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ASPECTS OF LABOUR MARKET THEORY AND BEHAVIOUR HIGHLIGHTED BY IMPACT PROJECT STUDIES

by

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The views expressed in this paper do not necessarily reflect the opinions of the participating agencies, nor of the Commonwealth government

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two points of view. First, if well done, it would provide a frame of reference for diagnosis of problems in the performance of more aggregative, less well founded, models. Secondly, using arbitrary (but not ridiculous) sets of parameters in the model, it would be possible to learn a good deal about the behaviour of the household sector from simulation trials. One would be able to identify, for instance, which elements of the model might safely be modelled (under typical settings of the exogenous variables) at the aggregate level. I think it would be a healthy development if some of the first class theorists with which the Australian economics profession is endowed were to turn to empirically motivated work of this type.

ASPECTS OF LABOUR MARKET THEORY AND BEHAVIOUR HIGHLIGHTED BY IMPACT PROJECT STUDIES

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Alan A. Powell*

1. Introduction

The IMPACT Project's economy-wide modelling framework naturally includes models of the demand for labour and for its supply. The former is treated in ORANI[1], a computable general equilibrium (CGE) model in the Johansen class.[2] In stand alone applications of the ORANI model, labour market closure is handled in one of two ways. Either wages are supplied exogenously, in which case the model endogenizes employment demands; or alternatively, if employment demands are supplied exogenously the model endogenizes wages. Wages are occupation-specific; disaggregation at least as far as a dozen occupations is possible in ORANI, although in some applications further disaggregation has been carried out.[3] Disaggregation of employment by 113 industries, as well as by occupation, is available in ORANI. However this model does not presently disaggregate person-hours demanded into persons and hours per person.

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* With the usual admission of sole responsibility for errors, I wish to thank Peter Higgs, Mike Kenderes, Tony Lawson, Dean Parham, Brian Parmenter, Dennis Sams, Ashok Tulpulé and Lynne Williams for helpful comments; and Henry Gardner and Dean Parham for computing assistance.

1. P.B. Dixon, B.R. Parmenter, J. Sutton and D.P. Vincent, ORANI, A Multisectoral Model of the Australian Economy (Amsterdam: North-Holland, 1982).
2. Leif Johansen, A Multisectoral Study of Economic Growth (Amsterdam: North-Holland, 1960).
3. E.g., Larry H. Cook and Peter B. Dixon, "Structural Change and Employment Prospects for Migrants in the Australian Workforce", Australian Economic Papers (forthcoming).

The supply of labour is modelled in BACHUROO, not yet omplete. This model is a synthesis of three main ingredients:

(a) conventional demographic accounting techniques (as extended by IMPACT team researchers),

(b) a 'new home economics' treatment of family decision making in the interrelated areas of marriage, fertility, and female workforce attachment,

(c) neo-classical approaches to the labour/leisure choice and to inter-occupational mobility and workforce composition inspired more by the system-wide approach to micro-economics than by the new-home economics.

Novel elements in this approach are detailed in a separate paper giving an overview of BACHUROO[1].

This paper is not primarily about labour supply or labour demand; rather its aim is to draw together theoretical and empirical results relevant to our understanding of the labour market. Since IMPACT as a Project has been large enough in its scope to require a comprehensive view of the labour market, our contributions are to be found in several areas. Since, on the other hand, the Project has not been big enough to carry out work in all important areas (for the last three years, the full time staff on BACHUROO has never exceeded two researchers), inevitably our coverage is patchy. This makes it difficult to organize this

1. Alan Powell, "Aspects of the Design of BACHUROO, An Economic Demographic Model of Labor Supply", in A.C. Kelley, W.G. Sanderson and J.G. Williamson (eds), Modeling Growing Economies in Equilibrium and Disequilibrium (Oxford: Pergamon Press, forthcoming) (available as IMPACT Preliminary Working Paper No. BP-24, November 1980, Melbourne).

I have quoted the above report at length because, given that the Government decided on grounds of economy not to publish the working papers supporting the Report of the Crawford Study Group[1], the above recommendations may not be widely known.

I now turn to the methodological point. The BACHUROO model of labour supply has foundations which draw eclectically on several streams of literature. The emphasis has been to develop theoretically sound but empirically implementable sub-modules of labour market behaviour. This means that interfaces must be built between these sub-modules. A successful example of this is the interface between econometric modelling and stock-flow demographic accounting in the work of Brooks, Sams and Williams[2] (who took their lead from Filmer and Silberberg).[3]

One difficulty with this approach is that the interfaces tend to emphasise the artificiality of the modular boundaries. A theoretically more satisfactory integration of the components of the model might have been achieved if the sub-modules had all been based on a single paradigm with all behavioural relations (rather than just some) being derived from the maximization of explicit utility functions. That is, an alternative approach would have been to attempt to improve the microeconomics of the household sector and to develop a rigorous general equilibrium model of it. There is, of course, no chance that the Australian data base would allow the estimation of more than a tiny percentage of the parameters of such a model. Nevertheless its construction would be a worthwhile exercise from

1. Report of the Study Group on Structural Adjustment, Sir John Crawford (Chairman), (Canberra: Australian Government Publishing Service, 1979).
2. Brooks et al., op.cit..
3. Filmer and Silberberg, op. cit..

"The Working Group considers that the most urgently needed improvements in labour market information are those which provide essential inputs to analyses of wage relativites, labour factor costs and the occupational distribution of employment by industry. ... [T]he Working Group strongly recommends ... that the ABS start work now on the design and development of an industry-wide survey of employers. This survey should be developed as an integrated economic survey of establishments and provide:

- quarterly information on employment, hours worked, wages (award and over award payments, ordinary time and overtime earnings), other employee benefits, and other components of labour cost, by occupation, industry, age and sex

- monthly information on employment and vacancies by industry and sex. ...

"Finally, the Working Group considers that for medium and longer-term analyses of the labour market there is a need to improve the information available on the structure and output of education and vocational training institutions and to undertake *selective longitudinal surveys* to elicit information on the evolving labour force experience of representative groups or 'panels' of individuals."[1] *[italics added]*

1. Ibid., pp. 58-59.

paper along satisfactory taxonomic lines. In the event I have decided to discuss theoretical insights first, followed by a resumé of empirical work. These comprise respectively Sections 2 and 3. In the fourth and final section I offer concluding remarks incorporating a perspective for further work.

2. Developments in Theory

The developments in theory discussed below have been empirically motivated, and in all cases but one, at least partially implemented. To varying extents, three of my doctoral students (Kriengsak Chareonwongsak, Ashok Tulpulé and Lynne Williams) have been involved in this work.

2.1 The Theory of Labour Supply and the Demand for Commodities and 'Leisure' when the Wage Rate is Endogenous

The 1970s saw an extension of the systems approach to micro-economic modelling[1] to include the simultaneous treatment of the demand for leisure and the demand for commodities.[2] Towards the end of

1. Henri Theil treats a wide variety of topics in applied microeconomics using this approach in his The System-Wide Approach to Microeconomics (Chicago: Chicago University Press, 1980), pp. xii + 260.
2. Betancourt's twice-extended linear expenditure system includes savings as an endogenous variable within the systems approach - see Roger R. Betancourt, "Household Behaviour in A Less Developed Country: An Econometric Analysis of Cross Section Data", Department of Economics, University of Maryland, College Park, Maryland, 1973 (mimeo). Other studies embedding labour supply within the systems approach include N.M. Kiefer, "Quadratic Utility, Labor Supply and Commodity Demand", Industrial Relations Section, Department of Economics, Princeton University, Princeton N.J., 1975 (mimeo); by the same author, "A Bayesian Analysis of Commodity Demand and Labor Supply", International Economic Review, Vol. 18, No.1 (1977), pp. 209-218; M. Abbott and O. Ashenfelter, "Labour Supply, Commodity Demand and the Allocation of Time", Review of Economic Studies, Vol. 43, No.3 (1976), pp. 389-411; W.A. Barnett, "The Joint Allocation of Leisure and Goods Expenditure", Econometrica, Vol. 47, No.3 (1979), pp. 539-564.

the seventies papers in this area explicitly recognized that, because of progressive income tax scales and penalty rates for overtime, the marginal wage should be treated as endogenous to the consumer/worker's twin problems of allocating his time budget between paid work and other activities, and of allocating his cash income among commodities. The fact that the budget constraint under these conditions could fail to be convex was recognized, and the implication that corner solutions would reflect the optimal choices of many individuals became well understood.[1]

IMPACT produced two papers in this stream of literature. Both were more general in their treatment of the budget constraint than the extant literature. In the first paper[2] we treated the utility function as being of a particular type, namely, the Klein-Rubin or Stone-Geary function. Apart from differentiability, the schedule describing the response of an individual's post tax earnings to the number of hours worked was allowed, in the development of the theory, to be completely arbitrary. In the illustrative application, however, we considered one plausible example in which the after-tax marginal wage rose as a function of increasing overtime hours.

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1. G. Burtless and J.A. Hausmann, "The Effect of Taxation on Labor Supply: Evaluating the Gary Negative Income Tax Experiment", Journal of Political Economy, Vol.86, No.6 (1978), pp.1103-1130; A.D. Woodland and T.J. Wales, "Labour Supply and Progressive Taxes", Review of Economic Studies, Vol.46(1), No.12 (1979), pp.83-96.
2. Alan A. Powell, Ashok Tulpulé and Richard J. Filmer, "Commodity-Specific Subsidies, Demand Patterns and the Incentive to Work", in Department of Housing and Construction, Housing Economics: Papers Prepared for National Housing Economics Conference 1978 (Canberra: Australian Government Publishing Service, 1980), pp.296-324.

At this point I should state that I have severe reservations about the directions in which the Australian Standard Classification of Occupations (ASCO) project is proceeding. Any serious attempt to base the classification on skills, rather than job description, seems at this juncture to have been abandoned. The problems with the data base, however, were seen by the Working Group to extend far beyond the current non-existence of a suitable skill-based occupational classification. In particular,

> "... the monthly labour force surveys, being based on a sample and designed to provide timely current indicators, are not an appropriate vehicle for collecting information on the characteristics of the labour force which need to be studied at reasonably disaggregated levels of detail - for example, occupational, regional and industrial mobility of labour. ... [A]n approach which appears attractive to the Working Group is to use a larger, but different, sample from the population survey framework for an annual manpower survey ... [which] ... could provide the vehicle for obtaining, with respect to a common reference period, information on important characteristics of the labour force which, at present is collected on a somewhat ad hoc basis, or not collected at all. ... Such a survey would provide much better quality of information for labour market analysis than is presently obtained ... Moreover, it is possible that one co-ordinated collection would not cost very much more than the numerous supplementary labour force surveys presently conducted.

"...there are serious deficiencies in the information available for analyzing the Australian labour market. Labour market statistics do not appear to have been developed in accordance with any conceptual framework within which labour market behaviour can be rationally explained. Probably largely as a consequence, the present information system consists of a pot-pourri of fragmented and overlapping series; there are serious gaps in the information; incompatibilities between different series substantially restricts their usefulness for analysis of labour market behaviour; data on the structural characteristics of the labour force are either available infrequently, or provided in such highly aggregated industry, occupational, regional and demographic detail that they are capable of supporting only the most rudimentary analyses; and difficulties in obtaining access to variable formats of the collected data further limits its usefulness for application to policy-relevant analyses.

"Subject to the introduction of an appropriate skill-based occupational classification and better access to results, the population censuses would provide an adequate basis for cross-sectional analysis of the structure of the labour force. The labour force surveys, subject also to introduction of a skill-based occupational classification and improved access to results, would provide adequate current information on changes in employment, unemployment and labour force characteristics for generally analysing short-term labour market trends."[1]

1. Report of Working Group No. 2 (A. Mumme, Chairman) to Sir John Crawford's Study Group on Structural Adjustment, Canberra, June 1978(mimeo), pp.57-58.

The second IMPACT paper[1] extended the first to make both the utility function and the hours/earnings opportunity schedules completely arbitrary (apart from the usually maintained neo-classical assumptions about the utility function and the differentiability assumptions about the opportunity schedule). This tidies up some loose ends in the literature; but, in applications of course, it is necessary to make some stronger assumptions.

The import of all this is to demonstrate that, in a framework in which the wage rate is endogenous there is no such thing as "the" wage elasticity of labour supply. Backward bending and forward bending supply schedules with widely differing slopes are possible, depending on the source of the initial change in the wage rate. This is illustrated in Table 1. To get numerical results it has been necessary to assume a particular functional form for each of the utility function and the hours/earnings opportunities schedule, and to assign parameters to both.[2] The particular values of the parameters have been chosen to be broadly consistent with what might be expected in a country like Australia in about the mid 1970's.

The hours/earning opportunities schedule underlying Table 1 is particularly simple. For the first 40 hours per week the consumer/worker receives net-of-tax four dollars per hour for each hour worked; if he works more than the standard 40 hours per week, his take-home hourly wage rate on each additional hour increases by 80 cents per hour for each

1. Alan A. Powell, "The Theory of Labour Supply and Commodity Demand with an Endogenous Marginal Wage Rate", Recherches Economiques de Louvain, Vol.45, No.3 (1979), pp. 215-239.
2. For further details, see ibid., pp. 230-235.

Table 1

Effect of a 10 per cent Change in Parameters of the Earnings Schedule on Hours Worked and on Earnings in HYPOTHETICAL Numerical Example

Parameter	Parameter Value		Hours Worked (H)		Earnings (G)		Labour Supply 'Elasticity' with Respect to:	
							Total Earnings	Average Wage *
	Before change	After change	Before change	After change (approx.)	Before change	After change	$\frac{\Delta H}{H} \div \frac{\Delta G}{G}$ (approx.)	$\frac{\Delta H}{H} \div \frac{\Delta \left[\frac{G}{H}\right]}{\left[\frac{G}{H}\right]}$ (approx.)
θ_1 (basic hourly wage) (10 % *increase*)	4	4.4	41	40.63	164.4	178.93	— 0.107	— 0.097
			43	42.72	175.6	190.90	— 0.078	— 0.072
			45	44.76	190.0	206.02	— 0.066	— 0.062
			48	47.80	217.6	234.69	— 0.055	— 0.052
θ_2 (standard hours) (10 % *decrease*)	40	36	41	42.58	164.4	187.64	0.286	0.401
			43	43.64	175.6	197.91	0.123	0.140
			45	45.29	190.0	215.68	0.051	0.054
			48	48.05	217.6	250.28	0.007	0.007
θ_3 (overtime progression) (10 % *increase*)	0.8	0.88	41	41.04	164.4	164.64	0.685	2.175
			43	43.06	175.6	176.35	0.318	0.466
			45	45.05	190.0	191.46	0.158	0.188
			48	48.04	217.6	220.62	0.063	0.070

Source: Powell (1979), op. cit., p. 237.

* Computed as follows: let elasticity in previous column be E. Figure in this column is E/(1-E).

The volume of child services variable (notionally the product of the stock of dependent children and their resource intensity) exerts a positive influence on labour market participation by women at any given level of fertility. Brooks, Sams and Williams describe the joint influences of fertility and the volume of child services in these terms:

> "in summary, the influence on the participation rates of young married women is such as to discourage them from working in the years soon after the birth of their children, but then to encourage them to undertake paid work in order to supply the level of child services demanded for their children."[1]

4. Concluding Perspective

I will confine these final remarks to two issues: one concerning the data, and the other methodological.

Two facts must be very obvious from Section 3. First, the level of detail at which IMPACT attempts to work is very modest in relation to the needs of most policy-makers concerned with the labour market. Second, the quantity and quality of the available data will scarcely support even this level of analysis. No real improvement seems evident since a working party of Sir John Crawford's Study Group on Structural Adjustment reported in 1978 that

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1. Ibid..

This calculation illustrates that as saturation is approached, the responsiveness of the participation rate to further increases in an exogenous variable declines so as to keep the participation rates below 100 per cent. The mathematics also guarantees that these rates can never become negative.

The importance of fertility in determining labour force participation of married women is highlighted by the relatively high absolute values of the semi-elasticities of labour force participation with respect to weighted nuptial confinements. With participation rates initially at the levels of the mid-1970s, for example, a 10 per cent increase in this fertility variable is projected to decrease the labour force participation rate of married prime aged females by 3 to 5 percentage points.

The general unemployment rate in these equations exerts a 'discouraged worker' effect. Consider a rise of one percentage point in the unemployment rate from a base of 6 per cent of the workforce and a base female participation rate as in 1975-76. The unit percentage point increase in the unemployment rate represents an increase of 16.67 per cent in the unemployment rate. Using Table 8 we see that for 15-24 year old married women the corresponding increase in projected participation is

$$(-0.09) \times (16.67) = -1.5 \ ;$$

that is, we expect their participation to decline by $1\frac{1}{2}$ percentage points if no changes in the other explanatory variables accompany the rise in unemployment.

additional hour worked in excess of 40. In the three horizontal compartments of Table 1 are considered in turn the following three changes in the worker's conditions of employment: (a) the basic hourly wage rate (for working hours up to and including standard hours) increases to $4.40 per hour; (b) standard hours decline from 40 to 36 (so that a worker who continues to work 40 hours is paid for 4 hours of overtime); (c) the overtime premium increases from 80 cents per hour per hour to 88 cents per hour per hour. The percentage responses in hours supplied per one per cent change in the average hourly wage rate are shown in the last column of Table 1.

Under the assumptions made, a change in the basic hourly wage rate alone leads to small declines in hours of work supplied. The reason for this is straightforward: although the wage rise has led to a higher shadow price on leisure and hence, via the substitution effect, to a tendency to increase labour supply, the income effect of the wage rise is stronger. Leisure is a normal good and therefore at fixed relative prices an increase in income will lead to higher consumption of leisure and therefore to a lower supply of labour. The relative strengths of the income and substitution effects change, however, as the number of hours initially worked increase. Thus it would be possible for the supply schedule of a worker already doing a large amount of overtime to become once again upward sloping with respect to a change in the basic hourly wage rate.

A reduction in standard hours is quite different. The income effect in this case is generated by the fact that a person initially working standard hours is paid overtime on the difference between old

standard hours and new standard hours.[1] This income effect is likely to be weaker than one generated by a comparable increase in the basic hourly wage rate since the latter applies to all hours worked. In these circumstances the substitution effect dominates the income effect, at least at hours not substantially above standard hours. The result is an upward sloping response curve of hours supplied to the average wage. But again this result could be reversed for a worker initially working a large amount of overtime.

Increasing the steepness of the schedule of premiums for overtime leads qualitatively to a picture very similar to that involved in cutting standard hours. Again the key is the fact that the income effect is being generated on only a fraction of the hours worked, rather than on all hours. This fraction of course increases at higher initial levels of overtime, so that once again a worker doing large amounts of overtime is more likely to show a negative response in hours supplied to rises in average wages caused by an improvement in the overtime premium schedule than would be a worker whose initial preferences are to work a more nearly standard week.

The final column serves as a salutory warning to those who would attempt to estimate labour supply functions by regressing the number of hours supplied against average earnings. The sign and magnitude of the responses depends critically upon the source of the change in average earnings. There is no reason to expect stability in such a function even if it were estimated from time series data for a single individual.

1. In this sentence "new" means an instant after the change in employment conditions; i.e., before the worker has adjusted his supply of hours to a new equilibrium.

TABLE 8

Semi-Elasticities of Labour Force Participation by Prime-Aged Married Females*

Age Group (years)	Semi-Elasticity Calculated at Initial Participation Rates Equal to**	Predetermined Variable				
		W't'd Nupt'l Confinement Rate	Female Real Wage Rate	Index of Female Labour Demand	Unemployment Rate	Volume of Child Services
15-24	3.39 (1921-22)	-0.07	0.03	0.03	-0.01	0.02
	17.50 (1950-51)	-0.29	0.14	0.13	-0.05	0.08
	54.18 (1975-76)	-0.49	0.24	0.23	-0.09	0.14
25-54	4.39 (1921-22)	-0.05	0.01	0.03	-0.00	0.03
	11.10 (1950-51)	-0.12	0.03	0.07	-0.01	0.08
	46.69 (1975-76)	-0.31	0.07	0.19	-0.03	0.20

* The number in the body of the table is the estimated percentage point change in the labour force participation ratio per one per cent increase in the relevant predetermined variable. If E_{ij} is the number in the body of Table 7, and $100I_{ij}$ is the initial participation rate shown in Table 8, the the number in the body of Table 8 is $I_{ij}(1 - I_{ij})E_{ij}$.

** Year at which this participation rate was observed is shown in parentheses. Participation rate shown as a percentage.

Source : Table 7 above and Table 5 of Brooks, Sams and Williams, op. cit..

I will confine my interpretation of the results to those for prime aged married females, 15-24 and 25-54 years of age. It is helpful to transform the relevant results of Table 7 into semi-elasticities before discussing them. By a 'semi-elasticity' I mean the percentage point change in the labour force participation ratio per one per cent increase in the explanatory variable under examination. These values are given in Table 8. The estimates suggest, for instance, that a ten per cent rise in the real wage rate of females in 1950-51 would have led (other things equal) to a 1.4 percentage point rise in the participation rate of married women aged 15-24 years of age; by 1975-76 the same stimulus would, according to the estimates have elicited a 2.4 percentage point response. The difference is due wholly to the differences in initial participation rate. This reflects the logistic transformation of the raw data on participation rates before econometric analysis. Thus the left-hand variables are (with the exception noted in the footnote to Table 8) of the form $[l_{ij}/(1 - l_{ij})]$, where l_{ij} is the participation ratio (expressed as a fraction) of the group having age i and marital state j. This transformation was carried out in order to ensure that projected participation rates stay within an interpretable interval. If, for instance, we projected for some future date that the participation rate for married women aged 25-54 years would have risen to 75 per cent, we would obtain the semi-elasticity of the participation rate with respect to the female real wage rate as follows:

$$\begin{aligned}\text{(semi-elasticity)} &= \text{(corresponding elasticity from Table 7)} \times l_{ij} \\ &\qquad \times (1 - l_{ij}) \\ &= 0.293 \times 0.75 \times (1 - 0.75) \\ &= 0.055.\end{aligned}$$

Other aspects of the theoretical framework developed suggest natural linkages with demography. In equilibrium we would envisage that different individuals would opt to work different numbers of hours per week if presented with the same set of opportunities. The reasons for choosing different numbers of hours of work therefore have nothing to do with the conditions of employment (which by assumption are the same for different individuals having the same set of marketable skills), but must reflect differences in 'preferences', where the latter are allowed to vary over the life cycle. Thus a mother of pre-school age children may choose to work a lower number of hours than a single woman without family commitments. If a household is one in which decisions on workforce attachment are made by a single individual or by consensus, it is possible to determine analytically how a change in the take-home hourly wage rate of one member of the household will affect the labour supplies offered by other members of the household (as well as by himself). The systems approach also allows one to deal with the consequences for labour supply of changes in the prices of different commodities and in non-labour income (including transfers).

This richness of detail in the theoretical framework has both advantages and drawbacks. Given appropriate micro-data we could model at a high level of plausibility many important aspects of household behaviour as it impinges on the labour market. Australia being virtually devoid of panel data of any sort, of course this is at present a pipe-dream. The alternative approach of actually constructing the fully articulated micro model, and then using simulation experiments

(i) to determine which sub-set of parameters are crucial for the performance of the model,

and

(ii) to establish plausible "ball parks" for the micro parameters,

is certainly worth exploring. IMPACT has so far lacked the resources to undertake this task.[1] Work along these lines would certainly be suitable for a doctoral dissertation for a student with above average energy.

2.2 The Transformational Approach to Occupational Mobility

The stocks of persons with different skill levels is taken in BACHUROO as given. This is because institutional elements in the education, training and immigration areas are so dominant and seem unlikely to be amenable to modelling except in the very long term.[2] Model users will therefore be required to specify their own scenarios on immigration and education.

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1. This micro simulation approach has been found useful in other areas of economics. It was, for example, used with effect in the study of the consumption function by W. Dolde and J. Tobin in "Monetary and Fiscal Effects on Consumption", in Consumer Spending and Monetary Policy: The Linkages, Federal Reserve Bank of Boston Conference Series No.5, 1971: reprinted in James Tobin, Essays in Economics, Vol. 2, Consumption and Econometrics (Amsterdam: North-Holland, 1975), pp. 175-216.
2. In the education area a major stumbling block was in any event posed by the lack of compatible data. (This was partially corrected by an IMPACT researcher's codification of available time-series data: see Rowen Craigie, "Australian Student Statistics 1966-1976", IMPACT Preliminary Working Paper No. BP-21, January 1980, Melbourne.) In the migration area the 1950's and 60's proved amenable to modelling at an aggregate level, but not at the level of disaggregation by skill of immigrant. Two IMPACT studies dealt with the gross flows of immigrants, one at a lower level of analytical sophistication (Allen C. Kelley and Robert M. Schmidt, "Modelling the Role of Government Policy in Post-War Australian Immigration", Economic Record, Vol. 55, No.149 (June 1979), pp.127-135), and the other within a more ambitious analytical framework (Vern Caddy, Brenda Jackson and Alan A. Powell, "Determinants of Australian Migration", IMPACT Working Paper No.B-07, June 1978, Melbourne); only the former was successful on its own terms.

TABLE 7

Estimated Equations Explaining Female Labour Force Participation 1921-22 to 1975-76

Labour Force Participation Rate of Women		Predetermined Variables											
Age Group (years)	Marital Status	Constant	Oral Contraceptive Usage (Ω)	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)	Dummy for Intro Widows' Pension (Z_5)	World War II Dummy (Z_2)	Volume of Child Services (KQ)	
15-24	married	6.16*	-0.004	-1.99*	0.963*	0.929	-0.366*				0.330*	0.545*	
15-24	other	1.29*			0.560	1.232	-0.032		0.252	-0.310	0.161		
25-54	married	0.13	0.123*	-1.237*	0.293	0.763	-0.109*				0.362*	0.808*	
25-54	other	1.07*			0.495*	-0.633	-0.030		0.029	-0.152	0.109*		
55+	married	-3.93*			0.512*	5.677*	0.298*	-0.088			-0.113		
55+	other	-0.376			0.108	0.049	0.017	-0.435	-0.042	-0.229*	-0.105*		

Abbreviations: W't'd, weighted; Nupt'l, nuptial; Hrly, hourly; Invld, invalid; Intro, introduction.

Notes: All equations are estimated by Two-Stage Least Squares. The endogenous variable in all cases except 15-24 year old other women is the logistic transform of the labour force participation rate of the group shown. The predetermined variables (other than dummies) are logged and entered linearly on the right hand side of the participation equations. The weighted nuptial confinement rate variable is a weighted sum of the confinement rates of married women in the current and the previous four years which 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. An asterisk indicates that an estimated coefficient differs significantly from zero. Values of R^2 were .985, .931, .985, .922, .930 and .790 respectively. The education participation rate influences the labour force participation rate directly in the equation for 15-24 year old other women which uses a modified logistic transform as endogenous variable.

Source : Brooks, Sams and Williams, op. cit.

3.7 Female Labour Force Participation

Modelling by IMPACT in the area of women's labour force participation goes back to a 1977 paper by Filmer and Silberberg.[1] A recent revision of this work follows these authors in taking its paradigm from the new home economics.[2] Thus participation in the labour market by women is seen as a decision taken jointly with marriage and the number and timing of children. Within this framework Brooks, Sams and Williams[3] analyse labour force participation rates by females for three age groups (15-24, 25-54, 55+) and two marital states (married, other). Their results are particularly successful in the case of married women. Details of the estimated labour force participation equations obtained in this recent work are shown in Table 7.

All of the variables explaining female labour market participation except one relate to the supply side of the market. The exception is the index of female labour demand (defined as the ratio of total employment (all persons) to the male labour supply). Thus the equations reported in Table 7 may be thought of as a partially reduced form. To the extent that the index of labour demand can be considered as an aggregate measure of female labour force participation, the role of these equations is to disaggregate this measure by age and marital status.

1. R. Filmer and R. Silberberg, "Fertility, Family Formation and Female Labour Force Participation ...", op. cit..
2. Clive Brooks, Dennis Sams and Lynne S. Williams, "An Econometric Model of Fertility, Marriage, Divorce, and Labour Force Participation for Australian Women, 1921-22 to 1975-76", IMPACT Preliminary Working Paper (forthcoming 1982).
3. Ibid..

Once the stocks of persons of different skill levels are specified, however, there remains a further problem of modelling that cannot be side-stepped. It was fashionable for a time to suppose there existed a 1:1 correspondence between a person's training and the occupation in which he would work. Such a rigid framework was at the back of much of the manpower planning literature. This approach is no longer acceptable because it is contradicted by actually observed mobility between occupations in the workforce in response to changes in relative wage rates and in differentials in the rates of unemployment in different occupations.

From the introductory section it will be recalled that the ORANI model endogenizes either the vector of occupational wage rates or the vector of occupational labour demands. To obtain full labour market closure it is necessary for BACHUROO to endogenize occupational labour supplies at given wage rates for the different occupations.[1] We need to be able to project how the available occupational mix of labour supplies is reallocated as a result of changes in occupational wage relativities.

The paradigm adopted by the IMPACT researchers involves the idea of a representative agent who can allocate his time across the occupations in such a way as to maximise the wage bill.[2] Unlike an

1. It should be noted that full labour market closure does not necessarily entail the assumption that the labour market clears. For details, see Section 3 of Alan A. Powell, "Aspects of the Design of BACHUROO ...", op. cit..
2. This idea is developed in R. Craigie, D. Parham and G.J. Ryland, "Educational Attainment and Occupational Supply: A Theoretical Outline", IMPACT Preliminary Working Paper No. BP-16, January 1979, Melbourne: and in Lynne S. Williams, "Occupational Mobility in Australia: A Quantitative Approach", IMPACT Working Paper No. B-13, December 1980, Melbourne.

individual worker, the representative worker can allocate ¼ hour per day as a cook, ½ hour per day as a medico, 1 hour per day as a fitter and turner, etc.. Thus the representative agent is a convenient fiction whose options mirror those for the workforce as a whole. The transformation schedule representing the feasible options for the occupational mix has a shape and position which itself is determined by the level and mix of skill endowments in the population of working age. The maximisation of the wage bill proceeds along neo-classical lines. The theory is made operational by postulating a particular functional form for the transformation schedule which is parsimonious in the use of parameters. The functional forms posited in the IMPACT literature are the CET (constant elasticity of transformation) and CRETH (constant ratios of elasticities of transformation, homothetic) functions involving respectively 1 and n transformation parameters, where n is the number of occupations distinguished.

From a theoretical viewpoint, the systems of labour supply equations developed have the following desirable characteristics:

(i) The supplies of the different occupations respond differentially to variations in the stocks of those possessing differing educational attainments, as well as to changes in occupational wage relativities and to occupation-specific unemployment.

(ii) The systems approach respects the requirements of demographic accounting.

occupational employment mixes of different industries; the ORANI 'short run', on the other hand, is a period more like two years[1]; it seems reasonable to treat 0.35 as an upper estimate, therefore, and 0.14 (about one standard deviation below it) as a lower bound. If this judgment is accepted, the relevant zone of Table 6 consists of columns 2, 3 ,6 and 7. Column 6 is directly comparable with column 2, and column 7 with column 3.

An obvious feature of these comparisons is that moving from the CES to the CRESH formulation does not have major consequences for broad conclusions based on ORANI concerning the implications of a change in tariffs. (I think it is reasonable to extrapolate from this to other policy shocks of moderate size.) Further, the results are not overly sensitive to plausible variations in the CES or average CRESH substitution elasticity. Among the different pairs of occupations, the maximal changes in relative wages as we move across columns 2, 3, 6 and 7 are 7.5, 5.8, 7.0 and 5.6 per cent respectively. The rankings among the occupations of the wage changes do not change radically as we move across these columns.

1. Indirect validation of ORANI via its linkage to a quarterly macroeconomic model suggests a short run of this order of magnitude; see Russel J. Cooper and Keith R. McLaren, "The ORANI-MACRO Interface: An Illustrative Exposition", IMPACT Preliminary Working Paper No. IP-13, June 1981, Melbourne.

TABLE 6

Sensitivity of Projected Short-Run Changes in Real Wages by Occupation to Different Assumptions about Inter-Occupational Labour Substitution Possibilities*

	SPECIFICATION						
	CES					CRESH with average substn elas =	
	$\sigma_{LL}=0$	$\sigma_{LL}=.14$	$\sigma_{LL}=.35$	$\sigma_{LL}=1$	$\sigma_{LL}=100$	0.14	0.35
1. Professional	-10.0	-0.53	-0.11	0.01	-0.18	-0.67	-0.23
2. Skilled White Collar	7.56	0.30	0.25	0.15	-0.18	0.32	0.19
3. Semi- & Unskilled White Collar	-1.60	0.28	0.25	0.16	-0.18	0.31	0.20
4. Skilled Blue Collar, Metal & Electrical	4.22	1.37	0.84	0.44	-0.18	1.70	1.00
5. Skilled Blue Collar, Building	21.03	1.32	0.72	0.34	-0.18	1.08	0.54
6. Skilled Blue Collar, Other	20.26	1.93	0.86	0.31	-0.18	1.69	0.67
7. Semi- & Unskilled Blue Collar	-5.73	0.06	0.21	0.17	-0.18	-0.14	0.14
8. Rural Workers	-7.12	-5.58	-4.98	-3.77	-0.28	-5.34	-4.57

* The numbers shown in the body of the Table are the percentage changes in real wages required to keep the employment demand for each occupation constant in the face of a 25 per cent across-the-board rise in tariffs.

Source : Higgs, Parham and Parmenter, op. cit., p.15.

(iii) The approach is compatible with the maximization of a utility function in which exertion appears as a 'bad' and real labour income as a good; i.e., the approach is compatible with the neo-classical approach to the demand for leisure and the supply of labour, but has the advantage of handling the occupational disaggregation of supply in a consistent manner[1].

2.3 Labour-Labour Substitution on the Demand Side of the Market

We now turn from the supply to the demand side of the labour market. In ORANI the substitution possibilities recognised are the following: between primary factors as a whole and materials, none; between aggregate indexes of capital and labour used in any given industry, CES;[2] between different types of labour, CRESH (constant ratios of elasticities of substitution, homothetic)[3]. This does not represent new theory as such, but makes use of the nested approach to production functions to allow a fairly flexible treatment of substitution between the different occupations without introducing a large number of parameters. The system-wide approach involved in this treatment is of course essential given that the demand relations must be imbedded in a general equilibrium framework.

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1. For the proof of proposition (iii), see Lynne S. Williams,"Occupational Mobility in Australia: A Quantitative Approach", European Economic Review (forthcoming), Section 4.1.
2. In agricultural industries, a third primary factor is recognized; namely, agricultural land. In these cases the theory is written to allow CRESH substitution among the three primary factors. Because of the dearth of parameter estimates, implemented versions of ORANI have used a CES specification for the agricultural industries.
3. Giora Hanoch, "CRESH Production Functions", Econometrica, Vol.39, No.5 (1971), pp. 695-712.

2.4 The Interface of the New Home Economics with Demography

Relatively early in the life of the Project a prototype econometric model of family decision making was developed to allow a unified treatment of marriage, divorce, fertility and female workforce participation.[1] This development also included a novel suggestion about how such a model should be interfaced with the demographic accounting equations of BACHUROO's population projection facility.[2] The facility requires that events involving changes in marital status be subscripted for age. The device suggested by Filmer and Silberberg involved treating the parameters of the age distributions of demographic events as endogenous variables in the econometric model. As these parameters respond through time to changing economic conditions, the age distribution of events such as first marriages also respond. This provides the link by which models along the lines of the 'new home economics' can be made to drive a system of demographic equations which track the population by single years of age and by marital status. This in turn allows long run labour supply effects to be captured. The treatment of female labour force participation within a unified model of family formation, on the other hand, should enhance our understanding of short through medium run supply of labour by females.

1. R. Filmer and R. Silberberg, "Fertility, Family Formation and Female Labour Force Participation in Australia, 1922-1974", IMPACT Preliminary Working Paper No. BP-08, December 1977, Melbourne, pp.86.
2. The Population Projection Facility is documented in Dennis Sams, "The Demographic Core of the IMPACT Project: An Overview", IMPACT Preliminary Working Paper No. BP-18, September 1979, Melbourne; in Dennis Sams and Pamela Williams, "The IMPACT Project's Facility for Disaggregated Population Projections: A Brief Exposition and Progress Report", IMPACT Preliminary Working Paper No. BP-22, May 1980, Melbourne; and in Dennis C. Sams, Lynne S. Williams, Pamela J. Williams and Jim D. Stevenson, "A Comparison between the ABS Population Projection Facility 1980-2001 and a Compatible Projection Using the IMPACT Population Projection Facility", IMPACT Preliminary Working Paper No. BP-27, July 1981, Melbourne.

Apart from the parametric grid described above, it was of course necessary also to nominate a simulation experiment for the sensitivity trials. A policy experiment was chosen; namely, a 25 per cent across-the-board tariff increase. This particular choice reflected the IMPACT team's relatively long experience in carrying out simulations of this type; consequently the mechanisms involved in producing ORANI results in such experiments were well understood.

The labour market closure selected for these trials was one of exogenous total employment in each occupation.[1] Many possible closures could have been chosen for the purposes of the sensitivity analysis, the essential ingredient being that a change in occupational wage relativities should be involved. In the particular experiment chosen, the question asked was: if tariffs were to increase by 25 per cent across-the-board, ceteris paribus what changes in the set of occupational wage rates would be needed to ensure that employment in each occupation remained unaffected? The results are shown in Table 6.

The polar assumptions of zero substitutability (column 1) and almost perfect substitutability (column 5) produce the expected results; namely, that relatively large swings in relative wages are needed to absorb the tariff shock in the Leontief world, and that very little in the way of changed wage relativities is needed when the occupations are highly substitutable against each other. The point estimate of $\sigma_{LL} = 0.35$ was estimated from a five year response (1968-69 to 1973-74) in the

1. It is, of course, an aim of the IMPACT Project in due course to allow closures which incorporate BACHUROO -- see Section 2.2 above.

3.6 Relative-wage Responsiveness of the Occupational Mix (Demand Side)

The inter-occupational substitution elasticities on the demand side of the labour market have proved almost as difficult to estimate as the transformation elasticities on the supply side. Again, the weakness of the data base is responsible for this unfortunate state of affairs.

Ryland and Parham[1] obtained estimates of CRESH substitution parameters for five occupational aggregates. Technical problems in their estimation procedure led in a later IMPACT paper to a reassessment of the evidence.[2] With hindsight it was concluded that the information load placed on the available data by CRESH was too high, and that the most that the data could be realistically expected to support was the estimation of a single (CES) substitution elasticity. The point estimate obtained (again on the basis of the five occupational groupings listed above on p. 17) was 0.35 (Student's $t = 1.6$).

Since a richer set of substitution possibilites could not be estimated, it was decided to test the sensitivity of the ORANI model to plausible variations in the substitution specification. Seven different sets of substitution possibilities were considered. Besides the above CES estimate of $\sigma_{LL} = 0.35$, values of σ_{LL} equal to zero, 0.14, 1 and 100 were selected for the sensitivity trials. As well, a notional disaggregation of the CES value of $\sigma_{LL} = 0.35$ to a set of CRESH parameters yielding this value as the average substitution elasticity was also caried out. Finally, a scaled down set of CRESH parameters was constructed so as to yield an average σ_{LL} of 0.14.

1. G. J. Ryland and D.J. Parham, "Estimation of Occupational Demands in Australian Industry", IMPACT Preliminary Working Paper No. OP-21, July 1978, Melbourne.
2. Peter J. Higgs, Dean Parham and B.R. Parmenter, "Occupational Wage Relativities and Labour-Labour Substitution in the Australian Economy: Applications of the ORANI Model," IMPACT Preliminary Working Paper No. OP-30, August 1981, Melbourne.

2.5 The Role of Craft Unions in a General Equilibrium Setting

Consider the case of a union organized along craft lines with an objective function whose arguments are the wages of its members and the size of its employed membership. Let the members of this, and other, craft unions be employed in a variety of industries, and assume that each of the other craft unions also wishes to maximise a function of average wage and employed membership in its respective union. Further assume that if in any particular industry the wage of a particular craft rises, it is possible (at least to some extent) for an industry to substitute other, less relatively expensive, crafts for it. Finally assume that each craft union accepts the demand curves of different industries for the different types of labour (i.e., crafts) as binding constraints, and takes the wages of other crafts as given. Under these conditions, what equilibrium set of craft and industry-specific wages will prevail? How will a change in the conditions in the product and/or non-labour factor markets in the different industries affect these wage bargains? These questions are addressed in an unpublished thesis by Kriengsak Chareonwongsak.[1]

The insights gained by this work are theoretical in nature and not directly applicable to the Australian labour market. In the first place, data on movements in wages and employment cross-classified by industry and union are not available. In the second, not all of the unions operating in Australia are craft unions.

1. Kriengsak Chareonwongsak, "The Occupational and Industrial Structure of Wages in Australia", Monash University, Department of Econometrics and Operations Research, unpublished Ph.D thesis, April 1981, pp. xvi + 228.

The thesis may pave the way for applied work, however. Besides deriving the supply behaviour of labour disaggregated by craft and industry in a unionized labour market, Chareonwongsak also derives employment and wages in a non-unionized labour market. The differences between the two solutions represent both the incentive to form a craft union and the pay-off from its operation. The work is a first step towards an understanding of unionization in a world of many occupations and many industries.

3. Empirical Results

In this section a brief survey of empirical results on the Australian labour market is given. This material commences with a brief review of IMPACT "data papers"; i.e., papers summarizing the pertinent features of special purpose data supplied by the ABS to IMPACT. This is followed by discussions of empirical results on the supply of hours worked, occupational mobility and labour-labour substitution.

3.1 Occupational and Industry-Specific Wage Data

The ABS, during its period as a participating agency in IMPACT, agreed to mobilize certain existing data sources for research use within the Project. The two Income Distribution Surveys of 1968-69 and 1973-74 and Labour Force Surveys from 1968 and 1974 were retabulated to yield information on the number of persons employed, number of hours worked and number of people in each of 13 income ranges; these variables were also tabulated according to age, sex, marital status, birthplace, and

TABLE 5

Estimates of Inter-occupational Wage Elasticities of Labour Supply

Destination Occupation whose Certainty Equivalent Wage Rate Changes, j	Component of Elasticity[a]	Own Wage Elasticity	S_j[b] 1972	S_j[b] 1975	S_j[b] Adopted
Professional White Collar	-0.0860	1.0919	0.0756	0.0703	0.0730
Lecturers and Teachers	-0.0342	1.1437	0.0262	0.0319	0.0290
Skilled White Collar	-0.1918	0.9861	0.1628	0.1629	0.1628
Semi- and Unskilled White Collar	-0.1796	0.9983	0.1508	0.1542	0.1525
Skilled Blue Collar: M & E	-0.1825	0.9954	0.1551	0.1547	0.1549
: Building	-0.0777	1.1002	0.0680	0.0640	0.0660
: Other	-0.0284	1.1495	0.0248	0.0233	0.0241
Semi- and Unskilled Blue Collar	-0.3269	0.8510	0.2748	0.2802	0.2775
Rural	-0.0709	1.1070	0.0619	0.0585	0.0602
Sum	-1.1779		1.0000	1.0000	1.0000

(a) The figure shown is the estimated per cent change in the stock of workers in the destination occupation as a result of inter-occupational transfers consequent to a one per cent rise in the ratio of the certainty equivalent wage in the destination occupation to the certainty equivalent wage in the source occupation. This value is independent of the source occupation i.

(b) S_j is the share of occupation j in the total certainty equivalent wage bill.

Source : Lynne S. Williams' Monash Ph.D thesis (op. cit.), p.110.

3.5 Relative-wage Responsiveness of the Occupational Mix (Supply Side)

The transformational approach to occupational mobility described above in Section 2.2 has been successfully applied by Williams to the net inter-occupational transfers occurring in 1972 and 1975.[1] The weakness of the data base ruled out capturing specific inter-occupational transformation parameters, and hence only a single transformation elasticity was estimated. The point estimates obtained for this average transformation elasticity ranged from -1.2 to -1.3 with student's t statistics equal to 3.2 and 3.6 respectively. The wage elasticities corresponding to the lower of these estimates are given in Table 5.

Critics of the approach followed by Williams might claim that the success of the method has more to do with her extremely tight econometric frame of inference than with the quantity and quality of available data. But this is hardly a criticism: in a world of very scarce data, their economical use demands such an approach. What one can conclude with reasonable confidence on the basis of this work is that the available evidence, scanty though it may be, is consistent with a fairly high degree of occupational flexibility in response to changes in wage relativities. If the institutional impediments to changing relative wages do not prove insuperable, therefore, one would not in the short run expect major bottlenecks in the supply of particular broadly defined occupations.

1. Lynne S. Williams, "Occupational Mobility in Australia", Monash University, Department of Econometrics and Operations Research, unpublished Ph.D thesis, September 1980, pp. ix + 215. For a brief account, see the reference cited above in footnote 1 of p.13.

industry and occupation of employment.[1]

From these data sources it was possible, without recourse to totally outrageous assumptions, to construct two matrices of wages per hour worked, cross classified by the following five occupational groups

Professional
Skilled White Collar
Unskilled White Collar
Skilled Blue Collar
Unskilled Blue Collar

and by 21 industry groups. The two wages per hour matrices are notionally dated 1968-69 and 1973-74. Regressions of the following forms were fitted separately to the data in the two tables:

$$(1) \qquad y_{ij} = ay_{i.} + by_{.j} + u + e_{ij}$$

$$(i = 1,\ldots, 5 \text{ occupations};$$

$$j = 1,\ldots, 21 \text{ industries}),$$

where y_{ij} is the income per hour in occupation i, industry j; $y_{i.}$ and $y_{.j}$ respectively are the mean over industries of the hourly wage rate in occupation i, and the mean over occupations of the hourly wage rate in industry j; a, b and u are coefficients and e_{ij} is a random term. Various

1. Dean Parham and G.J. Ryland, "ABS Labour Force Survey and Income Distribution Survey Data: Preliminary Analysis", IMPACT Preliminary Working Paper No. IP-05, September 1978, Melbourne.

refinements in the treatment of heteroscedasticity in the residuals were implemented, but these corrections turned out not to affect to any serious extent the simple regression results reported in Table 2.

Three regressions are shown for each of the two available matrices: two in which the data are regressed respectively on exactly one of the vector of occupation means or the vector of industry means; and one in which industry and occupation effects both enter on the right. From the last column of Table 2 we can deduce that about 40-50 per cent of the cross-sectional variation among hourly wages can be explained by industry and occupation of affiliation. Of the variation that can be so explained, moreover, about 80 to 90 per cent could be accounted for by occupational affiliation alone. On the other hand, only 10 to 20 per cent of the explained variation could be accounted for by the industry variable alone.

In summary, the data analysed by Parham and Ryland suggest:

(1) that mean hourly wages in a given industry and occupation at a given point of time depend significantly on industry and occupation, but to a considerable extent also on other, unspecified, variables;

(2) that occupation alone is almost as good a predictor of average hourly wages as occupation and industry taken together;

(3) that industry alone is a very poor predictor of average hourly wages.

working wives, (ii) married males with non-working wives, (iii) married working females, (iv) single males and (v) single females. The results indicate that the marginal leisure preferences of married males are very low (zero as far as the data and the method can distinguish); working wives, single females and single males are estimated to have marginal leisure preferences of 0.27, 0.28 and 0.29 respectively. It follows that virtually all the response in labour hours supplied in the workforce comes from these three groups. Very likely these results understate the responsiveness of hours worked by married males; the general features of the results, however, are credible.

The third and final stage of evaluating the response of hours worked involves estimating how after tax remuneration responds to hours worked for different sexes, ages (junior/adult) and occupational groups.[1] Tulpulé used mid 1970s cross sectional data from Earnings and Hours Surveys to estimate the parameters of the earnings opportunities curves. These show how a worker of a given type could receive different levels of remuneration by working different numbers of hours. (Of course, to obtain an acceptable approximation to the desired number of hours, a worker may have to change jobs.) From a knowledge of these parameters, and of the leisure preference parameters, it is possible to infer a worker's response to changes in conditions of employment such as: (i) the basic hourly wage rate; (ii) the number of hours in the standard working week, (iii) overtime premiums, (iv) commodity prices, and (v) the personal income tax rates on the average and at the margin. Unfortunately, lack of resources has so far precluded simulation work with Tulpulé's results.

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1. Ashok Tulpulé, "Effects on the Supply of Labour Hours by Employees of Changes in their Conditions of Employment", IMPACT Preliminary Working Paper No. BP-25, December 1980, Melbourne.

The development of estimates of the responsiveness of employees' supply of hours worked as a function of their conditions of employment has proceeded in three stages. In the first, aggregate time series data are used to estimate a basic behavioural parameter, the average Australian 'marginal leisure preference'.[1] This is to be interpreted as the fraction of a dollar of exogenously bestowed 'full income' which would be spent by a typical Australian member of the workforce in repurchasing his own time by virtue of declining additional hours of work. 'Full income' in this definition comprises both non-labour and labour income, where the latter includes the imputed cost of leisure already 'consumed' by the worker. The econometric estimate of this parameter obtained by Tulpulé from data on hours worked and hourly wage rates was 0.24 (with a standard error equal to 10 per cent of this value). This is approximately double the marginal leisure preference estimated from U.S. data by similar methods. Given the inherent ambiguities noted above in Section 2.1 in interpreting such a result, one should not be overly impressed by its statistical significance; in spite of these reservations, however, it is difficult to see how more satisfactory use of the available data could be made.

The second stage of the assessment of the supply of hours function consists of estimating how this national average marginal leisure preference parameter disaggregates to different socio-demographic groups of workers.[2] It proves possible to use the existing scant supply of data to infer separate marginal leisure preferences for (i) married males with

1. Ashok Tulpulé, "Revised Estimates of Labour Supply Elasticities," IMPACT Working Paper No. B-12, April 1980, Melbourne.
2. Ashok Tulpulé, "Estimation of Elasticities of Supply of Labour Hours for Australian Workers Classified by Sex and Marital Status", IMPACT Preliminary Working Paper No.BP-23, August 1980, Melbourne.

TABLE 2

Regressions of Earned Income Per Hour on Occupation and Industry Means*

(Parham and Ryland)

Year	Estimated Regression Coefficients: Constant u	Occupation a	Industry b	Coefficient of Multiple Determination**
	0.2712	0.9257		0.420
	(1.314)	(9.058)		
1968-69	1.264		0.4562	0.033
	(3.440)		(2.204)	
	-0.6177	0.9357	0.5021	0.466
	(-1.834)	(9.541)	(3.263)	
	1.199	0.7134		0.480
	(3.959)	(8.637)		
1973-74	2.219		0.4545	0.128
	(4.497)		(3.054)	
	-0.2642	0.7132	0.4541	0.515
	(-0.5735)	(9.206)	(4.034)	

* t statistics shown in parentheses.

** Includes correction for degrees of freedom: i.e., shown statistic is $\bar{R}^2$.

Source: Parham and Ryland, op. cit., p.31.

These conclusions are not wholly supported, however, by special tabulations of the ABS Earnings and Hours Surveys for 1974, 1975 and 1976.[1] Tulpulé tabulates matrices of average hourly earnings of non-managerial employees by the seventeen industry groups and nine occupations shown in Table 3. Regressions results on a comparable basis to those in Table 2 are shown in Table 4.

The analysis of Table 4 suggests that about half of the explained variation in hourly wages in 1974, and about forty per cent of the explained variation in hourly wages in 1975 and 1976, is due to industry effects. There are many differences between the data underlying Tables 2 and 4, of which the three most obvious are

(i) differences in aggregation,

(ii) differences in survey coverage,

and

(iii) differences in period covered (with the exception of 1974).

Some light on (i) could be shed by further statistical analysis, but the other two differences will prove harder to evaluate.

1. Ashok Tulpulé, "A Preliminary Analysis of Factors Affecting the Hourly and Weekly Earnings of Employees", IMPACT Preliminary Working Paper No. IP-12, February 1981, Melbourne.

3.3 Australian Student Statistics 1966 to 1976

The totally unsatisfactory nature of available data on the throughputs of the educational and vocational training systems is emphasised in a paper by Craigie.[1] In modelling the allocation of education system leavers to the various occupations along the lines sketched above in Section 2.2, it would be most desirable to use as data "comprehensive time series ... pertaining to the transition from the education system to the labour force". These data should be cross classified by "the type of occupation commenced" and "by the type of training undertaken".[2] Unfortunately, no such data are available. Even the more modest goal of obtaining from published information a consistent set of national statistics on the throughputs of the various arms of the educational system required an inordinate effort.[3]

3.4 The Supply of Hours Worked

The supply of hours worked has been analysed in detail in a series of studies by Tulpulé. These analyses take as given the decision concerning workforce participation. That is, Tulpulé builds his paradigm around the interior solutions of the theory described above in Section 2.1. The corner solutions, which correspond to the decision to opt in or out of the workforce, are not modelled within his framework, but as a separate econometric exercise (see Section 3.7 below).

1. Craigie, op. cit..
2. Ibid., p.2.
3. Ibid..

3.2 The Demographic Characteristics of People who Change Occupation

IMPACT was provided by the ABS with special tabulations of two Labour Mobility Surveys covering changes during 1972 and 1975 of job and occupation. The salient features of these data have been described by Williams.[1] I cannot do better than to quote her summary in full:

> "Mobility rates aggregated over all occupations have fallen from 5.26 per cent of the workforce in 1972 to 4.70 per cent in 1975. However, the demographic characteristics of movers appear relatively stable for the two survey years: males are more mobile than females; those occupations with high income overlap and low training differentials have the greatest two-way movements between them; the blue collar trades consistently exhibit the highest degree of labour turnover; mobility is highest for the youngest age groups and declines monotonically as age increases; and married workers are generally less mobile than their unmarried counterparts.
>
> "Several differences exist between results for Australian occupational mobility and that experienced in the U.K. and the USA. These include high rates of mobility displayed by the skilled blue collar workers; and the absences of consistent movements up a social status index of occupation."[2]

1. Lynne S. Williams, "The Demographic Characteristics of People Who Change their Occupations: A Preliminary Examination of the Data", Australian Bulletin of Labour, Vol. 7, No.3 (1981), pp.139-173.
2. Ibid..

TABLE 3

Industrial and Occupational Classification Used in Analysis of Earnings and Hours Surveys

Industry Grouping	Occupational Grouping
1 Food, Drink, Tobacco	1 Professional White Collar
2 Textile, Clothing, Footwear	
3 Paper, Printing, etc.	2 Teachers
4 Chemicals, Petroleum & Coal Products	
5 Basic Metal Products	3 Skilled White Collar
6 Fabricated Metal Products	
7 Transport Equipment	4 Unskilled White Collar
8 Other Manufacturing	
9 Mining	5 Skilled Blue Collar (Metal & Electrical)
10 Electricity, Gas & Water	
11 Construction	6 Skilled Blue Collar (Building)
12 Wholesale Trade	
13 Retail Trade	7 Skilled Blue Collar (Other)
14 Transport, Storage, Communication	
15 Finance, Business Services	8 Unskilled Blue Collar
16 Public Administration, Defence, Communication Services	
17 Other non-manufacturing	9 Other

Source : Tulpulé, op. cit., p.45.

TABLE 4

Regressions of Hourly Earnings on Occupation and Industry Means* (Tulpulé)

Year	Estimated Regression Coefficients			Coefficient of Multiple Determination**
	Constant u	Occupation a	Industry b	
1974	-1.251 (-3.895)	0.7916 (9.371)	0.6790 (9.105)	.5711
	1.009 (3.680)		0.6966 (7.224)	.2825
	0.6078 (1.918)	0.8109 (7.511)		.2989
1975	-1.441 (-4.093)	0.8068 (10.76)	0.6235 (8.917)	.6200
	1.315 (3.926)		.6634 (6.848)	.2686
	0.5707 (1.652)	0.8423 8.799		.3794
1976	-1.646 (-4.567)	0.7469 (12.96)	0.6713 (9.881)	.6864
	1.406 (3.358)		0.6977 (6.693)	.2610
	0.9563 (2.907)	0.7640 (9.921)		.4400

* t statistics shown in parentheses.

** Includes correction for degrees of freedom; i.e., shown statistic is $\bar{R}^2$.

Source : Regressions were carried out on data reported on pp. 67, 70 and 73 of Tulpulé, op. cit..

Three final remarks on the occupational versus industrial specificity of wages seem warranted. First, no currently available data source will settle the issue at the level of disaggregation adopted in the IMPACT models (113 industries and 9-11 occupations). Second, the adoption of an essentially skill-based occupational classification system has led unambiguously to the occupational variable's role as a very important explanator of average wage rates. Third, some of the important explanators of hourly wage rates missing in the work of Parham and Ryland, have been identified by Tulpulé.[1] Among the sets of cross classifications that the available data would allow, Tulpulé found that occupation, sex, age (junior vs adult), part-time vs full-time status, and size of firm, proved the most satisfactory set of explanators both of the basic hourly wage rate and of average weekly earnings.[2] Although his analysis does not address the issue, it seems likely that the addition of industry to the above set would, in the statistical sense, contribute significantly to overall explanatory power; but that the additional variation in wages and earnings explainable by industrial affiliation would be a relatively small percentage of the total explained variation. That is to say, it seems likely that knowledge of sex ratios in the workforce, the proportions of part-time and junior employees, and the average sizes of firms, would go a long way to identifying industries.

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1. Tulpulé, op. cit..
2. Ibid..