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THE ROLE OF LABOR STATISTICS IN THE MODELS OF THE IMPACT RESEARCH PROJECT

by

Alan A. Powell

University of Melbourne

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Dennis J. Trewin
Statistics in the Labor Market

Chapter -

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Alan A. Powell
IMPACT Project Research Centre
University of Melbourne, Victoria, Australia

List of Tables

List of Figures

THE ROLE OF LABOUR STATISTICS IN THE MODELS OF THE IMPACT RESEARCH PROJECT

by

Alan A. Powell*

1. OUTLINE OF THIS CHAPTER

The role of labour statistics in the IMPACT Project will not be intelligible to a reader who has no knowledge of the project itself. In order to make this chapter self-contained, therefore, in Sections 2 and 3 respectively I give brief accounts of the historical background of the project and its overall design strategy. Those already familiar with or uninterested in the institutional setting of the Project, could proceed directly to Section 3. In Section 4 I describe how labour statistics are used in modelling the demand for labour, while in Section 5 I address myself to the supply side of the market. Applications illustrating the use of the models are briefly discussed in Section 6. In the final Section I offer a brief perspective on directions for further work.

2. HISTORICAL AND INSTITUTIONAL BACKGROUND OF THE PROJECT

Origins of the Project

The IMPACT Project arose out of an initiative taken by the Industries Assistance Commission (IAC) in mid 1975. The Commission, under the leadership of its then Chairman, Mr G.A. Rattigan, perceived the need to upgrade the policy information system supporting the advice

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* Helpful comments of the following are acknowledged: Peter Higgs, Dean Parham, Lynne Williams and Dennis Sams. The remaining errors, and the views expressed are my own.

it was charged with supplying to the Commonwealth Government. The inter-related nature of policy making in the fields of protection, industry policy, manpower and training was recognized from the start. The need to harmonize policy making, so that decisions in one area did not have unintentional effects which vitiated efforts in another, was uppermost in the thinking of the Project's sponsors. Apart from the IAC, the latter included the (then) Department of Labour and Immigration and the Department of Manufacturing Industry. The Australian Bureau of Statistics (ABS) joined the Project as a participating agency late in 1975 and was followed early in 1976 by the Department of the Environment, Housing and Community Development.

Aims of the Project

The Project was not itself to provide advice to government; rather, its aim was to improve the quality of advice given by the participating agencies. It was to do this without cutting across their independent professional roles in the policy making field. The Project was not to have (and indeed has not had) direct access to the executive arm of government. This would ensure that the output of the Project could be placed fully in the public domain and thus would help to ensure the professional independence of the project team.

The policy information system was to be upgraded principally by the efforts of the Project in the following fields:

(a) Data gathering,

(b) Economic model building,

(c) Computer systems development,

and

(D) Training of personnel.

IMPACT's resources did not permit the gathering of primary data; thus the role of the ABS in retabulating and extracting the requisite data from already existing sources was critical. The data bases developed in the fields of industry statistics, labour statistics, and international trade were designed to provide a summary of the factual information pertinent to policy analysis in the several fields covered by the participating agencies.

The economic models (described below in Section 2) were to be policy-analytic in nature, designed to answer hypothetical questions such as

(i) How would the outputs of about 100 industry groups spanning the economy change as the result of any given change which might be implemented in the field of protection?

(ii) What impact would the policy change referred to above have on the employment demand facing some nine different occupational groups?

Above all else, the models were to recognize the interconnected nature of markets for commodities and factors of production, providing a systematic basis for tracing the passage of any given shock across the economy via input-output and other linkages. The models developed should, either separately or when interfaced with each other, provide sufficient scope for in-depth analysis of policy in the areas covered by the sponsoring agencies.

The economic models of course were formulated mathematically.

They were implemented by specially written software on the CSIRONET computer network. This ensured that access could be gained from some 100 terminals located throughout Australia.

Personnel training, it was envisaged, would take two forms. First, by assembling a team consisting largely of civil servants outposted from the participating agencies under senior professionals recruited especially for the Project, it was anticipated that in-house professional skills in the policy analysis field would be enhanced. At least in the case of the IAC (IMPACT's principal sponsor), this expectation has been substantially realized. Second, training courses in the use of the models would be held from time to time. These would be open to the government, private and academic sectors. Graduates of these courses would be in a position to use the models in their own professional situation since the latter were to be documented exhaustively in the public domain.* In fact, only two such courses have been held up to mid-1981, but a further course during 1981 is planned. To have achieved more in training outside the participating agencies would have required more resources than were approved for the Project under the financially stringent fiscal programs adopted by the Australian Federal Government since 1976.

Initial Development 1975-1978

Initial development during 1975-78 concentrated on the ORANI and SNAPSHOT models of industry structure (to be described presently).

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* More than 100 working documents of the Project are available to interested professionals. For a catalogue, write to The IMPACT Information Officer, Mr Mike Kenderes, Industries Assistance Commission, P.O. Box 80, BELCONNEN, A.C.T, 2616, Australia.

Parallel work on the BACHUROO model of labour supply lagged badly due to a combination of data problems and personnel shortages. The team working on these three models was assembled in Melbourne under the leadership of myself and of Peter B. Dixon. During this period Dr Dixon and I maintained a part-time affiliation with Monash University which proved very beneficial both to the University and to the Project because it gave the latter access to graduate students who wrote theses on topics of their own choice within the scope of the Project, while it provided the University with first class supervision and research internship facilities. During this first four-year intensive development period, the professional personnel committed to the project fluctuated between about 10 and 25 people. Following a review of its own priorities, the ABS left the Project in 1978.

Further Development 1979-82

The ORANI model, by far the most important of those under development at IMPACT, had completed one full development cycle by mid 1977. In 1978 the IAC began transferring IMPACT staff to Canberra in order to reap the return on its investment. These transferred professionals now form an operational model-using group within the Commission. A basic research and development group, consisting of myself and 4-6 professionals, was located on the campus at Melbourne University under an agreement with the Government. This coincided with Peter Dixon's move to a Chair in Economic Theory at La Trobe University in 1978 and with my move to the Ritchie Chair of Research in Economics at Melbourne University early in 1979. Professor Dixon remains closely associated with the Project as its Senior Adviser. At the date of writing, the participating agencies are the IAC, the Department of Industry and Commerce (via its research arm, the Bureau of Industry Economics) and the Department of Employment and Youth Affairs (via its Bureau of Labour Market Research). The University of Melbourne is in a special supportive and co-operative relationship to the Project under an agreement which comes up for renewal in mid 1982.

3. OVERALL DESIGN OF THE IMPACT MODELS

The IMPACT models were to allow the analysis of medium term (1-2 years) and long term issues (5 years or more, say). The medium term model itself was to consist of three separate models which would be interfaced to provide a single overall model. The three component models (or modules) are MACRO (a small macroeconomic model estimated from quarterly data), ORANI (a large comparative static model of industry structure, international trade and labour demand -- Dixon et al. (forthcoming 1982)) and BACHUROO (a large economic-demographic model of labour supply -- Powell (1980)). IMPACT's original long term model of industry structure and labour demand was SNAPSHOT (Dixon and Vincent (1980)); in 1977 it was realized that the ORANI model could also be used to produce 'snapshots' of the economy at a relatively distant future date and could address a larger range of issues than SNAPSHOT. Some further developments to ORANI were necessary to accomplish this; these have been carried out on a small prototype (viz., a small model of the ORANI model itself -- Dixon, Parmenter and Rimmer (1981)) and are to be implemented in the operational model during 1982.

Medium Term Model*

To a good first approximation the structure of IMPACT's medium term model is as shown in Figure 1. 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, and the aggregate price level are generated within a small macroeconomic model formulated in continuous time. This model has been borrowed from the work of Peter Jonson's team at the Reserve Bank of Australia (RBA, (1977)). All financial and monetary markets, and most disequilibrium behaviour, are modelled in MACRO.

Apart from possible disequilibria in the labour market, ORANI is a general equilibrium model. The values of the major aggregates are determined by MACRO, but their sectoral disaggregation takes place in ORANI. The latter model disaggregates the private consumption expenditure of households, private fixed capital formation by investors, and government spending, into 113 industries and 115 commodities. It also endogenizes the relative prices of these commodities and the international trade flows of many of them. Since the demand for all factors of production is determined in ORANI, a vector of labour demands (classified by occupation) is generated endogenously in ORANI.

The medium term model 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 labour demand from ORANI. When BACHUROO is operational

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* This section borrows freely from Powell & Lawson (1975).

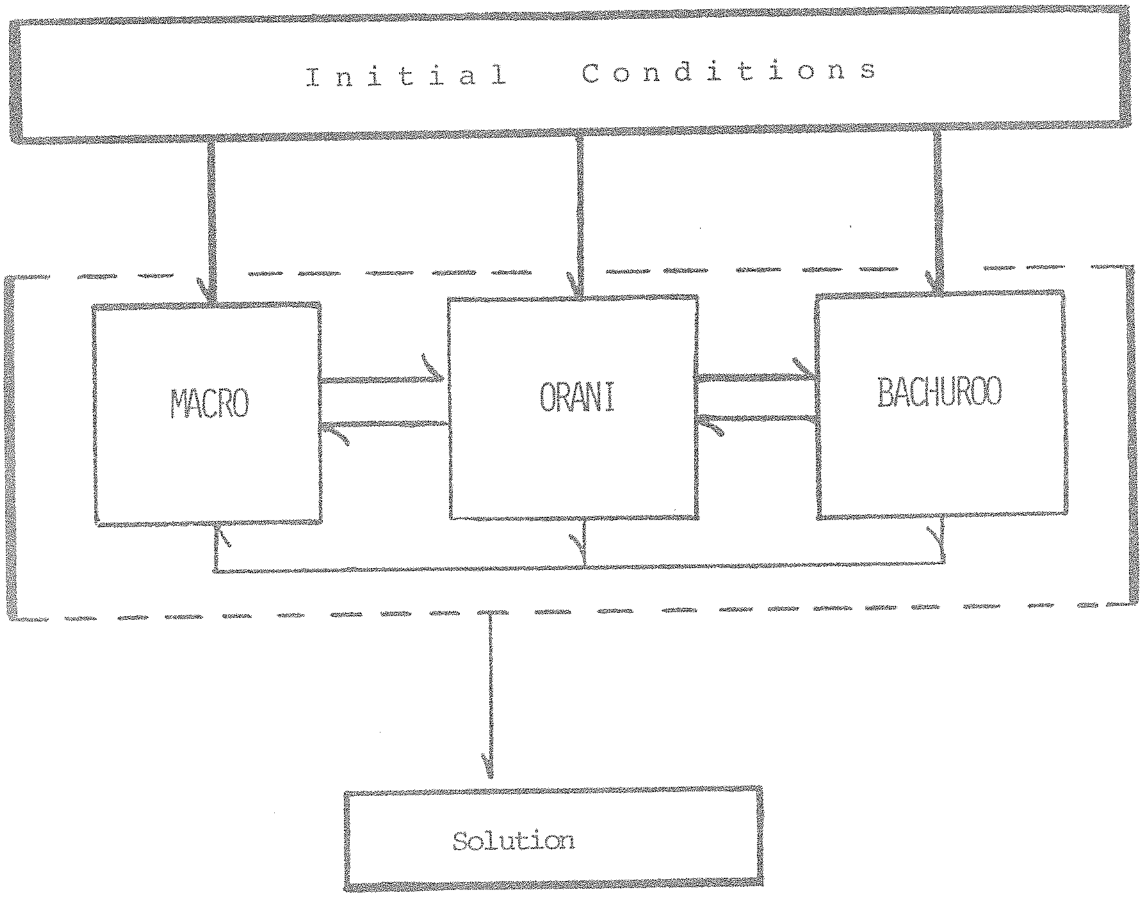

Figure 1 : Schematic view of modular structure of IMPACT's medium term model. The values of the main economic aggregates (consumption and investment) are determined in MACRO. ORANI disaggregates these into the industry composition of output, and also determines relative prices, international trade flows and labour demand. BACHUROO determines the population and labour supply.

it will endogenize the corresponding vector of labour supplies. The difference between these two vectors is to be interpreted as unemployment, or excess labour demand, depending on the sign. Alternatively, one can compute a full employment solution, solving for the implicit market-clearing vector of real wages.

The BACHUROO model is not yet complete. Its tasks are:

(i) to track the population at a detailed level of disaggregation by age, sex and marital status;

(ii) to endogenize household formation, marriages, divorces and fertility;

(iii) to endogenize labour force participation and the overall workforce size and its composition by age and sex;

(iv) to disaggregate the workforce into nine or more occupational groups;

(v) to endogenize the number of hours of work which will be offered by employees as a function of offered wage rates and overtime conditions.

Particularly severe data problems have made (iv) especially difficult -- this is discussed below in Section 5. The other tasks are complete or well in hand.* Upon the successful completion of (iv), the various elements of the model will require interfacing.

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* On (i) see Sams <u>et al</u>. (1981); on (i), (ii) and (iii) see Sams (1979); on (ii) and (iii) see Filmer and Silberburg (1977), Williams and Sams (1981); on (iv) see Craigie <u>et al</u>. (1979), Williams (1980a); on (v), see Tulpulé (1980a, 1980b).

While awaiting the completion of BACHUROO, work has proceeded at the interface of ORANI and MACRO. New theoretical developments were necessary to allow the interfacing of a macrodynamic model with a comparative static general equilibrium model (Cooper and McLaren (1980, 1981)). Pending the completion of the medium term model as a whole, the ORANI and MACRO models can each be used in stand-alone mode for the analysis of a large range of policy problems, and indeed this has been done.* If labour supply is not limiting at the going set of wage rates -- unhappily, the actual case in Australia over the last seven years -- then BACHUROO is not needed to close the medium term model, an exogenous set of real wages being all that is necessary to close ORANI-MACRO. In the future the BACHUROO model may, however, become critical for the medium term model, depending upon the speed at which existing slack in the labour market disappears. And of course BACHUROO has an independent role to play in long term modelling.

Long Term Models

The SNAPSHOT model has relatively modest aims. It is designed to provide a systematic accounting framework allowing the consistency of scenarios erected about potential developments in the economy to be checked. It will, for instance, allow a set of assumptions about demography or technical change to be checked for internal consistency, and may be used to make projections for a

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* Some applications are listed below in Section 6.

relatively distant 'snapshot' year of the industrial composition of the economy and of the occupational composition of labour demand implied by the maintained assumptions. Due to its highly linear structural form, the SNAPSHOT model is not a suitable vehicle for the analysis of international trade. This model was fully developed by late 1979; it has been used in two recent studies by the Bureau of Industry Economics (BIE) for analysis of the long run impact of technological changes on the structure of Australian industry to 1990-91 (BIE (1981a)) and to support a discussion of past developments and future trends in Australian industry (BIE (1981b)). The BIE has assumed responsibility for the maintenance of the SNAPSHOT model. It is possible to use the SNAPSHOT model with the demographic core of the BACHUROO model, the latter supplying the demographic scenario underlying projections made with SNAPSHOT.

The ORANI model can also be used in a manner similar to SNAPSHOT in order to obtain a structural picture of the economy in a relatively distant future year. ORANI has now been through a second cycle of development, although, as explained above, not all of the desirable modifications have yet been made to convert it into an ideal long run model.* Like SNAPSHOT, ORANI in long run mode can be used in conjunction with the demographic core of BACHUROO. Unlike SNAPSHOT, ORANI can be used to endogenize international trade flows. The IAC has assumed responsibility for the maintenance of ORANI.

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* For a critical appraisal of the required modifications, see Vincent (1980).

TABLE 1

IMPACT Major Occupational Groups *

IMPACT Major Group	Sub-groups comprising Major Group	
1. PROFESSIONAL WHITE COLLAR	1. Scientists 2. Engineers 3. Medical	4. Societal 5. University Teachers 6. Secondary and Other Teachers with Tertiary Qualifications
2. PARA-PROFESSIONAL	7. Primary Teachers 8. Other Teachers	9. Para-medical 10. Creative
3. SKILLED WHITE COLLAR	11. Technicians 12. Government	13. Employers
4. SEMI-SKILLED & UNSKILLED WHITE COLLAR	14. Clerical 15. Sales	16. Semi-skilled Medical 17. Audio visual
5. SKILLED BLUE COLLAR, METAL & ELECTRICAL	18. Metal Trades 19. Electrical Trades	20. Instrument Trades
6. SKILLED BLUE COLLAR, BUILDING	21. Wood Trades 22. Brick, Stone & Glass Trades	23. Painter
7. SKILLED BLUE COLLAR, OTHER	24. Food Trades 25. Textile Trades	26. Printing Trades
8. SEMI-SKILLED & UNSKILLED BLUE COLLAR	27. Semi-skilled Metal & Electrical 28. Building 29. Drivers	31. Protective Services 32. Production & Process 33. Services 34. Labourers
9. RURAL WORKERS	35. Farmers	36. Farm Workers
10. ARMED SERVICES	37. Officers	38. Other Ranks
11. OTHER (N.E.C.)	39. Other (n.e.c.)	
12. NOT EMPLOYED	40. Not Employed, Not in Work Force	

* As revised (see Tulpulé, Manion and Strzelecki (1981)).

The first ten occupation groups above are very similar to the nine occupation groups used in previous IMPACT work (see Craigie (1979)). The main difference is the creation of a new occupation group viz. Para-professionals by splitting the previous major IMPACT occupation group No. 2 into two groups. The other, relatively minor change is in the allocation of Apprentices. Most apprentices are allocated to minor group no. 27 (Semi-skilled Metal & Electrical) rather than 34 (Labourers). The rest of the classification is substantially the same.

4. THE ROLE OF LABOUR STATISTICS IN MODELLING LABOUR DEMAND

In this section the approach is as follows. In the case of each model discussed, the initial step is to write down the equations specifying labour demands. The data supporting the estimation of the equations are then discussed. All of this is in the context of the disaggregation of the economy along input-output lines, and disaggregation of the labour force into IMPACT major occupational groups along the lines of Table 1.

The SNAPSHOT Model

In SNAPSHOT the requirements in man-years of the i^{th} type of labour $(i = 1, \ldots, 9)$ per unit real output in the j^{th} industry $(j = 1, \ldots, 109)$ are specified as exogenous coefficients L_{ij}. It follows then that the demand M_i for the i^{th} occupation can be known completely from the vector $X = (X_1, \ldots, X_{109})$ of industry outputs. The latter are determined by the general equilibrium solution of the model. For current purposes we need only note that the labour demands M_i are determined as

$$M_i = \sum_{j=1}^{109} L_{ij} X_j \qquad (i = 1, \ldots, 9) \tag{1}$$

The matrix $L = \left[L_{ij}\right]$ has to be estimated separately for any given snapshot (or projection) year. A common procedure is to start with an estimate based on a given historical year and then to modify these L_{ij} to reflect productivity improvements expected to take place between the base year and the snapshot year. This was the approach adopted by Dixon and Vincent (1980) and by the BIE (1981a,b). A variety of sources of information is used to estimate these productivity improvements, including judgements by industry experts and historical trends observed locally and overseas -- for further details see BIE (1981a). The historical year chosen for the establishment of a bench-mark matrix L was 1971. This was in order to use information from the ABS Census of Population and Housing of June 1971. Special purpose tabulations made available by the ABS allowed the L_{ij} to be estimated. Recent work by the IAC (Tulpule, Manion and Strzelecki (1981)) has made it possible to update this matrix using the 1976 Census as the basic source, but supplementing this with information from the Integrated Economic Censuses, the Labour Force Surveys and the ABS Civilian Employees series.

While labour statistics do not enter SNAPSHOT via routes other than equation (1), household and demographic statistics do so. SNAPSHOT recognizes nine household types, each with its own consumption pattern determined by a group-specific set of demand parameters. The latter were estimated by Williams (1978) from the ABS Household Expenditure Survey, 1974-75. These parameters influence labour demand through their effect on the vector X of industry outputs.

The ORANI Model

The labour demand equations in ORANI are more complex because they allow factor price substitution. In particular, at a given output level a rise in the price of labour relative to capital will cause a substitution of capital for labour. Similarly, if the wage of occupation 3 rises relative to the wage occupation 5, the latter class of labour will be substituted for the former.

The labour demand equations in ORANI are more easily discussed in terms of percentage changes than in terms of levels. The labour demand of any given industry can be considered at two levels: labour in general (a scalar) and the set of nine* occupations recognized in ORANI (a vector). The two are related by the index number formula,

$$n^{(j)} = \sum_{i=1}^{9} W_i^{(j)} n_i^{(j)} \qquad (j=1, \ldots, 113 \text{ industries}) \qquad (2)$$

in which $n^{(j)}$ is the percentage change in demand (man-hours) by industry j for labour in general, $n_i^{(j)}$ is the percentage change in the demand (man-hours) by industry j for the i^{th} occupation, and the $W_i^{(j)}$ $(i = 1,\ldots,9)$ are the shares of the occupations in industry j's overall wage bill. These shares are base-period data for the model and are derived from ABS sources. The preferred method makes use of most of the relevant data available from ABS Input-Output statistics, the Integrated Economic Censuses, the Labour Force Surveys; for details see Tulpulé, Manion and Strzelecki (1981).

The demand equations for labour in general in ORANI may be written:

$$n^{(j)} = x_j + \sigma S_{Kj}(r_j - w^{(j)}), \qquad (3)$$

where, to keep matters simple, we have chosen a non-agricultural industry j. This allows us to avoid the complications which arise in multi-product industries and to concentrate on just two primary factors: labour and capital. On the right of (3) x_j is the percentage change in the output of industry j, σ is the elasticity of substitution between capital and labour, S_{Kj} is the share of capital in the value added by industry j, r_j is the percentage change in the rental price

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*In our most recent work, 11 working occupations are distinguished. See Table 1.

of capital in industry j (usually imputed as a residual), and $w^{(j)}$ is the percentage change in an index number of the cost of labour in industry j. This labour cost index is computed as

$$w^{(j)} = \sum_{i=1}^{9} W_i^{(j)} w_i \qquad (j = 1, \ldots, 113) \tag{4}$$

where the w_i $(i = 1, \ldots, 9)$ are the percentage changes in the wage rates of occupations i. These percentage changes in wage rates are assumed to be specific to occupations, but not to depend on industry of employment (a surmise substantially supported by the data*).

How is one to interpret equation (3)? Suppose the relative prices of labour and capital in industry j does not change. Then the expression $(r_j - w^{(j)})$ is zero. In this case j's use of labour expands at the same percentage rate as its output; i.e., $n^{(j)} = x_j$. Since σ is positive -- in typical short run applications it is set at the value 0.5, although ABS cross sectional industry data leads to a higher estimate (1.3) for long run work (Caddy (1977)) -- any rise in the price of labour relative to capital will lead to labour demand in industry j expanding slower than its output $(n^{(j)} < x_j)$.

Demand for particular types of labour by industry j is obtained by disaggregating $n^{(j)}$. This disaggregation is also influenced by relative prices.

$$n_i^{(j)} = n^{(j)} - \Theta(w_i - \sum_{k=1}^{9} W_k^{(j)} w_k) \tag{5}$$

On the right of equation (5) there are two terms. The second of these is zero if relative occupational wages do not change. In that case the demand by industry j for every occupation expands or contracts by the same rate, $n^{(j)}$, as the demand by that industry for labour in

*Parham and Ryland (1978).

general. The parameter θ is the elasticity of substitution (assumed common for each of the 36 pairs of occupations).* It is a positive number, estimated at 0.35 from special tabulations obtained from the ABS Income Distribution Surveys 1968-69 and 1973-74 and from Labour Force Surveys (Higgs, Parham and Parmenter (1981)). If the wage rate of occupation i were to rise two per cent faster than the cost of labour in general in industry j, then the term in parentheses on the right of equation (5) would take the value 2. Thus the change in the demand for occupation i by industry j would be 0.7 per cent less (0.35 x 2) in that case than if no change had taken place in relative wages.

The total demand for labour of type i in ORANI is obtained by summing demands for this type of labour over industries. In percentage change terms we would take the appropriate weighted sum over j of the $n_i^{(j)}$ as determined by equation (5).

Do labour statistics also enter this picture indirectly via the influence of the output changes $(x_1, \ldots, x_{113})$, the wages $(w_1, \ldots, w_9)$ and the rental prices of capital $(r_1, \ldots, r_{113})$? Indeed they do. The solution values of these variables in any given simulation are a function of all of the elements of the model's data base and parameter file, including each of the items discussed above.

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* ORANI does not require this assumption. It is made here for ease of exposition.

5. THE ROLE OF LABOUR STATISTICS IN MODELLING LABOUR SUPPLY

The BACHUROO Model

Naturally enough it is in IMPACT's labour supply model, BACHUROO, that labour statistics find their biggest role. It is here that disaggregated information on the labour market is most useful, and its absence most damaging. Unfortunately the set of structural information on the labour market collected by the ABS is very far from ideal (Mumme et al. (1978)).

The BACHUROO model is conveniently discussed under three main headings: the demographic core, occupational disaggregation of the workforce, and leisure vs hours worked.

The Demographic Core*

It is the task of the demographic core to provide projections:

(i) of the population, cross classified by sex, marital status and single years of age;

(ii) of the workforce, by sex, marital status and three age groups;

and

(iii) of the number of households, by the sex, marital status and quinquiennial age group of the household head.

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* In this and the following two sections I draw heavily on Powell (1980).

For these purposes conventional demographic accounting techniques are the basic tool; the framework has been extended, however, to allow an econometric model to endogenize changes in the behavioural characteristics of the population in response to exogenous changes in the social and economic environment. The linkages between the econometric model and the demographic accounting equations involve variables such as the propensities to marry, divorce, and remarry, as well as the means and variances across ages at given points in time of the number of first nuptial confinements and of 'desired' family size. These propensities, means and variances are endogeneous variables in the econometric model; their values enter the population projections via the demographic accounting equations where they appear as time-dependent parameters of the age distributions of important demographic characteristics. The econometric model itself (Filmer and Silberberg (1977)) is built along the lines of the 'new home economics' (Schultz (1973)).

The data base supporting the demographic accounting equations is based extensively on the Australian Demographic Data Bank of the late Horrie Brown and of Alan Hall (1978, 1980). This data bank has been built at the Australian National University in order to fill one crucial gap in the official statistics; namely, the lack of an official reconciliation of the population stock data at Census dates with the regular estimates of the flows of demographic events (as formerly published in the ABS _Demography_ series*). The demographic accounting equations of BACHUROO, as based on the Australian Demographic Data Bank, have been tested against the ABS population projection facility as benchmark (Sams _et al_. (1981)). The two facilities when presented with

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* This series was discontinued in 1971. Since then separate publications have covered _Births_, _Deaths_, _Marriages_ and _Divorces_.

identical scenarios on demographic parameters produce virtually identical results (although the IMPACT projections provide more detail).

The data base supporting the econometric model has been documented in detail by Brooks (1981). The principal sources of these data were official statistics on demography, education, the labour force and national income; where necessary the latter have been supplemented by unofficial data series. For example, Keating (1973) was the source of labour force participation rates and unemployment rates 1921-22 to 1960-61. While there are too many equations relating to labour supply in the demographic core to list here, something of their flavour can be gleaned from Table 2. This shows schematically the form of the equations explaining the labour force participation of women in different age groups and of different marital statuses.

Occupational Disaggregation

Given the size of the workforce, what could we expect its occupational composition to be at any given set of wage relativities, if people were able to locate themselves in the most preferred occupations for which they are formally qualified? The answer to this depends on the length of run envisaged. In the annual framework used in BACHUROO, one takes the educational endowments as given. In the longer run, individuals and the (largely public sector) education system can vary the occupational mix. The lack of a suitable data base makes modelling the education system in Australia extremely difficult. To obtain even an eleven year series of Australian student statistics on a compatible basis required a major input by the project team itself in primary data compilation and editing (see Craigie (1980)). At least for the foreseeable future, the throughputs of the educational sector will be treated exogenously.

TABLE 2

Schematic Outline of Equations Explaining Female Labour Force Participation Within The Demographic Core of The BACHUROO Model

Labour Force Participation rate of Women		Predetermined Variables :										
Age Group (years)	Marital Status	No. Chldrn <15 yr per married woman (K)	Index of child Quality (Q)	W't'd Nupt'l confinement Rate (C)	♀ hrly Wage Rate (W)	Index ♀ Labour Demand (L_D)	Unemployment Rate (U)	Old Age & Invld Pension Rate (G_a)	Widows' Pension Rate (G_w)	♀ Educ'n Participation Rate (e)	World War II Dummy (Z_2)	Pdt of Cols (1) & (2) (KQ)
15-24	married	(see last col'n)		√	√	√	√				√	√
15-24	other				√	√	√		√	√	√	
25-24	married	(see last col'n)		√	√	√	√				√	√
25-24	other				√	√	√		√		√	
55+	married				√	√	√	√			√	
55+	other				√	√	√	√	√		√	

Abbreviations: No., number; < less than; yr, years old; W't'd, weighted; Nupt'l, nuptial; ♀, Female; Invld, invalid; Educ'n Participation Rate, education participation rate of Other women aged 15-24; pdt, product; Cols, columns; col'n, column.

Notes: The endogenous variable in all cases is the logistic transform of the labour force participation rate of the group shown. The predetermined variables are logged and entered linearly on the right hand side of the participation equations. The weighted nuptial confinement rate variable takes a weighted sum of the confinement rates of married women in the current and the previous four years and attempts to measure the number of children under 5. The index of female labour demand is calculated as the ratio of total employment (all persons) to the male labour supply. A √ in a given row and column indicates that a particular predetermined variable appears as an explanator of the labour force participation rate. Where the logs of K and Q enter equations, they do so with the same coefficient.

The flavour of our approach to occupational disaggregation can be illustrated by Williams' (1980a) treatment of within-year inter-occupational mobility. Net transfers into the j^{th} occupation desired by appropriately qualified people currently in the workforce are denoted $SM_{.j}$, where $j = 1,...,9$ refers to a nine group aggregation of the occupational split shown in Table 1. "Desired" in the last sentence means desired by those who would transfer if the opportunity became available, and who are formally qualified to make the transfer. In the case of a potential transferee to two or more occupations other than the one currently occupied, only the most preferred transfer is counted in $SM_{.j}$. The net desired flow of these transferees, at the given conditions of employment, from occupation i to occupation j is SM_{ij}. Thus, by construction

$$- SM_{ij} \equiv SM_{ji} \tag{6}$$

$$SM_{.j} \equiv \sum_i SM_{ij} \tag{7}$$

Given the skill endowments of the workforce at the beginning of the year, there exists a schedule (viz., a transformation frontier) defining attainable occupational mixes. The paradigm adopted by Williams assumes that year-to-year movements in the desired occupational mix maintain equilibrium in the sense that the certainty-equivalent occupational wage bill is maximized in the light of the prevailing expected certainty equivalent wage relativities $\{R_j\}$ (which are taken as predetermined). Here the 'certainty equivalent' wage rate for occupation j means the actual after-tax wage rate in j multiplied by 1 minus the occupation-specific unemployment rate. "Expected" operationally implies that actual lagged data are used.

This basic mechanism is illustrated in Figure 2. Q_1 and Q_2 respectively are the supplies of workers in occupations 1 and 2. The movement from A to B is seen as a response to a change in the ratio of certainty equivalent occupational wage rates , R_1/R_2 , from tan Θ_A to tan Θ_B. Changes in certainty equivalent wage rates, therefore, are identified with shifts around the transformation frontier.

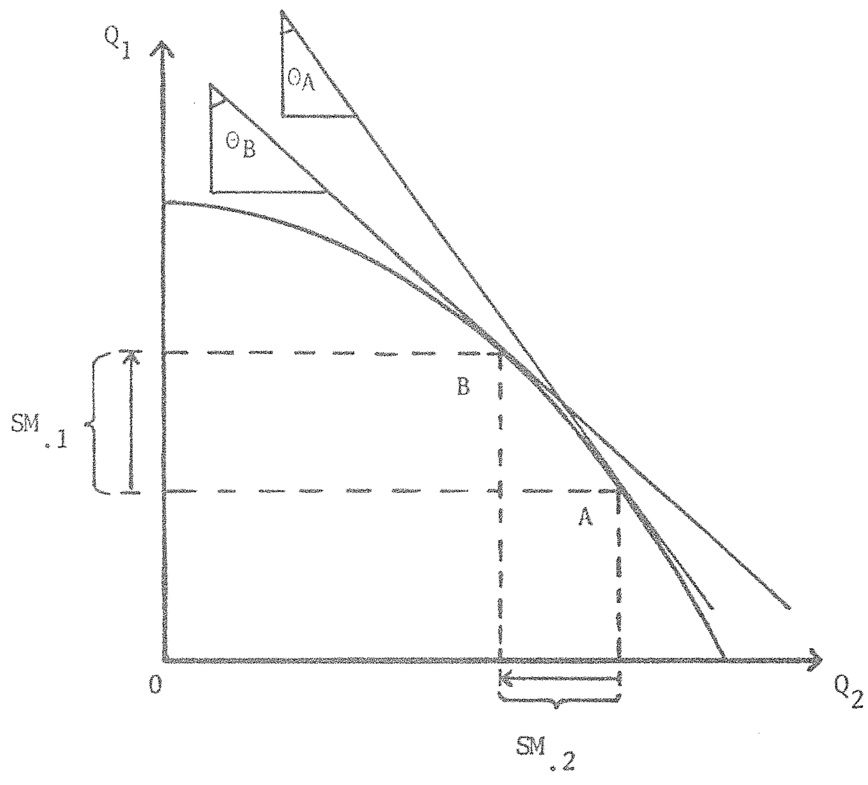

Figure 2 : Occupational transformation frontier in 2-occupation case. Initially the certainty equivalent occupational wage ratio (R_1/R_2) is tan Θ_A. This ratio then changes to tan Θ_B, resulting in a new equilibrium occupation mix at B.

It is supposed that apart from certainty equivalent wage rates $\{R_1, \ldots, R_9\}$, there are K other explanatory variables $\{N_1, \ldots, N_K\}$, which generate changes in occupational labour supplies $\{Q_1, \ldots, Q_9\}$. These other explanatory variables are to be identified with shifts of the occupational supply frontier in Figure 2 rather than with shifts around it. In the absence of suitable data, the $\{N_k\}$ in the empirical work are proxied by log-linear trends. In pragmatic spirit, it is assumed that a double-log functional form,

$$d \log Q_j = \sum_{i=1}^{9} \eta_{ji} \, d \log R_i + \sum_{k=1}^{K} \varepsilon_{jk} \, d \log N_k \tag{8}$$

will yield an adequate approximation to the supply functions. Parametric restraints induced by assumptions concerning the functional form of the transformation frontier reduce the 81 wage coefficients $\{\eta_{ji}\}$ to a more manageable number. In the case of the CRETH (Dixon (1976)) transformation frontier, these 81 coefficients are reduced to just nine transformation parameters (Craigie, Parham and Ryland (1979)). In the case of the extremely meagre data base available for fitting (8), however, nine parameters were too many; consequently Williams (1980a,b) fitted a CET (constant elasticity of transformation) transform of (8). Under this specification, the 81 coefficients η_{ji} can all be expressed as functions of just one unknown transformation elasticity, τ. Using the approximation

$$d \log Q_j \doteq SM_{.j}/Q_j \tag{9}$$

and using the CET postulate to constrain the η_{ij} coefficients to be

$$\eta_{ij} = \tau S_j \quad \text{for all } i \quad (j \neq i) \tag{10}$$

and

$$\eta_{ij} = -\tau(1 - S_j) \tag{11}$$

where S_j is the share of occupation j in the certainty equivalent wage bill, the best estimate obtainable from the data is $\hat{\tau} = -1.3$ ($t = 3.6$). Via equations (10) and (11) this estimate enables the $\{\eta_{ij}\}$ to be estimated. This brief account, it should be noted, has not dealt with the extremely difficult problem of generating data on the supply of transferees, $\{SM_{.j}\}$ as distinct from the actual number of transfers. Given the undoubted existence of a non-market clearing wage structure in one of the two years for which data were available, the natural starting point was Fair and Jaffee (1972). Strong priors on labour demand plus data on unemployment were essential ingredients in development of the $\{SM'_{.j}\}$. Readers requiring further details should consult Williams (1980a).

The remaining element of flexibility in the occupational mix not captured in Williams' work is that due to the flexibility of new workforce entrants. Although when an individual commits himself to a particular stream of higher education and/or vocational training he may have in mind a preferred occupation which he would like to enter upon graduation, he may nevertheless settle for another occupation if jobs are easier to find in it and/or if this other occupation commands higher relative wages at graduation than were expected at the time the educational decision was taken. His flexibility will be limited only by the formal requirements for entry into the various occupations. Thus the work planned by Craigie, Parham and Ryland (1979), and currently under way, uses an approach similar to the one described above.

It is in the occupational disaggregation area that the necessary labour statistics are hardest to come by. First, the occupational categories used in ABS compilations are far from ideal, bearing little relationship to skill level or formal educational and/or trade requirements for entry into an occupation.* It was this unsatisfactory state of affairs that led to the development of the IMPACT classification (Table 1) and to the ongoing ABS-DEYA(Department of Employment and Youth Affairs) occupational classification project. Second, the total stock of data capable of yielding details of IMPACT occupational affiliations of employees is extremely limited. Quinquiennial Censuses, it is true, when specially retabulated by the ABS to IMPACT specifications, do give a suitable disaggregation of the workforce. Also, special Labour Mobility Surveys by the ABS (conducted in 1972 and 1975) have provided valuable primary data which have been used by Williams (1980). But we have seen above that the theory also requires data on occupational wage relativities. These data have proved the most elusive of all. Williams' 1980 work and other work within the IMPACT Project (Higgs, Parham and Parmenter (1981)) has used two sets of data, one for 1968-69 and the other for 1973-74, based on the ABS Income Distribution Surveys conducted in August 1969 and August 1974. This extremely fragmentary data has had to bear the burden of all estimations of the effects of changes in relative wages on the labour market, on the demand side as well as on the supply side. Clearly this situation is totally unsatisfactory.

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* See Craigie (1979).

Leisure versus Hours Worked

In the last two sections I have described our approaches to the determination of the size and age structures of the population and workforce, and to the occupational composition of the latter. What remains to be discussed is the endogenization of the number of hours supplied by members of the workforce having a given occupational affiliation.

The framework adopted is the standard neo-classical labour-leisure choice paradigm in which the shadow price of 'leisure' is the wage rate foregone for an additional hour of work voluntarily declined. Early references include Robbins (1930), Paish (1941), and Gilbert and Pfouts (1958). For more recent contributions see Betancourt (1973), Abbott and Ashenfelter (1976), Phlips (1978) and Barnett (1979). Because of the increasing importance of part-time work and of progressive income tax scales and penalty rates for overtime, the required paradigm cannot, as in the early literature, take the after-tax marginal wage rate as an exogenous constant which is independent of the number of hours worked. Powell, Tulpulé and Filmer (1977) extended the standard framework to allow the after-tax marginal wage to be an arbitrary twice-differentiable function of the number of hours worked. This was in the context of a Klein-Rubin utility function. Burtless and Hausman (1978) worked with an arbitrary, not necessarily convex, budget constraint, and with a particular utility function (namely, the one implied by a constant elasticity labour supply function). Woodland and Wales (1979) also considered an arbitrary budget constraint allowing for endogenous variations in the shadow price of leisure. Their utility specification was CES. Finally, Powell (1979) gave a general treatment of the problem in which both the hours/earnings offer curve and the utility function are arbitrary. This last-mentioned paper covers all cases of movements in the supply of hours of an individual which are induced by changes in the parameters of the hours/earnings curve and/or of the utility function, except those changes involving discrete jumps and corner solutions. The extension of the conceptual framework to handle the latter is trivial; its empirical implementation, however, would involve a much stronger data base on the distribution of household characteristics than is available in Australia.

Basic to the estimation of the labour-leisure choice model are panel data, or at the very least, time series data on hours worked by members of households with different demographic characteristics. Such data are not available in Australia. Tulpulé (1980a) has made the best of available Australian aggregate time series data on hours worked combined with a good deal of extrapolation from fragmentary evidence in order to differentiate basic behavioural parameters by household type. The primary data sources utilized are the regular Labour Force Surveys, the infrequent Income Distribution Surveys, and the annual Surveys of Weekly Earnings and Hours. Data from the last mentioned source were retabulated by the ABS in order to estimate the relationship between the marginal wage rate and the number of hours worked by employees belonging to occupationally homogeneous groups (Tulpulé (1980b). This relationship is potentially of importance in explaining changes in the supply of hours which members of the work-force would be willing to work due to changes in their conditions of employment. Of major importance among the latter are standard hours, basic hourly rate of pay, and scale of overtime premia.

6. ILLUSTRATIVE APPLICATIONS

The IMPACT models have been built mainly for policy analysis rather than for forecasting. They may occasionally find use in the latter role, but that is not their primary objective. The principles of model design followed by the team reflect this emphasis on policy analysis -- for a further discussion see Powell (1981).

Three illustrative examples of the use of the models are given: one from ORANI, one from SNAPSHOT and one from BACHUROO. Each of these uses represents the attempts of the IMPACT team to provide answers to hypothetical questions. The three examples deal respectively with these questions:

(a) What inter-occupational mobility would be required to accommodate a twenty-five per cent cut in the levels of protection provided to the textiles, clothing, footwear, and motor vehicles industries? (ORANI)

(b) What changes in the structure of the workforce would be brought about over the next decade by currently anticipated changes in the techniques of production of various industries? (SNAPSHOT)

(c) How much inter-occupational mobility would be offered by the members of the existing workforce in response to a change in the relevant wage relativities? (BACHUROO)

Each simulation is carried out with <u>all other things equal</u>. The exact specification of these <u>ceteris paribus</u> conditions is beyond the scope of this chapter; they are fully spelt out in each of the primary sources quoted. Brief guiding remarks are, however, offered below. below.

Tariff Reform and Required Labour Mobility

The framework in which these ORANI simulations were mounted is as follows. A tariff reform which results in shaving a quarter off the protection levels of our most highly protected industries is implemented simultaneously with the application of fiscal and monetary policies. The latter are varied so as to keep the total level of employment demand in the economy constant, at least in the sense that after an adjustment period of about two years, the buoyancy of the labour market as a whole is comparable to the situation before the tariff reform is enacted. The tariff cut thus has the effect of redistributing jobs from the least internationally competitive industries to the rest of the economy. From equation (5), which is embedded in the very large simultaneous system comprising ORANI, we obtain the percentage changes in the demand by different industries for the different occupations. These results are brought about by the mechanisms outlined above in Section 4. By aggregating over all industries in the economy we can calculate the net changes in the demands for each occupational type.

The results of this simulation are given in Table 3. Separate columns give the projected effects of the cuts in protection of the motor vehicles, and of the textiles/footwear/clothing sectors. The sums of all changes are zero -- this is built into the simulation by requiring that the total of consumption, investment and government spending should change, if necessary, to be at a level which is consistent with no overall change in the number of jobs available.

One should be careful not to interpret Table 3 as a set

TABLE 3

Occupational Redistribution of Labour Demand Resulting From a 25 per cent Cut in Protection of Industries in The Textiles, Footwear, Clothing and Motor Vehicles Sector [(a)]

Occupational Group	Reallocation of Labour Demand due to Changed Levels of Protection on:					
	Motor Vehicles		Footwear, Clothing Textiles		Total	
	(per cent)	(No.of jobs)	(per cent)	(No.of jobs)	(per cent)	(No.of jobs)
1. Professional	+.005	10	+.032	64	+.036	74
2. Skilled White Collar	-.028	-220	+.003	24	-.025	-196
3. Semi- & Unskilled White Collar	-.021	-349	+.013	215	-.009	-134
4. Skilled Blue Collar (Metal & Electrical)	-.212	-1,318	+.080	494	-.132	-824
5. Skilled Blue Collar (Building)	-.059	-152	+.018	46	-.041	-106
6. Skilled Blue Collar (Other)	+.074	121	-.345	-566	-.270	-445
7. Semi- & Unskilled Blue Collar	-.015	-271	-.067	-1,211	-.082	-1,482
8. Rural Workers	+.445	2,210	+.187	923	+.632	3,133
9. Armed Forces	-.030	-31	+.011	11	-.020	-20
Sum of Changes		0		0		0
Weighted Sum of Changes	0		0		0	
Number of people required to change occupation [(b)]		2,341		1,777		3,207

(a) Total employment demand constrained to total 6.1 million persons.

(b) 'Occupation' here defined by groups in column above. Note that a larger number would be required to change occupations if the latter were more finely disaggregated.

Source: Dixon, Powell and Parmenter, (1979), p.69.

of forecasts. Consider the last column, eighth row. The entry 3,133 does not mean that it is believed that the number of jobs for rural workers will increase by about three thousand. The actual change in the number of such jobs is the result of many factors, not just the tariff change. Certainly we would expect the secular decline in the relative size of the rural workforce to continue. The significance of the entry in the Table is the inference that about 3,000 more jobs would be available for rural workers if the tariff reform went ahead than would be the case if it didn't.

Technical Change and the Pattern of Labour Demand

In Section 4 an abbreviated account was given of the determination of labour demand in the SNAPSHOT model. This model has been used by the IMPACT team (Dixon and Vincent (1980)) and by the Bureau of Industry Economics (BIE) (1981a,b) to estimate the effects of the adoption of new techniques of production which can be foreseen at this stage. As far as the model is concerned, these changes are represented by changed input requirements of the various types of labour, and of capital, per unit of output in the various industries. The results of supplying the SNAPSHOT model with BIE scenarios on technical change and on demographic change are shown in Table 4. Demographic change enters the picture through its effect on the structure of the demand for commodities. Relative to the technological changes, it produces second order effects.

The results given in Table 4 are a good deal closer to forecasts than those of Table 3. They are, nevertheless, not forecasts in the full sense of the word. That is to say, the BIE is not claiming

TABLE 4

Projected Change in the Occupational Structure of the Workforce 1990-91 Due to Foreseen Technical Changes

Occupational group	Actual number employed 1971–72 ('000)	Percentage contribution to total employment	Projected number employed 1990–91 ('000)	Percentage contribution to total employment	Average[a] annual employment growth
Professional white collar	193.3	3.8	318.4	4.1	2.7
Skilled white collar	668.9	13.1	1 199.3	15.5	3.1
Semi- and unskilled white collar	1 367.3	26.8	1 852.2	23.9	1.6
Skilled blue collar—metal and electrical	516.5	10.1	822.6	10.6	2.5
Skilled blue collar—building	202.3	4.0	363.7	4.7	3.1
Skilled blue collar—other	142.8	2.8	214.7	2.8	2.2
Semi- and unskilled blue collar	1 539.6	30.2	2 403.9	31.0	2.4
Rural workers	402.6	7.9	481.0	6.2	0.9
Armed services	65.7	1.3	96.0	1.2	2.0
Total	5 098.6	100.0	7 751.8	100.0	2.2

Note (a) The employment growth figures represent the average annual growth rates over the period 1971–72 to 1990–91. Actual growth figures for any particular year may show considerable variation from the figures shown.

Source : Bureau of Industry Economics (1981(a)).

that the only developments of relevance to the shape of the economy in a decade's time are technical and demographic changes which are foreseeable at this stage. Departures from the figures of Table 4 could be expected for any one of a large number of reasons. The projections give a picture of what the economy would look like if the maintained assumption were in fact satisfied. With these cautions in mind we see that within an overall growth rate of the workforce as a whole of 2.2 per cent per annum, there is expected to be fairly wide variation across occupations. The fastest growing occupations are projected to be skilled white collar, and skilled blue collar construction workers (3.1 per cent p.a. each), while the slowest growing are semi-and unskilled white collar (1.6 per cent p.a.) and (expectedly) rural workers (0.9 per cent p.a.).

Relative Wages and Occupational Supply

Changes in relative wages, we have seen in Section 5, can be expected to lead some employees who are qualified to change their occupations to decide to do so. Williams (1980a,b) estimated the size of these effects. They are conveniently summarized in Table 5. Because the data in this area are so weak, an extraordinary amount of ancillary data analysis and economic theory were required to reach the results in Table 5. In my judgement they represent the best estimates of the supply of transfers from within the workforce that can be made with the available evidence. The Table, incidentally, does not imply that all of these people would actually move; that would depend also on demand conditions in the labour market.

TABLE 5

Estimated Supply of Male Transferees into Different Occupations due to a 10 Per Cent Increase in the Expected Certainty Equivalent Wage Rate in the Destination Occupation

Destination Occupation whose Expected C.E. Wage Rate Changes	Nett inflow of Transferees from other Occupations*
Professional White Collar	21,500
Lecturers and Teachers	11,300
Skilled White Collar	52,300
Semi- and Unskilled White Collar	66,600
Skilled Blue Collar: M & E	66,900
: Building	33,300
: Other	13,900
Semi- and Unskilled Blue Collar	115,900
Rural	31,300

*Male employment constrained to 4.24 million persons. Base period shares of workforce taken at 1974 values. All other expected certainty equivalent (C.E.) wage rates are held constant. The response period is one year after the new certainty equivalent wage rates are established.

Source: Based on Williams (1980b), p.110.

7. CONCLUDING PERSPECTIVE

Economic and demographic models are a useful device for organizing what we know about the labour market and for drawing inferences from this body of knowledge in a systematic way. Such models are, of course, data hungry. One possible reaction to this aspect of modelling is to decide that the exercise is not worth the trouble (i.e., that it is too expensive). Yet a very large number of important questions in economic policy and in public administration simply cannot be answered without a suitable information system. Such a system presupposes an integrated body of data collected and maintained in anticipation of their being used by policy modellers and forecasters.

The Australian data base in some areas is relatively good. The establishment a decade or more ago of an integrated set of industry statistics greatly improved the ease with which data collected by the Australian Bureau of Statistics could be used to support economic analysis of industry structure. The compatability of these data with the national input-output accounts of course contributed to this. And again, Population Census data are relatively good. In the labour area on the other hand, Australian statistics are both sparse and extremely poorly integrated. As an expert Committee put it,

> "... there are serious deficiencies in the information presently available for analysis of the operations of the Australian labour market. Due to incompatibilities in classifications, data concepts and coverage, many of the relevant series cannot be brought together on a valid

> basis for analytical purposes; there are major gaps in the information; and in many cases important information is available only intermittently and/or in such highly aggregated industry, occupation and regional detail as to make it extremely difficult to analyse labour market behaviour." (Mumme et al. (1978),p.47)

The Committee's views are consistent with the experience of the IMPACT Project. The most serious difficulties encountered in attempting to model the labour market (especially within the BACHUROO model) were due to the unsatisfactory nature of the data, especially those based on the Labour Force Surveys. Data manipulation and editing in this area would account for well over half of IMPACT's total research input.

The brief descriptions above give only a glimpse of the IMPACT models. Their potential uses are extremely wide. The ORANI model, for instance, has been used to analyse (among other issues) the following: the consequences for industries, occupations and regions of economy-wide and selective changes in industrial tariffs; the consequences for the macroeconomy and for industries, occupations and regions of Keynesian demand stimulation policies and of real wage restraint; the consequences for the structure of the Australian economy of (a) a boom in our resources-based export sector, (b) changes in the prices of internationally traded commodities produced in third world countries (Dixon, Powell and Parmenter (1979)), (c) the OPEC-induced rises in the world price of oil (Vincent et al. (1979b), (d) a move to equal pay for women (vis-á-vis men doing the same or similar work) Dixon, Parmenter and Sutton (1978)), (e) a change in Australia's domestic oil-pricing policy (Vincent et al. (1979a)), and (f) the introduction of a two-price scheme for an Australian agricultural product (Parmenter et al. (1981)). The effects on workers of different ethnic origins of changes in Australia's commercial policy have also been analysed using ORANI (Cook and Dixon (1982)*). The BACHUROO model, which is not yet complete, has been used to project the size of the workforce to the turn of the century (Industries Assistance Commission (1981)).

The usefulness of a policy information system such as IMPACT depends critically on the following:

(i) The technical quality of the models

(ii) The extent to which the models are understood, at least in broad terms, by policy makers and by the general public

(iii) The coverage of the models

(iv) The timeliness and reliability of the data upon which the models are constructed.

We try to assure item (i) by exposing our work very widely to other professionals, and by competing with them for space in learned journals. This chapter has been written in the hope that it will increase (ii), give an idea of (iii) and help secure a favourable outcome with respect to (iv).

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* Forthcoming.

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