) to the LP package (APEX-I), (ii) solve the LP, and (iii) transfer the LP solution back from the LP package. With the whole process of approximating and refining the approximations under computer control, accurate solutions can be quickly obtained.

The complete SNAPSHOT solution algorithm may be described as follows:

(a) Read fixed data - read and store variables and matrices of data external to the model such as observed data and exogenous variables.
The equations specifying the snapshot model

<table>
<thead>
<tr>
<th>Equation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) ( \sum (t_j, d_j)^2 = \sum \bar{c} )</td>
<td>Weighted sum of squared differences</td>
</tr>
<tr>
<td>(2) ( \sum (t_j, d_j) = \sum \bar{c} )</td>
<td>Weighted sum of differences</td>
</tr>
<tr>
<td>(3) ( (\bar{t} - t_j, \bar{d} - d_j) = \sum \bar{c} )</td>
<td>Weighted difference equation</td>
</tr>
</tbody>
</table>

In the snapshot model, the equations are derived to find the optimal solutions for different scenarios. The objective is to minimize the weighted sum of squared differences and the weighted sum of differences. This is achieved through a weighted least squares approach, ensuring that the model accurately represents the data.
\[ J = K(t + 1) - (I - \hat{n})(K(t)) \]  
\[ X \leq K(t) \]  
\[ \Pi (X - K(t)) = 0 \]  
\[ r = \delta \hat{r} \]  
\[ r \geq (P^\top)^{-1} \Pi - \eta \]  
\[ \hat{r}(r - (P^\top)^{-1} \Pi + \eta) = 0 \]  
\[ p^K = K'r + (T_2 \ast K)'r \]  
\[ E = \hat{E} \]  
\[ M \leq \gamma X \]  
\[ \delta (M - \gamma X) = 0 \]  
\[ p = \delta p + \zeta - \delta p \]  

**In addition to the above list of exogenous variables, \( U_i \) the utility function of the \( i^{th} \) consumer group, is specified as \( U_i = \sum \beta_{ij} \ln (C_{ij} - \gamma_{ij}) \) where \( \beta_{ij} \) is the marginal budget share of group \( i \)'s expenditure on good \( j \), and \( \gamma_{ij} \) is the subsistence expenditure of group \( i \) on good \( j \).**

Q transformation matrix between the number of consumer goods and the number of input-output industries

The letters \( n \), \( g \), \( m \) and \( H \) represent the dimensions of variables and data in the problem as follows:

- \( n = 110 \), the number of industry groups (including non-competing imports)
- \( g = 9 \), the number of consumer goods
- \( m = 9 \), the number of consumer groups
- \( H = 9 \), the number of occupational groups.

### 3. Solution Technique

Inspection of Table 1 reveals a large non-linear system of equations and inequalities. To obtain values for the endogenous variables, the problem can be formulated in terms of maximising the utilities of the nine consumer groups subject to a set of linear and non-linear constraints. Using the theory of joint maximization (to transform the problem of many economic units into a single unit) the problem can be restated in terms of the constrained maximization of
### Equation Equivalents

<table>
<thead>
<tr>
<th>Equation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GNP = ( w' L + 2' K(t) + \sum_{i=1}^{n} \epsilon_i p_i' Q_i e_i + \epsilon_0 c_1 ) + ( (T_2' + K)J + \epsilon_0 e + (T_1' + A)X_1 )</td>
</tr>
</tbody>
</table>

All endogenous variables (with the possible exception of \( h \) and \( \xi \)) must be non-negative.

---

### ENDOGENOUS VARIABLES IN THE SNAPSHOT YEAR

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Number of Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>( K(t) )</td>
<td>industry levels of capital stock in the year after the snapshot year</td>
<td>(n)</td>
</tr>
<tr>
<td>( J )</td>
<td>gross investments by using industries</td>
<td>(n)</td>
</tr>
<tr>
<td>( X )</td>
<td>outputs of commodities</td>
<td>(n)</td>
</tr>
<tr>
<td>( \Pi )</td>
<td>rental prices on capital by industries</td>
<td>(n)</td>
</tr>
<tr>
<td>( P_k )</td>
<td>price of capital goods including taxes</td>
<td>(n)</td>
</tr>
<tr>
<td>( r )</td>
<td>minimum acceptable rates of return by industry</td>
<td>(n)</td>
</tr>
<tr>
<td>( \beta )</td>
<td>variable reflecting the absolute rate of return demanded on new capital formation in Australian industries</td>
<td>(1)</td>
</tr>
<tr>
<td>( E )</td>
<td>exports of commodities (quantity)</td>
<td>(n)</td>
</tr>
<tr>
<td>( M )</td>
<td>imports of commodities (quantity)</td>
<td>(n)</td>
</tr>
<tr>
<td>( \Phi )</td>
<td>exchange rate (US$ per unit of foreign currency)</td>
<td>(1)</td>
</tr>
<tr>
<td>( \Phi )</td>
<td>excess tariff revenue per unit of imports</td>
<td>(n-1)</td>
</tr>
<tr>
<td>( E )</td>
<td>export subsidy</td>
<td>(n)</td>
</tr>
<tr>
<td>( w )</td>
<td>wage rates by occupation before taxes</td>
<td>(n)</td>
</tr>
<tr>
<td>( L )</td>
<td>the number of labour units in each occupational group in the snapshot year</td>
<td>(H)</td>
</tr>
<tr>
<td>( \delta )</td>
<td>variable reflecting the absolute level of wages before taxes for the Australian labour force</td>
<td>(1)</td>
</tr>
</tbody>
</table>

### EXOGENOUS VARIABLE IN THE SNAPSHOT YEAR

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Number of Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>( s_i )</td>
<td>consumer group ( i )'s average propensity to save out of disposable income</td>
<td>(m)</td>
</tr>
<tr>
<td>( \alpha_i )</td>
<td>share of GNP which is disposable income for group ( i )</td>
<td>(m)</td>
</tr>
<tr>
<td>( \epsilon_c )</td>
<td>ad valorem taxes on consumption</td>
<td>(n)</td>
</tr>
</tbody>
</table>