(ii) The knowledge gained of updating techniques in the context of Australian input/output data will be invaluable in the specification of the dynamics of the model (which may include time dependent input/output coefficients).

In addition to this aspect of the manipulation of input/output data, a "matrix classifier" which allows consumer demand on a conventional consumer-oriented classification to be translated into demand in terms of the 1962-63 input/output classification has been developed by Mr. Klijn. As remarked by Johansen, this procedure adds an attractive element of flexibility into the modelling.[3] It also ensures that state of the art techniques can be applied to the estimation of the demand structure without raising complications from the viewpoint of interfacing BACHUROO with ORANI.

Other Data Sources

Many of the important basic data sources have been covered above in the discussion of previous IAC work. The basic data needs for BACHUROO have been reconnoitred in detail elsewhere.[4]

3. Johansen, op. cit., p. 177.

4. Bruce Chapman, "BACHUE-1 : The Availability of Data in Australia for the Application of the Model," Institute of Labour Studies, Flinders University of South Australia, July 1974, pp. 35 (mimeo).

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IMPACT PROJECT

A Commonwealth Government inter-agency project in co-operation with the University of Melbourne, to facilitate the analysis of the impact of economic demographic and social changes on the structure of the Australian economy

IMPACT : AN ECONOMIC-DEMOGRAPHIC MODEL OF AUSTRALIAN INDUSTRY STRUCTURE

PRELIMINARY OUTLINE

by

Alan A. Powell and Tony Lawson
Industries Assistance Commission

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(caused for instance by changes in tariff protection).[1] Such a study is essential for the ORANI model. The import demand functions have been estimated for a number of industries but further work is necessary to extend the industry coverage and to improve the present estimates.

(e) Input/Output Data

The Commission has built up considerable expertise in the manipulation of input/output tables. Two doctoral students respectively at the Australian National University and Monash University, Mr. N. Klijn and Mr. A. Meagher, have acted as consultants for the Commission in various aspects of this work. Mr. Klijn has updated the 1962-63 input/output table to 1967-68.[2] Although the revised table will be inferior to the ABS 1968-69 table, its preparation has two important aspects from the viewpoint of IMPACT:

(i) The 1967-68 table will serve as approximate data input during the early development of the specification and software of the model - - i.e., prior to the availability of the official 1968-69 table in late 1975.

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1. A recent paper in the continuing IAC work program on import demand is: L. Martin and R. Gregory, "Explantion of Recent Movements in Australia's Imports," paper presented to Section 24, 46th ANZAAS Congress, Canberra, January, 1975.

2. Nico Klijn, "A 1967-68 Input/Output Table (Preliminary)" Department of Economics, Monash University; part of a Progress Report on the Monash Econometric Analysis of Protection Project; paper presented to Section 24 (Economics), 44th Congress of the Australian and New Zealand Association for the Advancement of Science, Sydney, August, 1972, (roneo), pp. 9 + 12.

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assistance covering such matters as their size, growth, productivity, tariff and other assistance, profitability, concentration, labour requirements, overseas ownership and share of the market. These studies have necessitated the matching of a great many different data series including special collections made by the IAC. The studies cover many years and hence have involved dealing with many changes in classification. Expertise in this area will prove valuable in converting industrial time series statistics to a uniform basis for use in ORANI.

(c) Overseas Trade

An essential part of the analysis of the competitive structure of industries is the linking of statistics on overseas trade and tariffs with industry and commodity data. Cross classifications have been developed by the IAC for this purpose. These link the export, import and tariff classifications with the commodity and several different industry classifications. The trade classifications were completely revised in the mid-1960's; the industry classification changed completely between 1967-68 and 1968-69. In addition there are less important changes in the trade and commodity classifications every year which make it difficult and very time consuming to provide a link over a number of years.

(d) Import Demand Functions

The IAC has for some time been working on methods to determine the relationship between the quantities of imports and domestic production and changes in their relative prices

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APPENDIX

Notes on Data Sources

Previous IAC Work

The IAC has undertaken a number of projects over the last few years which have a direct bearing on this proposed work. These projects have been designed to provide input for the Commission's general reporting role, to assist in examining the effects of changes in assistance on the structure of industries (and hence the pattern of employment) and to interact with such studies as the Monash general equilibrium model. The relevant work has been mainly concerned with collecting and reconciling sets of data using different classifications and for different purposes. The most important work includes:

(a) Employment by Industry

Extensive work has been done to reconcile employment and industry data. This has been published by the IAC (formerly the Tariff Board) in its last three Annual Reports and in a study, "Employment in Australia by Industry and Occupation : 1961, 1966 and 1971," published by the Commission in February, 1974. The employment data has been obtained from the Australian Population Censuses and this has been related to industry data based on the Factory Class, 1962-63 Input-Output and Australian Standard Industrial Classifications.

(b) Annual Reports

As well as providing detailed information on employment, recent Annual Reports have contained considerable analytical and descriptive material on the structure of industries and levels of

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the calculation of 'representative' dynamic multipliers. The sequencing of the final two outputs from the study cannot be projected accurately at this stage, but the nature of the output is known. They are, respectively, 'snapshot' solutions for annual periods at distances of 15, 20, 25 years in the future,[1] and full dynamic annual solutions for periods of one through seven (perhaps as many as ten) years into the future. The latter are linked annual solutions; unlike those mentioned earlier, they will be expected to model transient behaviour which is not necessarily typical, and therefore to track the observed history of the variables well and (hopefully) to provide accurate conditional projections for periods one through seven years ahead.

1. The methodology for obtaining the 'snapshot' solutions in broad outline could follow that which is currently popular in the planning literature -- see, e.g., H. David Evans, A General Equilibrium Analysis of Protection (Amsterdam : North-Holland, 1972). Some important improvements to this approach are suggested by Peter B. Dixon and Matthew W. Butlin in "The Evans Model of Protection : An Interpretation and Review," Paper presented to the 5th Conference of Economists, Brisbane, August, 1975. An alternative (but computationally expensive) technique would consist of tracking the annual solutions into the distant future using the same simulation framework as is proposed for obtaining intermediate run solutions. Both approaches will be explored in our work.

IMPACT : AN ECONOMIC-DEMOGRAPHIC MODEL OF AUSTRALIAN INDUSTRY STRUCTURE

by

Alan A. Powell and Tony Lawson*

1. Background to the Study

In attempting to understand the implications of changing Australian patterns of immigration, household formation, fertility, and labor force participation, it is necessary to trace the impact of changes in these demographic variables all the way through the supply and demand structures of the evolving economy. Demographic changes influence the quantity and composition of skills entering the workforce, and so differentially affect the conditions of production in different activities. Changes in fertility also alter the age structure and size of households and hence influence the types of goods and services that are demanded.

The National Population inquiry has forecast a far smaller rate of growth of the Australian population, and hence

* We are grateful to Charles C. Holt for helpful comments on an earlier draft.

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the workforce, than had previously been believed.[1] The lower rate of growth will result from reduced fertility, a lower immigration rate and, in the case of the workforce, a slow down in the rate of increase of female participation. The result foreseen is an ageing workforce which is less able to respond quickly to changes in production patterns. Many employees may have to be retrained several times during the course of their working lives. If realized, the projected lower immigration rate would reduce the supply of unskilled labor traditionally absorbed in labor-intensive activities. Since many labor-intensive industries already receive high levels of assistance, the necessity for these industries to compete with other sectors for the available (more expensive) labor supply, would cause their costs to rise. Unless offset by such rapid gains in efficiency that they outpaced their overseas competitors, these industries would be forced to seek additional protection or else to contract (perhaps dramatically so).

A changing demographic structure will affect the volume and pattern of demand for goods and services from both the public and private sectors. A lower level of demand will make it difficult for some industries to take advantage of economies of scale and hence they may need additional or continued assistance to compete against imports. However, it may be that the smaller population will be richer on a per capita basis and hence the rate of growth in the demand for some goods may not fall.

1. Australian Government, National Population Inquiry (W.D. Borrie, Chairman), Population and Australia - A Demographic Analysis and Projection, (Canberra : Australian Government Publishing Service, Canberra 1975), Vols. 1&2, pp. xxxiv & 760.

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At its core, ORANI is based on an input-output table, although the production relations are modelled in such a way that imported intermediate inputs are less than perfect substitutes for domestically produced commodities in the same input-output class. Many basic features of BACHUROO (especially aspects relating to the mapping from the functional to the personal distribution of income) are developments and extensions of the economic-demographic framework incorporated in the ILO's "BACHUE" series of population and employment models.[1]

The major steps in the implementation of IMPACT are to be (i) estimation of the modules; (ii) validation of the model; and (iii) simulation experiments designed to project the evolution of the industrial structure over the simulated future in response to autonomous and policy instigated changes.

The first product in the sequence of outputs from IMPACT is likely to consist of an annual solution computed under 'typical' initial conditions. This will enable the estimation of 'representative' impact multipliers. Next would follow linked annual solutions spanning 5 to 10 years, again computed under 'typical' initial conditions and 'representative' assumptions about the time paths of exogenous variables. This will allow

1. World Employment Programme, International Labour Office, Geneva, "Economic-Demographic Modelling Activities of the World Employment Programme," July, 1973, pp. 31 (mimeo) ;

   G. B. Rodgers and R. Wery, "Population and Employment, A Strategy for Research," World Employment Programme, International Labour Organization, Geneva, March, 1974, pp. 13 (mimeo) ;

   Richard Blandy, Rene Wery, with others, "BACHUE-1 : The Dynamic Economic-Demographic Model of the Population and Employment Project of the World Employment Programme," International Labour Review, Vol. 107, No. 5 (May, 1973), pp. 441-449 ;

   R. Wery, G. B. Rodgers, and M. D. Hopkins, "BACHUE-2 : Version 1 : A Population and Employment Model for the Philippines," World Employment Programme, International Labour Office, Geneva, Population and Employment Working Paper No. 5 (July, 1974), pp. 129 (mimeo).

3.3 Major Variables in BACHUROO

BACHUROO will focus heavily on demographic accounting, but will take as many economic/demographic linkages into account as is feasible. Conditions affecting the availability of migrants and the government's immigration policy are exogenous inputs into BACHUROO. For medium and long term solutions, however, various immigration scenarios will be examined. The structure and level of wage income and/or unemployment by skill group determined within ORANI are inputs into BACHUROO which, besides tracking the demographic structure endogenously, also determines the skill and sex composition of the workforce, and the personal distribution of income. Where plausible feed-backs from income onto family size can be detected econometrically, they will be taken into account.[1] Likewise, if family size and ages of children are detected to have significant impacts on women's labor force participation rates, this will be taken into account.

3.4 Over-all Methodology

The three separate modules offer an opportunity to combine neo-Keynesian, neoclassical, inter-industry, and demographic influences within the same model. MACRO will benefit from the existing stock of macroeconometric models, incorporating a large neo-Keynesian element. ORANI has a much more heavily neoclassical flavour, reflecting its antecedents in the work of Johansen[2] and Taylor and Black.[3]

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1. See, e.g., Allen C. Kelley, "Savings, Demographic Change and Economic Development," Center for Demographic Studies, Department of Economics, Duke University, April 1973 (mimeo) pp. 17
2. Leif Johansen, A Multisectoral Study of Economic Growth, 2nd ed., (Amsterdam : North-Holland 1974)
3. Lance Taylor and Stephen L. Black, "Practical General Equilibrium Estimation of Resource Pulls under Trade Liberalization," Journal of International Economics, Vol. 4 (1974), pp. 37-58

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The relative slowness of demographic change, of course, adds an element of built-in stability to patterns of demand. Over the next two decades the demand for goods by the community's more senior citizens is unlikely to differ radically from previous expectations since the size (if not the real incomes) of these cohorts is predetermined at this stage.

It does seem likely, on the other hand, that some of the stock of capital and labor devoted to educating the young probably will have to be redirected (for instance to retraining adult workers) if it is to be of maximum value.

These simple examples illustrate that the implications of a changing demographic structure for any particular industry may not be clear a priori and are best analysed within a comprehensive analytical framework which takes adequate account of the dynamic nature of the economy. To the extent that changes in the Australian population structure can be foreseen, so too can the attendant consequences for the structure of Australian industry, provided it is possible to take the evolving supply and demand conditions into account in a sufficiently logical and systematic way. To enable inferences about manpower and demand conditions at some future date, sufficiently precise demographic accounting must be maintained for the intervening period.

As well, effects initially making their impact on a particular industry will have secondary impacts on all industries via the input/output structure of the economy. Accurate ideas about the consequences of demographic changes will be possible only if the inter-industry relationships of the economy are traced through in adequate detail.

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2. Scope of the Model

The focus of the model (which is called IMPACT) is heavily on Australian industry composition and its relationship to international trade, the domestic labor market, and population characteristics. Questions of interest of short through medium run on which IMPACT should be able to throw some light are, for example

(a) the effects on Australian industry of changes in current objective conditions and policy options in the immigration field;

(b) the effects on Australian industry structure of various developments in international trade, including tariff actions by Australia or exchange rate changes made by Australia or by its trading partners.

Examples of questions of medium through long term focus on which IMPACT should have something to say are

(c) the effects of changing fertility patterns on the structure of Australian industry and Australia's international trade;

(d) the effects on the personal income distribution of changes in the structure and growth of different Australian industries; and

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transferred from MACRO as input signals to ORANI may also be modelled. A possible role for such variables would be to introduce disequilibrium behaviour into ORANI. An example would be the application of shocks (generated in MACRO) to the (equilibrium) factor demand functions generated within ORANI in order to represent unintended accumulations/ decumulations in inventories.

3.2 Major Variables in ORANI

ORANI will take as inputs the prices of internationally traded goods, the exchange rate, and the tariff structure. The main inputs to ORANI predetermined elsewhere in the model are : (a) (from MACRO) the levels of aggregate investment, consumption and government spending; (b) (from BACHUROO) the size and skill composition of the workforce and the personal distribution of income and (c) (from ORANI at the previous time period) the composition of the capital stock. The major endogenous variables in ORANI are : (i) the sectoral composition of new investment; (ii) the composition of consumer demand, disaggregated by foreign/ domestic source of supply, consumer commodity classification and by input-output sector of origin; (iii) the demand for intermediate inputs distinguished by sector of origin and foreign/domestic source of supply; (iv) the levels of imports by input-output sectors; (v) the levels of exports by input-output sectors; (vi) the balance of trade; (vii) the domestic prices of non-traded goods; (viii) the rates of return on new domestic investment; and (ix) (depending on the precise details of how ORANI is closed) either the level and structure of wages, or (with wages given exogenously) the unemployment levels for different skill groups.

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Table 1

MAJOR CONTEMPORANEOUS INFORMATION FLOWS IN IMPACT

Module	Inputs to Module	Output from Module
Macro	Tax rates Level and composition of government spending Size of work force[B]	Aggregate Investment Aggregate consumption General level of prices
Orani	Prices of internationally traded goods Exchange rate Tariff structure Levels of aggregate investment, consumption and government spending[M] Size, age structure, skill composition of work force[B] Personal distribution of income[B]	Structure and level of wages and/or skill specific unemployment levels* Disaggregation of investment Disaggregation of consumer demand Demand for intermediate inputs Demand for various skill groups in employment* Disaggregated demand for imports Disaggregated supply of exports Balance of trade Pattern of domestic prices Rates of return on new investment
Bachuroo	Conditions affecting availability of migrants Immigration policy Education policy Manpower training schemes Structure and level of wages*[O] Employment Opportunities for various skill groups*[O]	Size, age structure, skill composition of work force Personal distribution of income

M,B,O : Superscripted variable is an output from Macro (M), Bachuroo (B) or Orani (O) respectively

* Details depend on procedure adopted for closure of Orani.

(e) the long-term living standards compatible with the adoption of any particular strategy towards Australia's economic development.

Any model can give only an approximation, necessarily imperfect, to the process (economy, whatever) under investigation. At best the approximation can be good from one or a (limited) number of points of view. Of necessity there will be many points of view from which any given model has little or nothing to say.

IMPACT is an annual model with no geography other than the distinction between Australia and the rest of the world. Therefore it will have nothing to say about monthly or quarterly movements in variables, nor about regional matters.[1] IMPACT is a medium and long term model : it is designed to give annual information for the proximate period of five to seven (possibly as many as ten) years, with full dynamic behaviour traced out for a large number of variables. For more remote future periods (15, 20, 25 years), only 'snapshots' of the economy will be attempted, with no detailed dynamics connecting the intervening periods.[2]

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1. For some variables, some limited classification into rural/urban location may be possible, even in early versions of IMPACT. The possibility of extending the geographic dimension will be investigated after satisfactory performance has been achieved with existing versions of IMPACT. There are no plans to convert IMPACT to a quarterly model (although quarterly variables may appear in its macroeconomic module, MACRO) : it is almost certain that the data base would not allow such a conversion.

2. It would not make sense to attempt to track transient components at such great distances into the future.

3. Structure of IMPACT

In the research framework for IMPACT now outlined, major attention is devoted to the demographic and inter-industry aspects of the Australian economy. IMPACT itself consists of three modules : A macroeconomic module MACRO; a general equilibrium module ORANI, specifying the sectoral composition of final demand, output, imports and exports, plus skill-specific demands for labor; and finally a demographic-economic module BACHUROO specifying the demographic composition of the population, the skill composition of the workforce, and mapping the functional distribution of income (obtained from ORANI) into the personal distribution of income.[1]

To a first approximation, the operation of IMPACT can be visualized as in Figure 1. Each of the three modules is an annual model in the sense that the endogenous variables codetermined within each are either annual flows or stocks at the end of a given year. Figure 1 abstracts from the many contemporaneous information flows at the interfaces of the modules . Not shown are the many inputs which are predetermined from the viewpoint of one module but which are endogenously determined within the same accounting period by another module. Details of these can be obtained from Figure 2.

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1. The personal distribution of income appears at the interface of ORANI with BACHUROO; it is a matter of convenience whether to locate the mapping in ORANI or BACHUROO. Currently developed mapping techniques focus exclusively on labor income; if substantial work on the distribution of asset income becomes feasible, it may prove desirable to transfer the entire income distribution mapping into a separate module.

but at an earlier period (the lagged codetermined variables). The time path of the complete set of variables in the model is determined by:

(a) The initial values of those codetermined variables which appear (with a lag) as predetermined variables in parts of the system;

(b) The time paths of the exogenous variables (including exogenous policy variables).

Major information flows are summarized in Table 1.

At this stage, a complete and final listing of the variables in IMPACT would be premature. The listing of variables in each module given below, whilst broadly correct, is provisional at this stage.

3.1 Major Variables in MACRO

The principal endogenous variables in MACRO will be aggregate real investment, aggregate real consumption, and the aggregate price level. Predetermined variables will include the size, and, if relevant, the age structure and skill composition of the workforce (endogenous in BACHUROO). Policy variables to be treated exogenously (at least from the viewpoint of annual solutions) include tax rates and the level (and composition) of government spending.[1] Business cycle indicators capable of being

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1. For long run work, it may be possible to endogenize government spending and its composition. This is being investigated as part of our research program.

MACRO, thus introducing a major non-linearity which would involve the iterative mutual solution (by Gauss-Seidel or otherwise) of the three modules in order to obtain a complete annual solution to the entire model.

Medium and longer term solutions, as well as dynamic behaviour, are obtained by embedding IMPACT within a simulated time loop. Lagged feedback controls are then used to ensure that simulated time paths reflect realistic possibilities. An example would be the triggering of simulated policy action to alter the exchange rate in response to external reserves reaching some critical maximum or minimum. For medium and long term solutions, other policy variables will be endogenized in a similar way, provided sufficiently realistic and well defined decision rules are at hand.[1]

The scope of each module is conveniently summarized by noting the variables input into it (i.e., predetermined variables, from the viewpoint of that module) and output from it (i.e., the variables codetermined within the module in question). From the viewpoint of the model as a whole, those variables which appear nowhere as currently codetermined are predetermined - - that is, their explanation either lies outside the model completely (the exogenous variables) or are determined by the model,

1. For medium and long term modelling, there is no alternative to endogenizing, at least in a vague way, policy actions with respect to a range of key economic policy instruments. This technique (i.e., a scenario approach) to government decisions over the intermediate to long run seems to offer the potential for realistic modelling. This does not preclude the use of a control-theoretic approach to the determination of optimal feedback rules, whose investigation will proceed as one element in our research program.

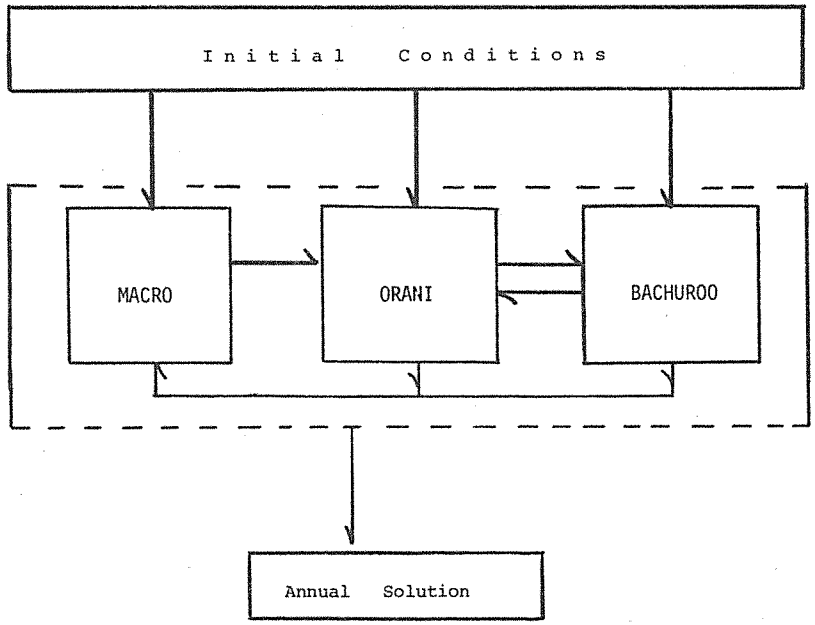

Figure 1 : Schematic view of modular structure of IMPACT

All three modules are dependent on initial conditions; e.g., initial levels of world prices, exchange rates, Australian tariff levels. The 'front end' of the model is MACRO, in which aggregate real consumption expenditure, aggregate real investment, government spending and the aggregate price level are generated within a conventional macroeconomic framework. All financial and monetary markets, and most disequilibrium behaviour are to be modelled in MACRO.[1] Given the values of the major aggregates, their sectoral allocation (across some 100 input-output sectors) and the determination of relative prices proceeds along neoclassical lines in ORANI. Apart from possible disequilibria in the labor market, ORANI is a general equilibrium model.

Since the demand for all factors of production is determined in ORANI, a vector of labor demands (classified by occupation) is generated endogenously in ORANI. BACHUROO, on the other hand, endogenizes the supply (vector) of labor.

IMPACT can be closed in a number of ways. Two interesting (but extreme) alternatives consist of taking a set of exogenously given wage relativities, and solving for the resulting vector of (labor) unemployment; or alternatively, of insisting on full employment, and solving for the implicit wage relativities. (The most realistic solution will probably lie between these two extremes.) Given the level and occupational composition of unemployment determined through the interaction of BACHUROO and ORANI, these labor market variables may feedback contemporaneously into

1. At the date of writing, the development of MACRO is well behind the other two modules - - hence the future tense is common when referring to MACRO in this paper.

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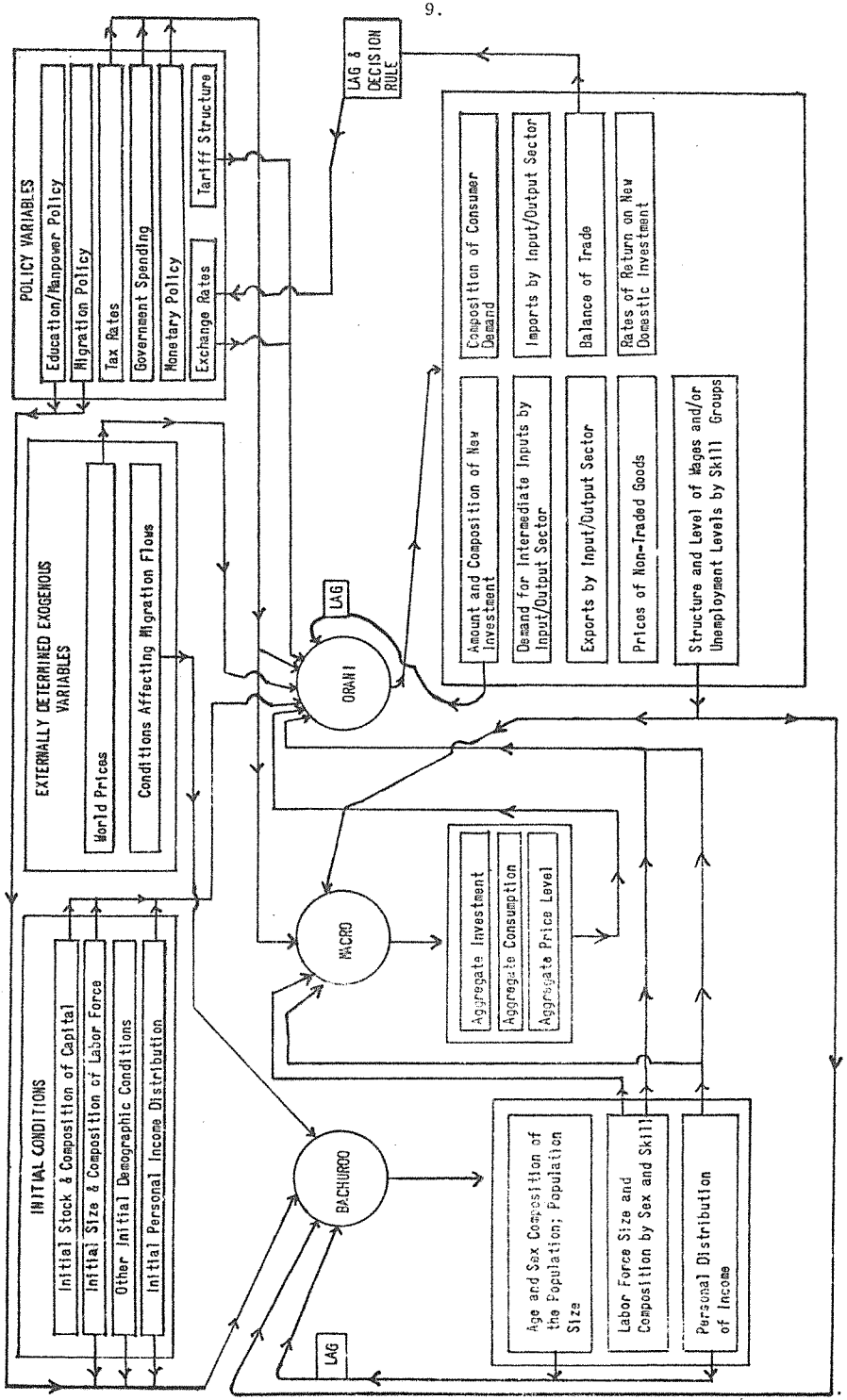

FIGURE 2 : PROVISIONAL FLOW CHART OF IMPACT'S MEDIUM TERM MODEL

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