IMPACT OF DEMOGRAPHIC CHANGE ON INDUSTRY STRUCTURE IN AUSTRALIA

A joint study by the Australian Bureau of Statistics, the Department of Employment and Industrial Relations, the Department of Environment, Housing and Community Development, the Department of Industry and Commerce and the Industries Assistance Commission

ESTIMATION AND MAPPING OF THE DISTRIBUTION OF INCOME IN AUSTRALIA FOR THE IMPACT MODEL

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CONTENTS

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1. INTRODUCTION

One important output of the IMPACT model[1], when fully developed, will be the distribution of personal income and the estimates of average income for several groups of typical consumers, i.e., families classified by socio-economic and demographic characteristics. Although in many econometric studies, the aggregate demand for goods and services of different types in an economy is based on the demand behaviour of one typical customer, accuracy of estimates can be improved by studying demand behaviour of several groups of typical consuming units. Williams[2] has clearly shown that the demand patterns of families depend not only on their income level but also on the occupation of the head, age of the head, family size and whether the wife is working or not.

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1. Alan A. Powell and Tony Lawson, "IMPACT : An Economic-Demographic Model of Australian Industry Structure - Preliminary Outline," Impact of Demographic Change on Industry Structure in Australia, Working Paper No. I-01, Industries Assistance Commission, Melbourne, September, 1975.

2. Ross Williams, "Household Consumption in Australia : An Examination of Patterns Across Socio-Economic Classes," Impact of Demographic Change on Industry Structure in Australia, Preliminary Working Paper No. SP-04, Industries Assistance Commission, Melbourne, May, 1976.

* I am grateful to Vince Manion for assistance in compiling the data series. The computer programming was done by Alexandra Strzelecki.

The model presented here has two distinct but not unrelated purposes. One is to estimate the personal distribution of income, i.e., number of persons in different income ranges. The second purpose of the model is to estimate the average income of different types of families and the numbers of such family units in Australia.

In addition to a specification of a model for estimating the personal distribution of income and a procedure for estimating average family incomes, the paper contains preliminary calculations of average family incomes for the years 1966 to 1971 based on available data and some crude estimates of variables on which data are not available at present. Values of most of the relevant variables will ultimately be endogenous in the IMPACT model but a few policy type variables will be exogenous. Crude estimates of a number of variables have to be used, firstly because the BACHUROO module and the BACHUROO-ORANI interface are not yet operational, and secondly because the required base year data are not yet fully available. The paper is divided into seven sections. Section 2 gives a brief review of literature; a model for estimating the personal distribution of income and a procedure for estimating average family income is presented in sections 3 and 4 respectively. A list of input requirements of the model, a brief discussion on how the values are presently estimated and how they will be ultimately obtained is included in section 5; and the results obtained from calibration of the family income model are presented in section 6. Some tentative conclusions are in section 7.

2. A BRIEF REVIEW

The subject of income distribution has been studied extensively by economists, statisticians and sociologists in this century. These studies can be divided into three main groups. In one attention is focussed on the distribution of national incomes to primary factors of production, viz., labour, capital and land. In this paper we are not concerned with this particular aspect of distribution of income. The second area of research is concerned with describing the shape of the distribution of personal income, comparing the distributions for different countries or over time and commenting on the degree of equality and inequality. Some of these studies have attempted to explain the causes of inequality but few attempt to project changes in the distribution of income. This last aspect is of interest to our modelling work and is briefly reviewed in section 2.1 below.

The third area of research is concerned with household or family incomes as distinct from personal or individual incomes. Several studies describe the distribution of family income in relation to the characteristics of the families, but there has been very little work on predictive models of family income distribution. This is a difficult area because it requires research not only on the distribution of personal income but also on how the persons earning incomes are grouped into family units. The socio-economic factors that determine the composition of families and their work and earning behaviour are complex. The models that attempt to bring them together have complex mechanisms but rather simplistic underlying assumptions. This does not mean that the first component, viz., family formation and work-leisure behaviour of members of families, is not properly modelled. It is the extension of this work to estimate the income consequences that lacks rigour and is rather mechanistic. Some literature of this kind is briefly discussed in section 2.2.

The research referred to in this section covers only a small part of the extensive literature. Those interested in a full review are referred to a paper by Bjerke[1] and a bibliography compiled at the World Bank.[2]

2.1 Personal Distribution of Income

A great deal of research on the personal distribution of income is related to describing the shapes and parameters of the observed income distributions. Mincer[3] has commented that

> " ... the emphasis of contemporary research has been almost completely shifted from the study of causes of inequality to the study of the facts and of their consequences ... "

The early literature postulated that the distribution of income is related to the distribution of individual abilities[4], whereas Tinbergen[5] considers the income distribution to result from the supply and demand for attributes. The distribution of many human abilities tends to be normal, but empirical investigations have conclusively shown that the distribution of income is usually skew and often sharply lepto-kurtic (positively skew). Specific shapes such as the log-normal distribution and the Pareto distribution have been fitted to observed data on income distribution with a fair degree of success. These studies are of limited use in a predictive model unless one uses a stochastic process to explain changes

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1. Bjerke, Kjeld, "Income and Wage Distributions Part 1 : A Survey of the Literature," Review of Income and Wealth, Vol. 16, No. 3, 1970, pp. 235-252.
2. Ahluwalia, Montek, "Income Distribution Bibliography," Unpublished Mimeo, Development Research Center, World Bank, Washington, D.C., November, 1972.
3. Mincer, J., "Investment in Human Capital and Personal Distribution of Income," Journal of Political Economy, Vol. 66, 1958, pp. 281-302, and further work in "The Distribution of Labour Incomes," Journal of Economic Literature, Vol. 8, 1970, pp. 1-26.
4. For details, see Staehle, H., "Ability, Wages and Income," Review of Economic Statistics, Vol. 25, 1943, pp. 77-87.
5. Tinbergen, J., "On the Theory of Income Distribution," Weltwirtschaffsliches Archiv, Band 77, 1956.

in the distribution over time. A stochastic method has been used with some success by Champernowne[1] who estimates the number of income receivers $X_r(t+1)$ in the income range R_r in year t+1 in terms of $X_r(0)$ and the proportion $p_{rs}(t)$ (which can be interpreted as the probability) of occupants of R_r in year t who have shifted to R_s in the following year t+1. Once the proportions are estimated the distribution of income in successive years can be obtained.

Such an approach, often assuming constant probability of movement, would be unsatisfactory in a model intended to project the distribution of income. To be effective for the latter purpose, models should be addressed to the causes determining the shape of the income distributions in the base period and to identifying the factors that would change the underlying causes. Mincer[2] puts forward a simple model which postulates that income inequality is caused by the amount of training received. The higher incomes earned by those with more training is to compensate for the deferral of earnings during the course of training. Differences in the costs of training were also consdidered by Friedman and Kuznets.[3] Friedman[4] also emphasizes that differing propensities to undertake risks influences the distribution of income.

Starting with a simple model, Mincer[5] has shown that the positive skewness of income distribution is necessary to compensate for training costs and is consistent with an otherwise symmetrical distribution, and he also shows how the skewness increases with differences in age and experience. In addition to

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1. Champernowne, D. G., "A Model of Income Distribution," The Economic Journal, June, 1955, pp. 318-351.
2. Mincer, op. cit..
3. Friedman, M. and Kuznets, S., "Income from Independent Professional Practices," National Bureau of Economic Research, 1953.
4. Friedman, M., "Choice, Chance and Personal Distribution of Income," Journal of Political Economy, Vol. 61, 1952.
5. Mincer, op. cit..

the above causes, viz., education, the resulting occupation, and experience (often proxied by age), Spengler[1] has listed regional differences, sex and race as the factors that affect distribution of income. In Australia, Podder and Kakwani[2] have studied the distribution of income derived from the 1966-67 Macquarie Survey of Consumer Finances and Expenditures. Since they concentrate more on family income rather than individual income, their work will be discussed (albeit briefly) in the next section.

To summarise, the following factors are claimed to have influence on the personal distribution of income :

1)	Education	2)	Occupation
3)	Age or experience	4)	Sex
5)	Race	6)	Region
7)	Demand for attributes	8)	Propensity to undertake risk .

A model that relates the distribution of income to the above factors will be a useful tool if satisfactory methods of projecting the values of the factors are developed. In addition to the above factors, marital status and hours worked are also likely to influence the level and distribution of earned income.

Throughout the discussion we have emphasized personal characteristics and ignored the inherited wealth and unearned component of income. The proposed model for use in IMPACT will be discussed in section 3.

2.2 Distribution of Family Income

Although there is an extensive literature on personal income distribution, we have come across very few theoretical studies of family income distribution. In studies of consumer behaviour the distribution of family or

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1. Spengler, J. J., "Changes in Income Distribution and Social Stratification : A Note," American Journal of Sociology, 1953.

2. Podder, N. and Kakwani, N. C., "Distribution and Redistribution of Household Income in Australia," The University of N.S.W. and the Australian National University, February, 1974 (mimeo), pp. 75.

household income is treated as given, as these studies are primarily concerned with estimating consumption expenditure given the family income and other characteristics. Podder and Kakwani[1] have shown that the distribution of family income varies according to family size, education, occupation, sex and age of the head. The family income also depends on the number of income earners in the family. This last factor along with the industry in which the head works, is used to estimate family income distribution in the BACHUE models.[2] In those models the average family income for families whose head is working in a given industry depends on the average wage in that industry and on the probability and number of other family members working in different industries, and the wages paid on average in those industries. We have adopted a somewhat similar approach. However, as will be seen in section 4, we calculate the average family income classified by the head's occupation, and we do not attempt to estimate the distribution of family income around these averages. This is because in IMPACT, we will be concerned with estimating consumption patterns of several "typical" consuming units[3] (i.e., groups of families with similar socio-economic characteristics). From our viewpoint, therefore, it is sufficient to estimate the distribution of income between these groups, and we do not address ourselves to the question of the distribution within the socio-economic groups distinguished.

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1. Podder and Kakwani, op. cit..

2. Wery, R., Rodgers, G. B., Hopkins, M. D., "BACHUE-2 : Version 1 : A Population and Employment Model for the Philippines," Working Paper 5, World Employment Programme, International Labour Office, Geneva, July, 1974.

3. In SNAPSHOT (see Dixon, Peter B., Harrower J. D., and Powell, Alan A., "SNAPSHOT, A Long Term Economy-wide Model of Australia," Impact of Demographic Change on Industry Structure in Australia, Preliminary Working Paper No. SP-01, Industries Assistance Commission, Melbourne, February, 1976 (mimeo), pp. 26), the long term component of IMPACT, several "typical consumers" are distinguished among the economic agents whose behaviour is modelled. In the current development of the ORANI module (Dixon, Peter B., "The Theoretical Structure of the ORANI Module," Impact of Demographic Change on Industry Structure in Australia, Working Paper No. O-01, Industries Assistance Commission, Melbourne, October, 1975 (mimeo), pp.41) which forms part of the short through medium term model, only one representative consuming agent has so far been incorporated into the specification.

3. PERSONAL DISTRIBUTION OF INCOME

Several factors that may affect the personal distribution of income were listed in section 2.1. Any practical approach to the problem of estimating income distribution cannot take into account all the factors. In our model we have taken into account the more important factors, but the model is constrained by data availability and by the overall framework of IMPACT in which only limited disaggregation is possible. The model is restricted to earned incomes for three reasons. Firstly, because in a model with major emphasis on the workforce it is appropriate to concentrate on labour income; secondly, because for most persons unearned income from investments constitutes a small proportion of total income, and, thirdly, because no data base currently exists which would allow the mapping of income from assets to their owners suitably classified by socio-economic group.

In IMPACT, the total earned income of all persons in an occupation is calculated by the interaction between demand for labour input and the supply of labour in that occupation. At present the demand is not disaggregated by sex or age of persons, but it will be possible to obtain the demand levels for males and females separately at a later stage. Starting from the base year (year 0), the demand supply interaction will provide for year 1 (the first year of projection), estimates of the following[1] :

- Total hours worked in each occupation ;
- Average hourly earnings in each occupation .

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1. The base year is 1971-72. Because projections are to be made under a variety of scenarios, the "first year of projection" does not necessarily correspond to historical 1972-73.

The BACHUROO module provides estimates of the supply of persons in each occupation in the labour force classified by sex and age. In the present paper the disaggregation by sex and age is not taken into consideration but this can be added at a later stage within essentially the same basic framework.

Persons in the workforce are grouped into a number of occupations. The occupation groups are constructed in such a way that each occupation group is synonomous with a formally obtained skill level and it is expected that the distribution of income within each IMPACT occupation group will be in a much more narrow band than if the ABS occupation groups were used.[1] Thus the disaggregation by occupation is expected to take into account the unequal earnings of persons due to differences in their educational attainment and associated skill level. The influence of demand pressure on earnings will be reflected in the estimated average earnings obtained by the interaction between the demand and supply of labour.

In an occupation group, given the average hourly earnings and the total number of hours worked, the distribution of income will depend on the distribution of number of hours worked per person and the corresponding hourly wage rate. As will be seen below, average hourly earnings are postulated to be a non-decreasing function of hours worked per week. The distribution of the number of persons by hours worked per week in the base year (1971-72) is known. All the above information is incorporated in estimating the distribution of earned income. The distribution is estimated for each occupation (except the professional white collar occupations) separately, using the following method.

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1. See Tulpulé, A. and McIntosh, M. K., "BACHUROO - An Economic-Demographic Module for Australia," Impact of Demographic Change on Industry Structure in Australia, Working Paper No. B-02, Industries Assistance Commission, Melbourne, April, 1976 (mimeo), pp. 12-13.

For a given occupation, the basic hourly wage is expected to be the same irrespective of the age of persons in the occupation. The actual hourly earnings will vary according to the number of hours worked per week. It is postulated that the higher the average hours worked per week, the higher will be the average hourly earnings, due to two reasons. Firstly, there are institutional factors that lay down rules regarding overtime rates, and, secondly, in an occupation the persons who work more than the average number of hours per week are likely to be in industries in which there is pressure of demand which necessitates over-award payment to the workers. Now for a given occupation, let

x = number of hours per person per week ($0 \leqslant x \leqslant M$; M large) ;

p_x = $f(x)$ is the probability function[1] ;

$p_x \delta_x$ = proportion of persons working $(x - \frac{\delta x}{2})$ to $(x + \frac{\delta x}{2})$ hours per week .

For the base year, the Labour Force Survey will provide information to construct Figure 1.

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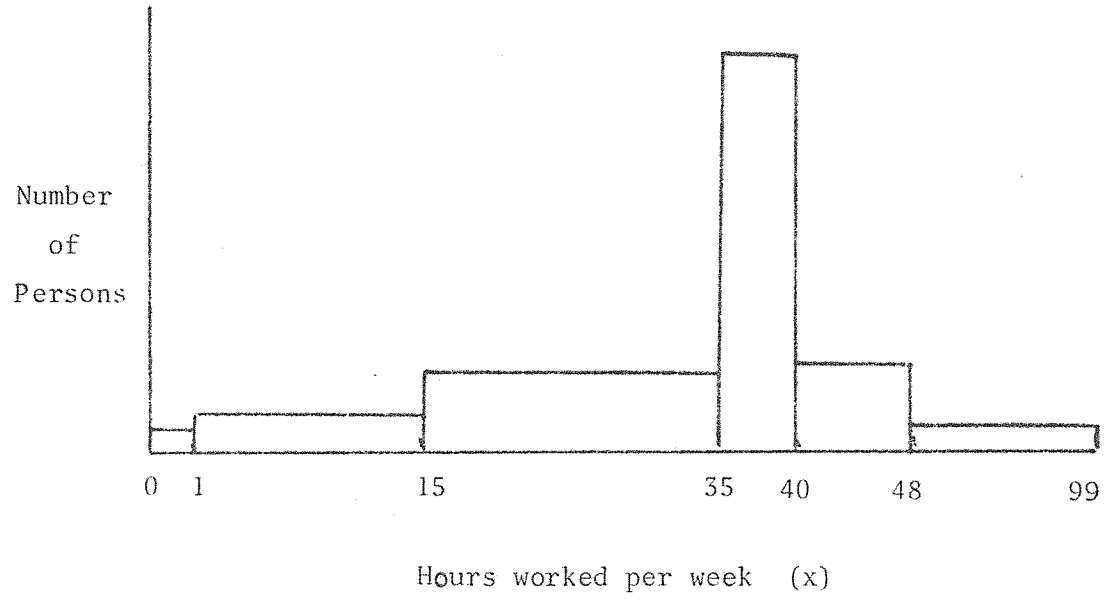
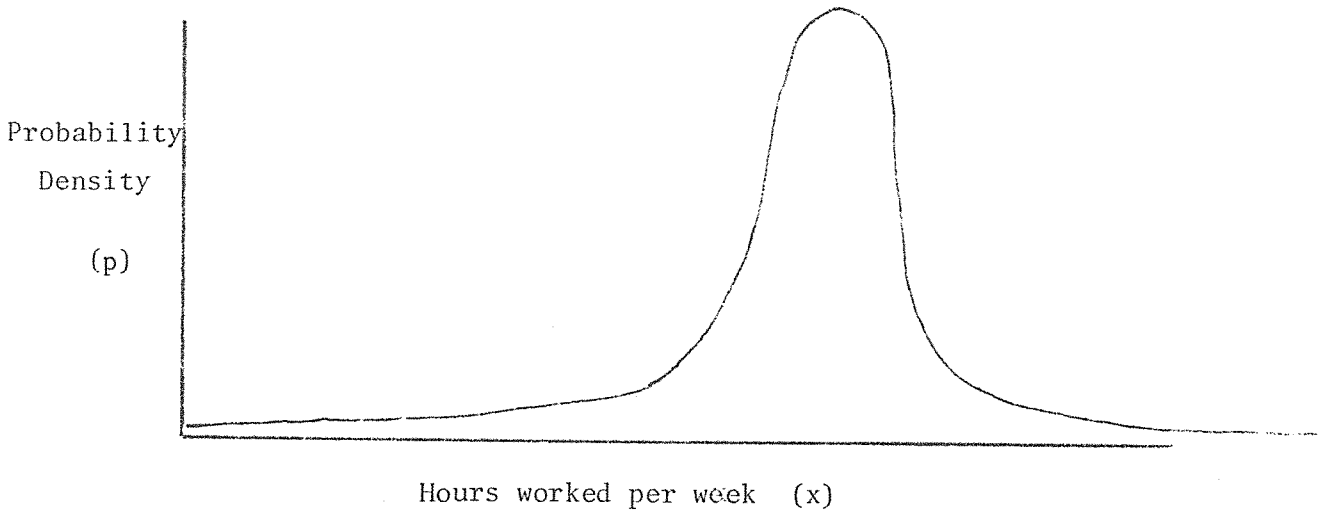
1. We restrict ourselves to distributions with two parameters u and σ . The parameters could be the mean and standard deviation respectively, but they are not so defined presently. They will be defined after alternative forms of two parameter distributions are fitted to the data in order to determine the most appropriate forms.

Figure 1 : Distribution of Persons in an Occupation by Hours Worked



In addition, average number of hours per person is also given. This information can be used to fit a distribution like that in Figure 2.

Figure 2 : Probability Density Function



Whilst the above curve need not be normal, for the purpose of discussion, irrespective of how the functional form of the probability distributions is specified, it will be possible to fit smooth curves to the data. In order to firm up ideas about the estimation of parameters, the discussion below proceeds as if the distributions are normal (or some close relative). Other options are not ruled out at this stage. The aggregate data on all occupations combined indicates that the curve is negatively skew. When the data for different occupations become available, it will be possible to fit distributions, estimate the parameters and test whether σ is stable over time or has changed systematically or is related to μ . The ORANI-BACHUROO interface will give the value of μ for year 1. σ can be projected on the basis of the base year value and the past trends.[1] Once these parameters are known for year 1, the following can be estimated :

$$\int_0^1 f(x)\,dx = \text{proportion of unemployed persons ;}$$

$$\int_1^s f(x)\,dx = \text{proportion of part-time workers (s is the standard award week) ;}$$

and

$$\int_s^M f(x)\,dx = \text{proportion of full time workers .}$$

The above procedure will be applicable to all occupation groups except the professional white collar occupations and can be extended to give disaggregated figures for males and females at a later stage.

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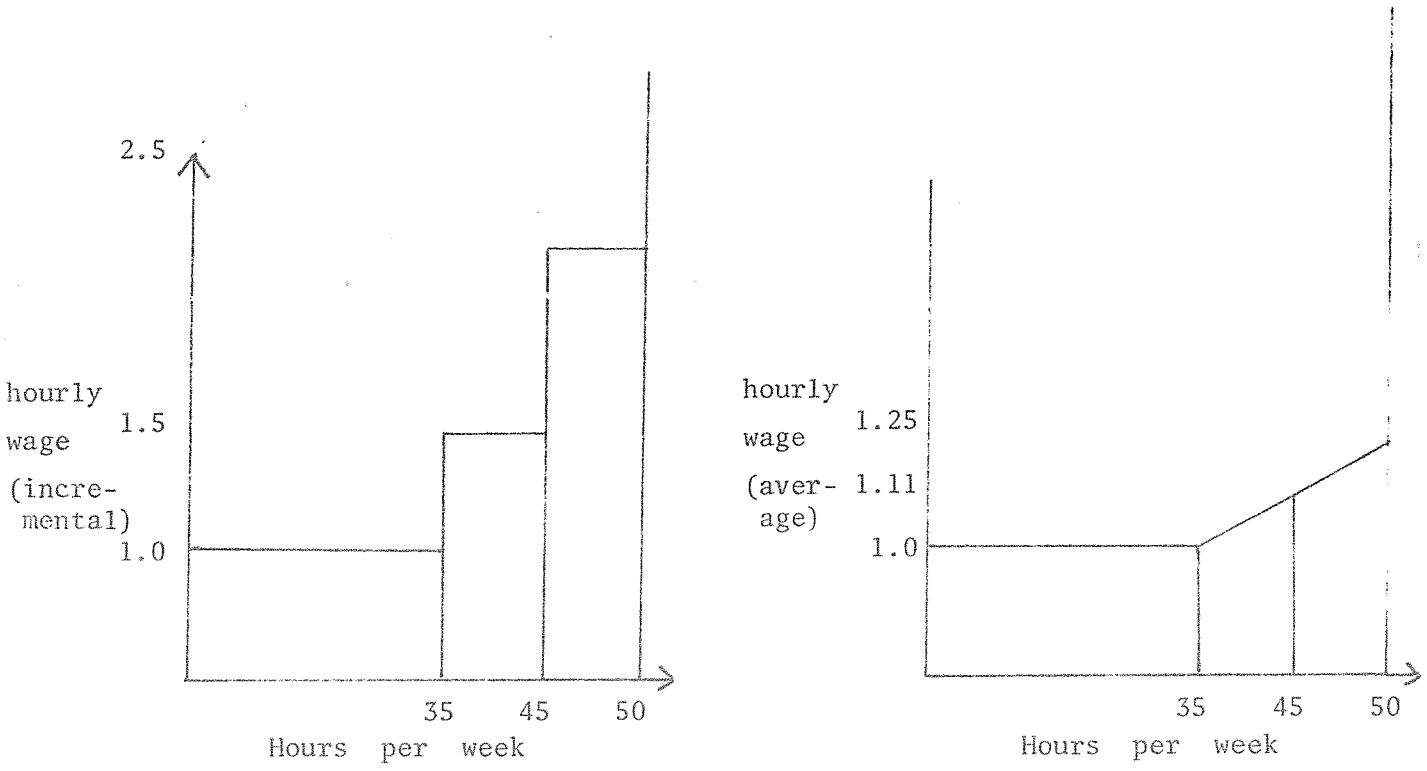
1. In studying the past trends in σ , tests will be made to investigate whether the coefficient of variation is stable over time. If the data supports such an hypothesis then σ could be estimated endogenously.

The average hourly wage is likely to be a function of the number of hours worked per week as shown in Figure 4. Such a curve can be fitted for each occupation on the basis of institutional arrangements relating to overtime working conditions and on the over award payments made to workers in an occupation due to high level of demand for their work.

In an occupation, the hourly wage rate might be w for a basic award week (say $\leq 35^*$ hours per week), 1.5^* w for the first 10^* hours of overtime (35 to 45 hours), and 2.5^* w for the next 5 hours of overtime (45 to 50 hours). Let us suppose that no worker is prepared to work more than 50^* hours per week.[1] This corresponds to a wage rate of infinity for ≥ 50 hours per week. Such a situation can be illustrated diagrammatically by Figure 3.

Figure 3 : Relationship Between Hourly Wage and Hours per Week Based on Institutional Arrangements

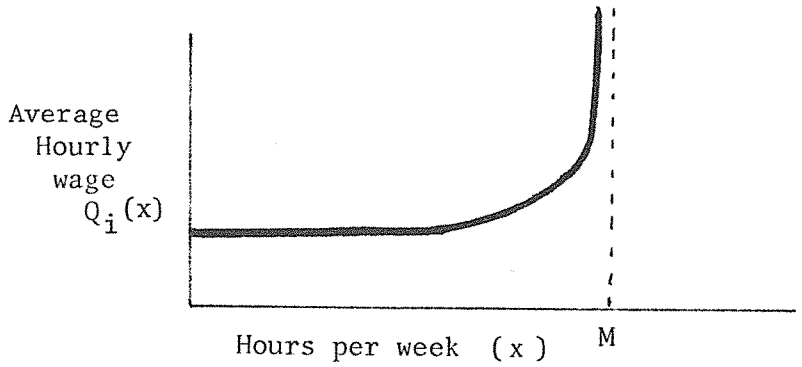


* These figures are for the purposes of illustration only.

1. Such a number will determine the location of asymptole M in figure 4.

In addition to the institutional rates, workers in an occupation who work in an industry or firm that has a high level of demand for their services will tend to receive an over-award payment. Consequently, persons working above normal hours per week may receive an hourly rate that is greater than that illustrated in Figure 3. It is expected that a smooth curve like that shown in Figure 4 can be fitted for each occupation. This curve is supposed to take into account both the institutional conditions and the effects of demand pressure. In addition to these two factors there may be another factor that could cause the curve to shift upwards because, due to market imperfections, a tight labour market situation could lead to over award payments to workers in some key occupations. There will be different curves for different occupations and in particular overtime wage rates for professionals may be no different from the ordinary rates.

Figure 4 : Relationship Between Hourly Wage and Hours per Week



For an occupation i

$x\ Q_i(x)$ = Average weekly earnings for x hours of work.

Now the income ranges R_1, R_2 ... R_k are defined so that R_1 includes incomes up to R_1 dollars per week, R_2 includes incomes from R_1

to R_2 dollars per week, and so on. For the i^{th} occupation,

$$x_{i1} = \frac{R_1}{Q_i(x_{i1})}$$

= weekly hours of work required to earn R_1 dollars per week .

The amounts x_{i1}, x_{i2}, etc., define the income boundaries R_1, R_2, etc., in terms of weekly hours of work required in occupation i. The proportion of persons in income group R_1, R_2, etc., are given by

$$\sum_i \int_1^{x_{i1}} f_i(x)\,dx , \qquad \sum_i \int_{x_{i1}}^{x_{i2}} f_i(x)\,dx , \qquad \text{etc.},$$

The distribution of incomes in the professional occupations will have to be estimated separately by relating average earnings to age.[1] When the number of persons in the professional occupations are added to different income ranges, a complete distribution of personal earned income is obtained.

It may be assumed that the income of unemployed people and pensioners is derived from government payment of unemployment benefit and pensions respectively. If the unemployed persons and pensioners are allocated to the appropriate income range, the distribution of incomes for all persons in the workforce and the pensioners can be obtained. Methods of estimating unearned income remain to be developed, but for persons in the workforce it is expected to be a small part of total income.

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1. The relationship between age and income can be seen from the data given by Mincer, J., "Labour Supply, Family Income and Consumption," American Economic Review, Vol. 50, 1966, pp. 574-583. Data on average incomes of male family heads by age group and level of education are given. While the average income of family heads with elementary education remains stable over the age groups, for those with college education (i.e., total 13 years or more), the average income for the oldest group (over 55 years) tends to be about 50% greater than the average income of family heads in the less than 35 years age group. Australian data on the age and income of professionals will be studied to estimate a relationship between the two variables. Selby Smith, C. ("Rates of Return to Post-Secondary Education in Australia", The Economic Record, Vol. 51, 1975, pp. 455-485) has referred to some work in this area currently in progress in Australia.

The above model will be calibrated when the necessary data become available. It is not necessary to fit a curve to the distribution of persons by income range but it is expected that such a curve will be positively skew even when the distribution of hours worked is negatively skew because it is expected that there will be fewer people working large amounts of overtime and earning high hourly and weekly rates as compared to the number of people working fewer hours and earning relatively less dollars per week; in other words, it is expected that a negative correlation will prevail between hours worked and average rates of pay per hour.

4. ESTIMATION OF FAMILY INCOME

It was mentioned earlier that when IMPACT is fully developed the consumption levels for different goods and services will be estimated by looking at the consumption pattern of several typical "consuming units," viz., families classified by their demographic and socio-economic characteristics. For this purpose, it is necessary to estimate average incomes for families of different types. The method of estimation described in a previous working paper[1] is restated below with certain modifications that were necessary in the light of the data.

The method used to estimate family earned income in BACHUROO is similar to the one used in BACHUE-2[2] with one major and some minor differences. In BACHUE-2 the average wage is determined for each industry, and activity rates of non-heads in the household are related to the industry in which the head of the household works. The main reason for relating the industry of head and non-head in the household is the less developed structure of the economy described by BACHUE-2 in which several members of the same household often work in the one industry. It has been suggested that

> "In principle the employment status of the head would be a more superior explanatory variable, but the behavioural base of the sectoral variable was preferable."[3]

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1. Tulpulé and McIntosh, op. cit..

2. R. Wery, G.B. Rodgers, M.D. Hopkins, "BACHUE-2," op. cit.. In this paper it is stated that the methodology is "Largely due to Sherman Robinson". For details, see I. Adelman and S. Robinson, Planning for Income Distribution, Stanford Press, 1977.

3. M.D. Hopkins, G.B. Rodgers and R. Wery, Population and Employment Working Paper 20, "A Structural Overview of BACHUE : Philippines, " ILO, Geneva, May, 1975, p.17.

However, the association between the industry (sector) of the head and non-heads in a household observed in the Philippines does not appear to apply in Australia. Instead, there may be a stronger correlation between the occupational category of the head and non-heads. Some sociological surveys show such links between the occupations of husbands and wives.[1,2] In view of this rather limited evidence, some further analysis is desirable, but at this stage it was felt that heads and other members of families[3] should be linked, but by their occupations rather than the industries in which they work. In order to estimate the family earned income, the procedure described below is used :

4.1 Estimation of *Earned Income*[4]

In order to make estimates of family earned income, it is first necessary to estimate the average earned income of the head, the spouse and other non-heads. This is done for families classified by sex and occupation of the head. (At a later stage they could be classified by age group of the family head.) The procedure adopted requires estimates of earnings relativities ($ actually earned per week) between males and females and heads and non-heads in each occupational category. Initial relativities will be estimated from the base period data and those for future years will be estimated exogenously in short through medium term applications.

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1. Lois Bryson and Faith Thompson, An Australian Newtown, Life and Leadership in a Working-Class Suburb, Harmondsworth, 1972.

2. M. Alain Gerard, "The Time Budget of Married Women in Urban Centres," in Employment of Women, Regional Trade Union Seminar, OECD, Paris, 1970.

3. In BACHUROO, families are defined as the appropriate unit instead of households. This is because (a) the surveys which will provide the data base are "family income surveys," (b) in Australia most households contain only one family, and (c) the family is the more appropriate consuming unit.

4. *Earned income* means actually earned income for working population and transfer payments (unemployment benefits, pensions and studentships) for others.

Most workers come from families with male heads. In the 1971 Census in Australia, about 10% of the total families had female heads, but in only 1,500 families (i.e., less than 0.05%) was a female recorded as a head when her spouse was present. The procedure for estimating average family *earned income* for families with a working head or a non-working head receiving a pension, unemployment benefit or studentship, is described by the accounting equation,

$$y_i = k_1 w_i + f_i \sum_j k_2 w_j \alpha_{ij} + m_i \sum_j k_3 w_j \gamma_{ij} \quad , \qquad (1)$$

where:

y_i = mean family *earned income* where the household head is in occupational category i ($i = 1, 2, \ldots, 26$; the first 13 i's represent males in the 13 occupational categories[1] and the second 13 i's represent females in those categories).

w_i = mean *earned income* per worker in category i .

k_1, k_2 and k_3 are overall factors incorporated to take account of the differences in average earnings due to position in the family. On an average, female spouses and other non-heads tend to earn less than the average rate due to working part-time and junior workforce status respectively. For the purpose of calibration, k_1 and k_3 differ between males and females in occupations 1 to 9 and 14 to 22 respectively. For the remaining occupations, the values vary between occupations and over time.

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1. See the list in Appendix 1.

α_{ij} = proportion of spouses in category j when the head is in category i; $\sum_j \alpha_{ij} = 1$ (all i) .

Thus in matrix[1] form $[\alpha]$ = $\begin{bmatrix} 0 & \vdots & \alpha_{12} \\ \cdots & \vdots & \cdots \\ \alpha_{21} & \vdots & 0 \end{bmatrix}$

The calibrated model (see next section) assumes $\alpha_{21} = 0$.

γ_{ij} = proportion of non-heads in category j when the head is in category i ; $\sum_j \gamma_{ij} = 1$ (all i) .

f_i = mean number of spouses per family when the head is in category i $(f_i \leqslant 1)$.

m_i = mean number of non-spouse non-heads over 15 years of age when the head is in category i .

$\alpha_{ij} f_i$ = mean number of spouses per family working in category j when the head is in category i .

$\gamma_{ij} m_i$ = mean number of non-heads (excluding spouses) per family working in category j when the head is in category i .

$\hat{f}$ = $\begin{bmatrix} f_1 & & \underline{0} \\ & \ddots & \\ & & \ddots \\ \underline{0} & & f_{26} \end{bmatrix}$.

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1. The $[\alpha_{ij}]$ matrix is derived from a cross tabulation classifying the number of spouses in different occupational groups by the occupation of family head. The first 13 occupations are male occupations and the second 13 are female occupations. As the male heads will have female spouses by definition, there will be no entries in the left-hand corner of the $[\alpha]$ matrix. In other words, $[\alpha_{11}] = [0]$. Similarly, $[\alpha_{22}] = [0]$.

$$\hat{m} = \begin{bmatrix} m_1 & & \underline{0} \\ & \ddots & \\ & & \ddots \\ \underline{0} & & m_{26} \end{bmatrix}$$

It may be difficult to obtain data on γ_{ij} classified by the sex of non-heads. The total will be split by assuming that the proportions of male and female non-heads overall applies in all occupational categories.

Let H_i be the number of families where the head is in category i , and N_i the number of workers in category i . Further, among these non-heads (over the age of 15) whose family head works in occupational category i , let the proportion who work in category j be B_{ij} . It follows that[1] :

$$N_i = H_i + \sum_j H_j B_{ji} n_j \quad , \tag{2}$$

or in matrix form

$$N' = H' [I + \hat{n}B] \quad , \tag{3}$$

which gives

$$H' = N' [I + \hat{n}B]^{-1} \quad , \tag{4}$$

where

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1. See Tulpulé and McIntosh, op. cit., pp. 44-46, for these results.

$$B_{ij} = \frac{\alpha_{ij} f_i + \gamma_{ij} m_i}{f_i + m_i} \qquad (\sum_j B_{ij} = 1, \text{ all } i) \quad ,$$

$$n_i = f_i + m_i \quad ,$$

and

$$\hat{n} = \begin{bmatrix} n_1 & & \underline{0} \\ & \ddots & \\ & & \ddots \\ & & \ddots \\ \underline{0} & & n_{26} \end{bmatrix}$$

(Note : $n_i + 1$ = average number of adults per family in families whose head is in category i .)

Estimates of mean family *earned income* are obtained by (1), and of the number of families by (4). These estimates will then be checked in order to ensure that the sum total of all family *earned income* is the same as the weighted total *earned incomes* in all categories.

Values of α_{ij}, γ_{ij} and B_{ij} in the base period are known. In each subsequent period, the values will be adjusted by an interative procedure that ensures that the row and column totals are correct.[1] It is not yet clear how the values of the elements of the three matrices will change over time and it would be desirable to study the sociological factors that may change marriage rates between men and women in different occupations and also study the trends in children's occupations in relation to the family heads' occupation.

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1. The technique used is called the RAS technique. The details are given in Bacharach, H., Biproportional Matrices and Input Output Change, Cambridge University Press, 1969.

4.2 Treatment of Unearned Income

The unearned income is defined in the national accounts as income from government transfer payments and from investments. Income from these two sources is treated separately : the former includes[1] pensions, unemployment benefits, child endowments, and educational scholarships; the latter[2] includes property rent, profits from unincorporated private enterprise, interest and dividends. Out of the government transfer payments all except the child endowments have been considered above as components of *earned incomes*. Child endowments are estimated from the average number of children per family and the prevailing rates. Both the average number of children and the rate per child are exogenous; the former is obtained from the family formation and fertility sub-modules and the latter is a policy variable.

Investment income of families depends on the level of asset endowment and the rates of return. The rate of return on investment may vary according to the occupation of the head of the family. Professional workers, for example, may be in a position to receive a better rate of return due to their knowledge of investment opportunities. On the other hand, if they have a high level of earned income as well as asset endowment, they may invest in such a way as to defer income from investment and this may reduce the immediate rate of return in favour of either capital gains or a high rate of return to be realised at some later date. As information on the ownership of assets is not readily available, it was decided to estimate the investment income for typical

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1. The national accounts definition also includes government health benefits. These are not covered by our model for two reasons. Firstly, because it will be difficult to allocate the benefits to families, and, secondly, because it is likely that a large proportion of the benefits are received by the institutional population not covered by our model.

2. The national accounts definition includes the value of imputed rent, interest accrued to life insurance policies and transfers from overseas. These are not included in the investment income for the purpose of this paper.

families from a regression of investment income on total earned income fitted to the Macquarie data. The Macquarie survey was based on urban families only. In rural areas the unincorporated enterprises (mostly farms) income per family constitutes a far greater proportion of the total (earned plus unearned) income as compared with urban areas. The model, as it stands, underestimates the unearned income for families in the rural occupations. It is not possible to make an allowance for this under estimation at this stage but in a later version of the model farm incomes will have to be treated separately. For this and other reasons, the procedure for estimating investment income, of which details are given below in section 5, will have to be modified at a later stage.

4.3 Total Family Income

The average family income from all sources for families for the year 1 can now be estimated as a sum of head and non-head earned income, government transfer payments and income from investments. The projections for year 1 and for each future year will be reconciled with the aggregates being estimated in other parts of the IMPACT model.

The above procedure estimates the average family income and its components for families whose heads are in the different occupational categories. By referring to the appropriate elements in the $[\alpha]$ matrix, estimates of average family income for families with working spouse and non-working spouse can be obtained and income of single person families can be obtained by subtraction. Thus the model will enable us to estimate the average income of several types of typical consuming units. At a later stage, depending on data availability, the procedure can be extended to give disaggregated estimates for two or three age groups of family heads.

The above model has been calibrated using currently available data. The problems encountered in arriving at approximate estimates of the variables involved are discussed in section 5 and Appendix 2, and the results of calibration in section 6.

5. INPUT REQUIREMENTS OF THE MODEL

For the purpose of estimating the income distributions data on a number of variables for the base year (1971-72, year 0) and for year 1 are required. For the purpose of calibration and parameter estimation it is desirable to have data on the past trends in income distribution so that the model can be tested. At this stage most of the data are not readily available and therefore it has been necessary to make approximate estimates. In this section the sources of data for the purpose of calibration are listed, and the submodules that will give estimates for year one are also shown.

For estimating the personal distribution of income values of the following variables are required.

5.1. Number of workers by occupation : For the past years the information will be obtained from the special tabulations of Labour Force Survey data. For year 1 the numbers are based on total hours worked and the distribution of workers by hours worked per week.

5.2 The total hours worked in year 1 will be obtained from the BACHUROO-ORANI interface and for years prior to 1972-73 from the Labour Force Surveys.

5.3 The distribution of number of workers by hours worked per week in year 1 will be assumed to have the same functional form as in the base year and the mean values will be estimated from 5.1 and 5.2 above using the method described in section 3. The other parameter, σ , will be assumed to be either the same as in the base year or changing

systematically if the past trends indicate a systematic change. In particular, tests will be made to investigate whether $\frac{\sigma}{\mu}$ is stable over time. If the ratio is found to be stable, then σ will be estimated endogenously.

5.4. The average hourly wage for year 1 will be given by the BACHUROO-ORANI interface.

5.5. Distribution of income for the professional workers will be related to their age distribution which is given by the 'labour force by occupation' submodule.

Given the above data the distribution of personal income in year 1 can be estimated.

In order to estimate the average family income for different types of families values of the following variables are required :

5.6. The number of workers in year 1 in each occupation are estimated in 5.3 above, and for the past years from the Labour Force Survey special tabulations. As the past data are not yet available, approximate estimates were obtained for the purpose of calibration as shown in Appendix 2.

5.7. The average wage per person in the year 1 is caluclated from the total number of employed persons and total wage bill for each occupation. For the purposes of initial calibration, rough estimates were made by regrouping the average earnings data for 1968/69 published by the ABS[1] and for other years the figures were adjusted in line

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1. Australian Bureau of Statistics, Income Distribution Survey 1968-69, (ABS Ref. 17.12), Canberra, 1972.

with the trends in average earnings.[1] For the details of the procedure used see Appendix 2.

5.8. The average wage relativities between the family head, spouse and the other non-heads were estimated from the aggregate figures for all occupations obtained from the Macquarie data and were applied to all occupations.[2]

5.9. The number of now-married females by occupation in the year 1 will be obtained from the distribution of all females by occupation in the 'labour force by occupation' submodule combined with the labour force participation rates for married women in the 'overall labour supply' submodule. For the purpose of final calibration data will be obtained from the Labour Force Surveys but in the meantime approximate estimates are being used. The number of married men will be set equal to the total number of married women. The distribution of men by marital status in each occupation will be obtained from the 'Family Formation' submodule. The above figures give the number of families with a married male head in each occupational group. The number of single person families are obtained by applying a 'headship rate' to the total number of not married persons by sex in each occupation.

5.10. The non-head and spouse activity rates in the base year, i.e. elements of $[\alpha_{ij}]$ and $[\gamma_{ij}]$ matrices will be obtained

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1. Australian Bureau of Statistics Survey of weekly Earnings & Hours, (ABS Ref. 6.1), Canberra.

2. Figures for 1968/69 and 1973/74 will be available later. For projection purposes the relativities will be set exogenously.

from the 1971 Population Census special tabulations and for year 1 the elements of the two matrices will be obtained by the RAS method given the base year values of the elements and the row and column totals obtained in 5.9 above. For the purpose of initial calibration the matrices obtained from the Macquarie sample are used. There are a number of anomalies observed in these data but as the sample is too small it is not possible to improve the estimates at this stage.

5.11. The various rates of Government transfer payment for the past years were obtained from published data on social security. A single figure is used for each variable in each year. For year 1 the figures will be exogenous.

5.12. In order to calculate income from investments a regression of investment income on total family earned income was fitted to the Macquarie data. The following regression equation was obtained :

$$\underset{}{\text{Investment income}} = \underset{(t=-6.32)}{-461} + \underset{(t=10.72)}{0.1658}\ \text{Total Earned Income} \quad (R=0.2212).$$

The regression was based on data for 2239 families in the Macquarie sample. The t value indicates that the regression coefficient is significant at the 5 per cent level. Investment income for families with less than $2781 earned income in 1966 was assumed zero. Adjustment for the higher than average investment incomes of pensioners in relation to their lower than average earned income (i.e. pension) has not been made. Similarly it has not been possible to allow for the higher than average investment income of persons in the rural occupations who tend to receive a very large proportion of their total income from unincorporated enterprises (farms). The constant in the

regression equation has been adjusted by changing its value at the same rate as the change in C.P.I. in order to allow for changes in total money income over time due to inflation. The regression coefficient 0.1546 is assumed to be stable over time. This procedure of estimating unearned income does not take into account any movement in rates of return over the business cycle. At a later stage attempts will be made to ensure that the aggregate investment income of all families is the same as the total projected by the ORANI module.

Given all the above information, the distribution of income can be estimated from the model. The personal distribution of income has not been calibrated yet but the results obtained from the calibration of the family income model are given in the next section.

6. CALIBRATION OF FAMILY INCOME MODEL

The main purpose of the model is to project the average family incomes for different types of families given the base year data, values of the various parameters and the projected values of the independent variables most of which are endogenous to the IMPACT model with the exceptions of a few policy type variables. Before using the model for projection purposes it is important to study whether the model is satisfactory by using the model framework and past data on the independent variables, and check whether the model reproduces the actual distributions. This procedure is usually described as 'validation'. As data are not yet available for validation, the model is 'calibrated' using the available data. Calibration is a useful exercise because it indicates whether the model is operational from the programming point of view and also whether the aggregate output, not in great detail, are approximately equal to the actual values. If the calibrated results diverge from the actuals it is possible to study the reasons for the divergence.

It is clear from the comments in the last section that input data for testing the model are not available due to two reasons. Firstly the various submodules in the BACHUROO module are not fully operational; in particular the Family Formation submodule and the ORANI-BACHUROO interface are yet to be finalised. Secondly the special tabulations from the Population Censuses and the various surveys are not yet all ready. In view of the lack of data, approximate estimates of all the variables involved were made for the years 1966 to 1971, and the model was calibrated. It is not possible to check in detail whether the calibrated results are roughly the same as the actual values but some

aggregate checks are possible. When the data from both the 1968-69 and 1973-74 Family Income Surveys become available it will be possible to validate the model by checking whether the model is able to reproduce the actual 1973-74 distributions, starting from the base year 1968-69.

Appendix 2 shows the very large number of assumptions necessary to provide approximate values of the variables used in the model. In view of these assumptions, caution is necessary in interpreting the results.

The base year (1966) data on all the variables (except α_{ij} and γ_{ij}) are given in Appendix 2 and some of the 1971 values of the independent variables are also shown. Values for the intervening years were often obtained by scaling the available data on aggregates or by interpolation.

The average income for different types of families for 1966 calibrated from the model are shown in Appendix 3 in Tables 3.1 to 3.4 and for 1971 in Tables 3.5 to 3.8 in order to give an idea about the type of output that can be obtained from the model. In estimating the average income of families classified by occupation and sex of the head the model described in section 4 has been applied to the data on appropriate averages (heads' income, spouses' and non-head's income multiplied by the probability of their working in different occupations, average number of children under 15, etc.) compiled under various assumptions. The average income for families with a working spouse is calculated by referring to the appropriate elements of the α_{ij} matrix (i.e. excluding the following four occupations of spouses: student, unemployed, pensioner and not in the work force). The average income

for families with a non-working spouse is calculated similarly and for the single person family, the average income is calculated by subtraction.

In the Macquarie survey it was found that families whose head had a working wife tended to have on average fewer children under 15 than families where the wife did not work. On the other hand families whose head had a working wife tended to have on average more children over 15 than families where the wife did not work. Adjustments were made to take into account these two factors. The approximate adjustment may cause the sum of incomes in Tables 3.2 to 3.4 to diverge slightly from the total in Table 3.1.

Between 1966 and 1971 the number of persons over 15 in Australia increased by 11 per cent but the number of working persons (occupations 1 to 9) increased by 17 per cent. The number of pensioners increased by 27 per cent but the number not in workforce remained static. The number of rural workers fell and the numbers in the armed forces changed slightly. Significant increases are observed in all other occupations.

The total number of families increased 14 per cent, i.e. at a greater rate than the adult population and the number of families with a working wife increased 42 per cent.

The figures in Appendix 3 are for the purpose of illustration only. The increase in average family incomes are of the order of 40 to 50 per cent but any divergence from the average should not be treated as a significant result. In general, these results are a consequence of the

assumptions built into the preliminary data.

Data required to estimate unearned income were not available on a time series basis and therefore often the same numbers were used throughout the period. Also it was not possible to allow for any changes in the rates of return or in the overall investment income over the business cycle. All that the results demonstrate is that prima facie the model is capable of producing plausible output given the necessary input data. The preliminary data on elements in the two matrices are dubious and caution is necessary in looking at the results. No firm conclusions can be drawn from these preliminary results except that the family incomes overall can be expected to have increased faster than the average wage rates due to increasing participation of married women in the workforce.

7. CONCLUSIONS

The family income model described above is capable of providing information on average earnings for different types of families. Although the model has been calibrated on a provisional basis using low quality data it is not possible to validate the results until better data on incomes at two points in time and on trends in the exogenous variables in the intervening period become available for use in this framework. Comments on the framework are welcome but it should not be considered that the results in Appendix 3 are claimed to be representative of the real situation.

Appendix 1

LIST OF OCCUPATIONAL GROUPS

1. Professional White Collar
2. Skilled White Collar
3. Semi and Unskilled White Collar
4. Skilled Blue Collar, Metal and Electrical
5. Skilled Blue Collar, Building
6. Skilled Blue Collar, Other
7. Semi and Unskilled Blue Collar
8. Rural Workers
9. Armed Services

10. Pensioners
11. Unemployed
12. Students
13. Not in work force

Appendix 2*

DATA FOR CALIBRATION OF FAMILY INCOME MODEL

Most of the calculations described below were carried out for males and females separately. For the purpose of calibration, data on the independent variables (i.e. those which are exogenous to the family income model) for years 1966 to 1971 was prepared mostly using the published information. A brief description of the methods followed and assumptions made is included here. Data on selected variables are given. The values are approximate but give a rough indication of magnitudes and trends.

Wages

The average wage for full time workers in all occupations combined for each year was obtained by multiplying the all industry average weekly earnings figure[1] by the ratio of average earnings for all occupations in 1968-69[2] to average earnings in all occupations except 'professional white collar' and 'skilled white collar' in order to allow for the exclusion of managerial, executive, professional & higher supervisory staff in the annual Survey Weekly Earnings and Hours.

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* This appendix is prepared on the basis of tables and notes prepared by Vince Manion.

1. Australian Bureau of Statistics, Survey of Weekly Earnings and Hours (ABS Ref. 6.1), Canberra. Note that the published figures are for juniors and adults separately. These were weighted by the proportion of the workforce who were adults and juniors to give an all persons average.

2. Australian Bureau of Statistics, Income Distribution 1968-69, (ABS Ref. 17.12), Canberra.

In order to calculate the wage rates for part-time and full-time workers combined in each IMPACT occupation group in each year the following procedure was adopted :

(a) An overall wage rate for part-time workers in 1968 was estimated by multiplying the 1968 full-time figure by the ratio of part-time rate to full-time rate in the 1968-69 estimated by Leaper.[1] For other years, it was assumed that the overall wage rate for part-time workers has changed in the same manner as the overall rate for full-time workers.

(b) Wage rates for full-time and part-time workers in different IMPACT occupations in each year 1966 to 1971 were calculated by applying the relativities calculated separately for the two types of workers by Leaper[1] based on 1968-69 data.

(c) Weighted averages of the two rates were calculated by using the proportions[2], of workers in part-time and full-time employment in each occupation in each year, as weights.

It is likely that the average earnings will vary according to whether a person is a family head, spouse (more likely to be working part-time) or other family member (more likely to be a junior). For this reason the Macquarie survey data was used to obtain the overall relativities between the average earnings between male heads and non-heads and female spouses and non-heads. These relativities were applied to the average earnings in each occupation to give earnings by sex,

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1. Unpublished research memorandum (January 1975).

2. Australian Bureau of Statistics, The Labour Force, (ABS Ref. 6.22), Canberra.

occupation and position in the family.

Rates of pensions, unemployment benefits and child endowment were obtained from a publication of the Department of Social Security.[1]

Workforce by sex, marital status and IMPACT occupations

Data on the number of employed persons (full-time and part-time) by the ABS occupation groups and sex for the May quarter are obtained from the Population Surveys.[2] These figures were split into now married and others by using the information from the 1971 Population Census on number of workers by occupation and marital status. A further adjustment was made in order to separate the permanently separated from the total married workers. The Labour Force provides data on unemployed by marital status; the numbers of married workers were adjusted to exclude permanently separated who were allocated to the not now married group. The May quarter figures were then averaged to give financial year estimates and converted to IMPACT occupations by using the relationship between the numbers of persons in various IMPACT and ABS occupations at the 1971 census as shown in Table 2.1 below. The resultant figures for total workforce by sex and marital status differed slightly from the initial figures from which they were derived but the differences were small enough to be ignored.

Number of family heads by occupation

It was assumed that all now married males are family heads and all now married female are spouses. Because of the various

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1. Department of Social Security, Statistical Summary 1963 to 1972, Canberra 1972.

2. The Labour Force op. cit.

Table 2.1 - Derivation of workforce by sex, marital status and IMPACT occupations

IMPACT occupations	General Operations on workforce by sex, marital status and A.B.S. occupation	Males		Females	
		Now Married	Single(1)	Now Married	Single(1)
Professional hite ollar; Skilled hite ollar	Add professional and technical and administrative	Multiply by 1.0086 and split total 22.04% to PWC and 77.96% to SWC	Multiply by 1.0038 and split total 25.71% to PWC and 74.29% to SWC	Multiply by .9511 and split 21.41% to PWC and 78.59% to SWC	Multiply by .8135 and split 22.62% to PWC and 77.38% to SWC
Semi and unskilled white collar	Add sales and clerical	Multiply by 1.0369	Multiply by 1.0341	Multiply by 1.0837	Multiply by 1.1409
Skilled blue collar (SBC) - Metal & Electrical; SBC - building; SBC - other; Semi and unskilled blue collar	Add transport and communication; tradesmen, production process workers etc; and service sport and recreation	Multiply by .9873 and split total 26.37% to SBC - M & E; 11.76% to SBC - B; 4.63% to SBC-0; and 57.24% to S & USBC	Multiply by .9883 and split total 28.26% to SBC - M & E; 10.19% to SBC - B; 5.48% to SBC - 0; and 56.07% to S & USBC	Multiply by .9226 and split total 0.83% to SBC - M & E; 0.40% to SBC - B; 9.41% to SBC-0; and 89.36% to S & USBC	Multiply by .8606 and split total 0.71% to SBC - M & E; 0.37% to SBC - B; 8.96% to SBC-0; and 89.96% to S & USBC
Rural	Exactly equivalent to farmers, fishermen, timber-getters, etc.				
Defence	Obtained from year book split into marital status by the same process outlined in the above text for civilian occupations				
Unemployed	Exactly equivalent to unemployed				

(1) Never married, widowed, divorced and permanently separated.

manipulations involved in obtaining the above workforce figures (and because this assumption is not exactly correct) the numbers of now married males and females will not be equal. They were equated by changing the numbers of married females not in the workforce, as this is the largest of all groups and hence any given change in numbers will have the smallest proportionate effect. In all years the adjustment was positive (of between forty and fifty thousand) indicating a consistent underestimating of the number of married women not in the workforce. It was thought that this will represent the wives of defence personnel (i.e. not included in Labour Force Surveys) hence no compensating decrease was made in the numbers of not married women who are not in the workforce.

The proportion of 'single' family heads by sex and occupation was obtained by multiplying the numbers of single persons by 'headship rates' obtained from the Macquarie survey, which were increased over time to allow for the rising family headship rates[1] observed during the late 1960's.

Occupation of spouses and other non-heads by occupation of family heads

The Macquarie survey data was used to obtain the initial $[\alpha_{ij}]$ matrix (occupation of spouses x heads' occupation) for 1966-67 with spouses of defence personnel and the unemployed assumed to have the same occupational distribution as the combined skilled, semi skilled and unskilled blue collar groups except for a small alteration to allow for all married female defence workers to have male family heads in the defence forces; pensioner heads were assumed to have only pensioner

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1. Di Ullio, O., "Household Formation 1911-2001", National Population Enquiry, Working Paper No. 24, Canberra, April 1976.

spouses. As the Macquarie survey covered only urban areas it was necessary to alter the entries for rural heads to ensure the correct numbers of married female rural workers given by the 1971 census.

The $[\gamma_{ij}]$ (occupation of non-head non-spouses over 15 x head's occupation) matrix was also initially obtained from the Macquarie survey with separate matrices for males and females. All non-head non-spouses were assumed to be located in families with married male heads as the small number present in families headed by 'single' persons in the Macquarie survey made the construction of a $[\gamma_{ij}]$ matrix for them a dubious exercise (several occupations of non-head non-spouse had no entries). Again family heads in the defence occupation and the unemployed heads were assumed to have the same entries as the combined blue collar groups; and pensioners and the same entries as the not in workforce group.

α_{ij} and γ_{ij} are the proportions of spouses (i.e. wives) and non-heads respectively in occupation j when the head is in occupation i. After obtaining initial estimates of α_{ij} and γ_{ij} as described above, it was necessary to check whether they are consistent with the total numbers of spouses and non-heads classified by their own occupation. The consistency check was made as follows :

Let S_{ij} = Number of spouses in occupation j when the head is in occupation i.

also R_{ij} = Number of non-heads in occupation j when the head is in occupation i.

Now $\alpha_{ij} = \frac{S_{ij}}{\sum_j S_{ij}}$ and $\gamma_{ij} = \frac{R_{ij}}{\sum_j R_{ij}}$

The elements of $[S_{ij}]$ and $[R_{ij}]$ matrices can be obtained by multiplying $[\gamma_{ij}]$ and $[\gamma_{ij}]$ by $f_i H_i$ and $m_i H_i$ respectively. $\sum_i S_{ij}$ and $\sum_i R_{ij}$ were compared with the numbers of married females in occupation j and numbers of non-heads in occupation j respectively. It was found that there were discrepancies in both sets of figures. Pro-rata adjustments using the RAS technique were made to ensure that the row and column totals of matrices $[S]$ and $[R]$ are consistent in the year 1966 and the corrected values of S_{ij} and R_{ij} were used to obtain initial estimates of α_{ij} and γ_{ij} respectively. Having obtained consistent values of $[S]$ and $[R]$ for the base year, for future years the matrices are obtained using the RAS technique and the estimated values of row and column totals for each year.

Children under 15 by occupation of head

Children under 15 were allocated to families with both 'single' and married heads. The Macquarie survey figures for the average number of children by occupation and marital status of head were multiplied by our estimates of the number of families of each type (derived as above) to give an initial estimate of the total number of children under 15 and corrected according to the actual number of children under 15[1] (ABS Estimated Age Distribution of the Population Ref. 4.15).

Some of these data are given in the attached tables.

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1. Australian Bureau of Statistics, Estimated Age Distribution of the Population, (Ref. 4.15), Canberra.

Table 2.2 Workforce by occupation and sex
1966 and 1971
(Thousands)

	Occupation	1966			1971		
		Male*	Female*	Total	Male*	Female*	Total
1.	Professional White Collar	131.1	47.9	179.0	151.7	56.1	207.8
2.	Skilled White Collar	444.6	169.6	614.2	518.1	199.5	717.6
3.	Semi and Unskilled White Collar	503.3	688.4	1191.7	572.3	882.2	1454.5
4.	Skilled Blue Collar, Metal and Electrical	506.9	3.5	510.4	556.5	4.4	560.9
5.	Skilled Blue Collar, Building	211.5	1.7	213.2	233.1	2.2	235.3
6.	Skilled Blue Collar, Other	92.2	41.9	134.1	100.9	51.2	152.1
7.	Semi and Unskilled Blue Collar	1068.3	408.1	1476.4	1175.1	494.8	1669.9
8.	Rural Workers	421.0	50.4	471.4	392.4	57.0	449.4
9.	Armed Services	69.3	2.9	72.2	71.0	3.2	74.2
10.	Pensioners	205.7	438.4	644.1	259.5	560.6	820.1
11.	Unemployed	36.5	35.7	72.2	52.5	43.9	96.4
12.	Students	186.8	144.2	331.0	260.9	212.0	472.9
13.	Not in work force	261.1	2133.2	2394.3	263.3	2092.0	2355.3
	All occupations	4138.3	4165.9	8304.2	4607.3	4659.1	9266.4

* Values of N_i (i=1...13 for males and 14 to 26 for females)

Source : See text in Appendix B.

Table 2.3 Number of now married persons by occupation
1966 and 1971
(Thousands)

	Occupation	1966			1971		
		Male	Female	Total	Male	Female	Total
1.	Professional White Collar	101.8	22.7	124.5	120.8	30.5	151.3
2.	Skilled White Collar	360.0	83.3	443.3	427.3	115.6	542.9
3.	Semi and Unskilled White Collar	316.2	300.8	617.0	369.2	429.8	799.0
4.	Skilled Blue Collar, Metal and Electrical	335.4	2.1	337.5	380.2	3.3	383.5
5.	Skilled Blue Collar, Building	149.6	1.0	150.6	169.6	1.5	171.1
6.	Skilled Blue Collar, Other	58.9	24.3	83.2	66.7	35.4	102.1
7.	Semi and Unskilled Blue Collar	727.9	231.2	959.1	825.3	336.0	1161.3
8.	Rural Workers	291.7	34.4	326.1	279.0	41.6	320.6
9.	Armed Services	34.6	0.3	34.9	40.3	0.3	40.6
10.	Pensioners	123.3	123.3	246.6	158.7	158.7	317.4
11.	Unemployed	15.1	17.0	32.1	19.2	26.3	45.5
12.	Students	1.5	1.2	2.7	5.2	4.2	9.4
13.	Not in work force	153.3	1827.7	1981.0	177.5	1856.1	2033.6
	All occupations	2669.3	2669.3	5338.6	3039.2	3039.2	6078.4

Source : See text in Appendix B.

Table 2.4 Number of families by occupation and sex of the head
1966 and 1971
(Thousands)

	Occupation	1966			1971		
		Male*	Female*	Total	Male*	Female*	Total
1.	Professional White Collar	111.6	9.7	121.3	133.1	11.5	144.6
2.	Skilled White Collar	398.9	37.9	436.8	476.2	44.9	521.1
3.	Semi and Unskilled White Collar	339.5	71.2	410.7	399.2	90.4	489.6
4.	Skilled Blue Collar, Metal and Electrical	363.4	0.4	363.8	414.4	0.4	414.8
5.	Skilled Blue Collar, Building	159.7	0.2	159.9	181.9	0.2	182.1
6.	Skilled Blue Collar, Other	64.3	4.6	68.9	73.4	4.7	78.1
7.	Semi and Unskilled Blue Collar	815.2	95.1	910.3	931.9	97.3	1029.2
8.	Rural Workers	319.7	0	319.7	308.9	0	308.9
9.	Armed Services	41.5	1.1	42.6	47.6	1.3	48.9
10.	Pensioners	183.8	275.1	458.9	246.7	393.7	640.4
11.	Unemployed	19.3	7.7	27.0	27.1	9.4	36.5
12.	Students	2.4	0.4	2.8	6.7	0.7	7.4
13.	Not in work force	232.4	266.7	499.1	252.4	234.9	487.3
	All occupations	3051.8	770.0	3821.8	3499.4	889.4	4388.8

* Values of H_i (i=1...13 for males and 14 to 26 for females)

Source : See text in Appendix B.

Table 2.5 Average wage* by sex and occupation
($ per year)

Occupation	1966		1971	
	Male	Female	Male	Female
1. Professional White Collar	6817	2660	10472	4540
2. Skilled White Collar	4482	2304	6885	3932
3. Semi and Unskilled White Collar	3162	1519	4671	2287
4. Skilled Blue Collar, Metal and Electrical	3086	2367	4572	3572
5. Skilled Blue Collar, Building	3085	2298	4571	3468
6. Skilled Blue Collar, Other	2922	1796	4329	2711
7. Semi and Unskilled Blue Collar	2763	1295	4094	1955
8. Rural Workers	2955	1787	4374	2836
9. Armed Services	3415	1919	5074	3018

* Values of w_i (i=1 to 9 for males and 14 to 22 for females)

Source : See text in Appendix B.

Table 2.6 Wage relativities between heads and non-heads
1966 Macquarie data

	Wage Relativity
All males and Male head	1.0234
All males and Male non-head	0.6323
All females and Female head	1.0958
All females and Female spouse	1.0439
All females and Female non-head	0.7981

Source : Macquarie University, Survey of Consumer Expenditures and Finances Australia, 1966-68.

Table 2.7 Average number of children per family

Occupation of family head	1966 Sex of family head Male	1966 Sex of family head Female	1971 Sex of family head Male	1971 Sex of family head Female
1. Professional White Collar	1.161	0.179	1.098	0.170
2. Skilled White Collar	1.188	0.154	1.124	0.146
3. Semi and Unskilled White Collar	1.232	0.215	1.164	0.205
4. Skilled Blue Collar, Metal and Electrical	1.220	0.122	1.154	0.116
5. Skilled Blue Collar, Building	1.234	0.122	1.169	0.116
6. Skilled Blue Collar, Other	1.212	0.122	1.147	0.116
7. Semi and Unskilled Blue Collar	1.196	0.407	1.129	0.387
8. Rural Workers	1.313	0	1.239	0
9. Armed Services	1.127	0.328	1.086	0.312
10. Pensioners	0.079	0.251	0.072	0.239
11. Unemployed	1.069	0.328	0.942	0.312
12. Students	0.226	0	0.267	0
13. Not in work force	0.078	0.251	0.078	0.239

Source : See text in Appendix B.

Table 2.8 Average number of children under and over 15 by family type
1966 Macquarie data

	Average number of children per family	
	under 15	15 and over
Male head working wife	1.0630	0.9882
Male head non-working wife	1.0470	0.7669

Source : Macquarie University, Survey of Consumer Expenditures and Finances Australia, 1966-68.

Appendix 3

CALIBRATION RESULTS

The tables included in this appendix are for the purpose of illustration only. They indicate the type of results that can be obtained given the necessary information on input variables. In general the unearned income is understated because rates of transfer payment are understated. In particular the unearned incomes of pensioners and those in the rural occupations are considerably underestimated by the model (see section 4.2). In general the earned incomes of families with a working head are slightly overstated. Almost all the persons over 15 are allocated to families. Those in institutions may have a smaller income per head but no adjustment has been made. It has not been possible to get better data on earnings by occupation. It will be possible to scale the results using information on aggregates but it was felt that the results as they stand, are reasonable for the purpose of illustration. The model will be recalibrated with better data in the near future.

Example Only

Table 3.1 Average Family Income by Head's Occupation and Sex

Family Type: All families - 1966

	Occupation	Number of Families (thousands)	Average[a] Earned Income	Average[b] Unearned Income	Average Total Income
Males	1. Professional White Collar	111.61	8038	931	8969
	2. Skilled White Collar	398.89	5843	569	6412
	3. Semi and Unskilled White Collar	339.53	4516	350	4866
	4. Skilled Blue Collar, Metal and Electrical	363.43	4421	333	4754
	5. Skilled Blue Collar, Building	159.73	4439	336	4775
	6. Skilled Blue Collar, Other	64.34	4243	303	4546
	7. Semi and Unskilled Blue Collar	815.23	4126	282	4408
	8. Rural Workers	319.74	4190	292	4482
	9. Armed Services	41.49	4684	371	5055
	10. Pensioners	183.77	1540	n.a.	n.a.
	11. Unemployed	19.34	1921	53	1974[d]
	12. Students	2.37	n.a.	n.a.	n.a.
	13. Not in work force	232.98	576	n.a.	n.a.
	All Occupations	3051.85	4164	323	4487
Females	14. Professional White Collar	9.69	2915	30	2945
	15. Skilled White Collar	37.92	2525	7	2532
	16. Semi and Unskilled White Collar	71.16	1665	10	1675
	17. Skilled Blue Collar, Metal and Electrical	0.36	2593	6	2599
	18. Skilled Blue Collar, Building	0.18	2518	6	2524
	19. Skilled Blue Collar, Other	4.55	1968	6	1974
	20. Semi and Unskilled Blue Collar	95.12	1419	19	1438
	21. Rural Workers	0.00	-	-	-
	22. Armed Services	1.08	2103	15	2118
	23. Pensioners	275.08	676	n.a.	n.a.
	24. Unemployed	7.73	429	15	444[d]
	25. Students	0.44	n.a.	n.a.	n.a.
	26. Not in work force	266.70	n.a.	n.a.	n.a.
	All Occupations	770.03	752	13	765

Source : Model outlined in section 4 of this paper.

Notes
(a) In general earned income is somewhat overstated.
(b) In general unearned income is somewhat understated. This is especially so in the case of occupations 8 and 10 to 13.
(c) Results based on a small number of families are unreliable.
(d) The annual income of the unemployed as estimated by the model is not very meaningful because in a real world situation the annual income will depend on the duration of unemployment and also on the occupation during the rest of the year.

Example Only

Table 3.2 Average Family Income by Head's Occupation and Sex
Family Type: Male head, wife working - 1966

		Occupation	Number of Families (thousands)	Average Earned Income	Average Unearned Income	Average Total Income
Males	1.	Professional White Collar	29.48	9586	1171	10757
	2.	Skilled White Collar	97.25	7283	789	8072
	3.	Semi and Unskilled White Collar	106.32	5681	523	6204
	4.	Skilled Blue Collar, Metal and Electrical	94.89	5641	515	6156
	5.	Skilled Blue Collar, Building	44.56	5652	518	6170
	6.	Skilled Blue Collar, Other	17.54	5466	486	5952
	7.	Semi and Unskilled Blue Collar	229.65	5291	455	5746
	8.	Rural Workers	49.45	5702	529	6231
	9.	Armed Services	10.88	5907	556	6463
	10.	Pensioners	0.00	-	-	-
	11.	Unemployed	4.65	3169	100	3269
	12.	Students	0.00	-	-	-
	13.	Not in work force	10.42	2246	n.a.	n.a.
		All Occupations	700.10	5870	553	6423

Source: Model outlined in Section 4 of this paper

See notes to Table 3.1.

Example Only

Table 3.3 Average Family Income by Head's Occupation and Sex

Family Type: Male head, wife not working - 1966

	Occupation	Number of Families (thousands)	Average Earned Income	Average Unearned Income	Average Total Income
Males	1. Professional White Collar	72.36	7484	844	8328
	2. Skilled White Collar	262.87	5382	497	5879
	3. Semi and Unskilled White Collar	210.03	3993	268	4261
	4. Skilled Blue Collar, Metal and Electrical	235.62	3963	262	4225
	5. Skilled Blue Collar, Building	105.09	3975	264	4239
	6. Skilled Blue Collar, Other	41.38	3789	233	4022
	7. Semi and Unskilled Blue Collar	498.46	3676	212	3888
	8. Rural Workers	241.56	3904	257	4161
	9. Armed Services	23.73	4252	305	4557
	10. Pensioners	123.30	1714	n.a.	n.a.
	11. Unemployed	10.45	1528	56	1584
	12. Students	1.50	n.a.	n.a.	n.a.
	13. Not in work force	142.85	484	n.a.	n.a.
	All Occupations	1969.20	3799	266	4065

Source: Model outlined in Section 4 of this paper.

See notes to Table 3.1.

Example Only

Table 3.4 Average Family Income by Head's Occupation and Sex

Family Type: Single persons - 1966

		Occupation	Number of Families (thousands)	Average Earned Income	Average Unearned Income	Average Total Income
Males	1.	Professional White Collar	9.77	6972	700	7672
	2.	Skilled White Collar	38.77	4582	308	4890
	3.	Semi and Unskilled White Collar	23.18	3233	83	3316
	4.	Skilled Blue Collar, Metal and Electrical	27.92	3156	77	3233
	5.	Skilled Blue Collar, Building	10.08	3154	77	3231
	6.	Skilled Blue Collar, Other	5.42	2988	49	3037
	7.	Semi and Unskilled Blue Collar	87.11	2825	18	2843
	8.	Rural Workers	28.73	3020	44	3064
	9.	Armed Services	6.87	3492	131	3623
	10.	Pensioners	60.47	676	n.a.	n.a.
	11.	Unemployed	4.24	817	12	829
	12.	Students	0.87	n.a.	n.a.	n.a.
	13.	Not in work force	79.11	n.a.	n.a.	n.a.
		All Occupations	382.55	2245	73	2318
Females	14.	Professional White Collar	9.69	2915	30	2945
	15.	Skilled White Collar	37.92	2525	7	2532
	16.	Semi and Unskilled White Collar	71.16	1665	10	1675
	17.	Skilled Blue Collar, Metal and Electrical	0.36	2593	6	2599
	18.	Skilled Blue Collar, Building	0.18	2518	6	2524
	19.	Skilled Blue Collar, Other	4.55	1968	6	1974
	20.	Semi and Unskilled Blue Collar	95.12	1419	19	1438
	21.	Rural Workers	0.00	-	-	-
	22.	Armed Services	1.08	2103	15	2118
	23.	Pensioners	275.08	676	n.a.	n.a.
	24.	Unemployed	7.73	426	15	441
	25.	Students	0.44	n.a.	n.a.	n.a.
	26.	Not in work force	266.70	n.a.	n.a.	n.a.
		All Occupations	770.03	752	13	765

Source: Model outlined in Section 4 of this paper.

See notes to Table 3.1.

Example Only

Table 3.5 Average Family Income by Head's Occupation and Sex

Family Type: All families - 1971

		Occupation	Number of Families (thousands)	Average Earned Income	Average Unearned Income	Average Total Income
Males	1.	Professional White Collar	133.10	12336	1540	13876
	2.	Skilled White Collar	476.22	8869	967	9836
	3.	Semi and Unskilled White Collar	399.21	6667	602	7269
	4.	Skilled Blue Collar, Metal and Electrical	414.39	6543	581	7124
	5.	Skilled Blue Collar, Building	181.91	6572	586	7158
	6.	Skilled Blue Collar, Other	73.36	6279	536	6815
	7.	Semi and Unskilled Blue Collar	931.93	6101	505	6606
	8.	Rural Workers	308.93	6109	514	6623
	9.	Armed Services	49.44	6917	637	7554
	10.	Pensioners	246.69	1927	n.a.	n.a.
	11.	Unemployed	27.06	2505	47	2552
	12.	Students	6.65	n.a.	n.a.	n.a.
	13.	Not in work force	252.42	936	n.a.	n.a.
		All Occupations	3501.31	6169	559	6728
Females	14.	Professional White Collar	11.48	4975	270	5245
	15.	Skilled White Collar	44.92	4309	158	4467
	16.	Semi and Unskilled White Collar	90.42	2506	10	2516
	17.	Skilled Blue Collar, Metal and Electrical	0.38	3915	91	4006
	18.	Skilled Blue Collar, Building	0.20	3800	73	3873
	19.	Skilled Blue Collar, Other	4.68	2971	5	2976
	20.	Semi and Unskilled Blue Collar	97.26	2143	18	2161
	21.	Rural Workers	0.00	-	-	-
	22.	Armed Services	1.35	3307	15	3322
	23.	Pensioners	393.70	832	n.a.	n.a.
	24.	Unemployed	9.37	520	15	535
	25.	Students	0.72	n.a.	n.a.	n.a.
	26.	Not in work force	234.91	n.a.	n.a.	n.a.
		All Occupations	889.38	1168	22	1190

Source: Model outlined in Section 4 of this paper.

See notes to Table 3.1.

Example Only

Table 3.6 Average Family Income by Head's Occupation and Sex

Family Type: Male head, wife working - 1971

	Occupation	Number of Families (thousands)	Average Earned Income	Average Unearned Income	Average Total Income
Males	1. Professional White Collar	42.79	14616	1902	16518
	2. Skilled White Collar	143.98	10955	1293	12248
	3. Semi and Unskilled White Collar	152.59	8269	848	9117
	4. Skilled Blue Collar, Metal and Electrical	141.39	8234	841	9075
	5. Skilled Blue Collar, Building	63.07	8250	844	9094
	6. Skilled Blue Collar, Other	24.82	7977	798	8775
	7. Semi and Unskilled Blue Collar	325.23	7711	752	8463
	8. Rural Workers	60.91	8358	865	9223
	9. Armed Services	15.71	8641	904	9545
	10. Pensioners	0.00	-	-	-
	11. Unemployed	7.41	4321	184	4505
	12. Students	0.00	-	-	-
	13. Not in work force	16.11	3846	n.a.	n.a.
	All Occupations	994.01	8650	908	9558

Source: Model outlined in Section 4 of this paper.

See notes to Table 3.1.

Example Only

Table 3.7 Average Family Income by Head's Occupation and Sex

Family Type: Male head, wife not working - 1971

	Occupation	Number of Families (thousands)	Average Earned Income	Average Unearned Income	Average Total Income
Males	1. Professional White Collar	78.02	11262	1266	12628
	2. Skilled White Collar	283.35	7973	824	8797
	3. Semi and Unskilled White Collar	216.65	5691	446	6137
	4. Skilled Blue Collar, Metal and Electrical	238.83	5680	443	6123
	5. Skilled Blue Collar, Building	106.53	5695	446	6141
	6. Skilled Blue Collar, Other	41.92	5422	400	5822
	7. Semi and Unskilled Blue Collar	500.10	5251	370	5621
	8. Rural Workers	218.07	5557	428	5985
	9. Armed Services	24.62	6124	510	6634
	10. Pensioners	158.70	2151	n.a.	n.a.
	11. Unemployed	11.80	1824	50	1874
	12. Students	5.22	n.a.	n.a.	n.a.
	13. Not in work force	161.42	730	n.a.	n.a.
	All Occupations	2045.23	5397	440	5837

Source: Model outlined in Section 4 of this paper.

See notes to Table 3.1.

Example Only

Table 3.8 Average Family Income by Head's Occupation and Sex

Family Type: Single persons - 1971

		Occupation	Number of Families (thousands)	Average Earned Income	Average Unearned Income	Average Total Income
Males	1.	Professional White Collar	12.29	10712	1219	11931
	2.	Skilled White Collar	48.90	7040	615	7655
	3.	Semi and Unskilled White Collar	29.96	4775	239	5014
	4.	Skilled Blue Collar, Metal and Electrical	34.18	4675	228	4903
	5.	Skilled Blue Collar, Building	12.32	4674	228	4902
	6.	Skilled Blue Collar, Other	6.62	4426	187	4613
	7.	Semi and Unskilled Blue Collar	106.59	4187	142	4329
	8.	Rural Workers	29.94	4472	184	4656
	9.	Armed Services	9.12	5189	311	5500
	10.	Pensioners	87.99	832	n.a.	n.a.
	11.	Unemployed	7.85	1011	12	1023
	12.	Students	1.43	n.a.	n.a.	n.a.
	13.	Not in work force	74.89	n.a.	n.a.	n.a.
		All Occupations	462.07	3410	190	3600
Females	14.	Professional White Collar	11.48	4975	270	5245
	15.	Skilled White Collar	44.92	4309	158	4467
	16.	Semi and Unskilled White Collar	90.42	2506	10	2516
	17.	Skilled Blue Collar, Metal and Electrical	0.38	3915	91	4006
	18.	Skilled Blue Collar, Building	0.20	3800	73	3873
	19.	Skilled Blue Collar, Other	4.68	2971	5	2976
	20.	Semi and Unskilled Blue Collar	97.26	2143	18	2161
	21.	Rural Workers	0.00	-	-	-
	22.	Armed Services	1.35	3307	15	3322
	23.	Pensioners	393.70	832	n.a.	n.a.
	24.	Unemployed	9.37	520	15	535
	25.	Students	0.72	n.a.	n.a.	n.a.
	26.	Not in work force	234.91	n.a.	n.a.	n.a.
		All Occupations	889.38	1168	22	1190

Source: Model outlined in Section 4 of this paper.

See notes to Table 3.1.