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EFFECTS ON THE SUPPLY OF LABOUR HOURS BY EMPLOYEES OF CHANGES IN THEIR CONDITIONS OF EMPLOYMENT

by

Ashok Tulpulé
Industries Assistance Commission

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The views expressed in this paper do not necessarily reflect the opinions of the participating agencies, nor of the Australian Government.

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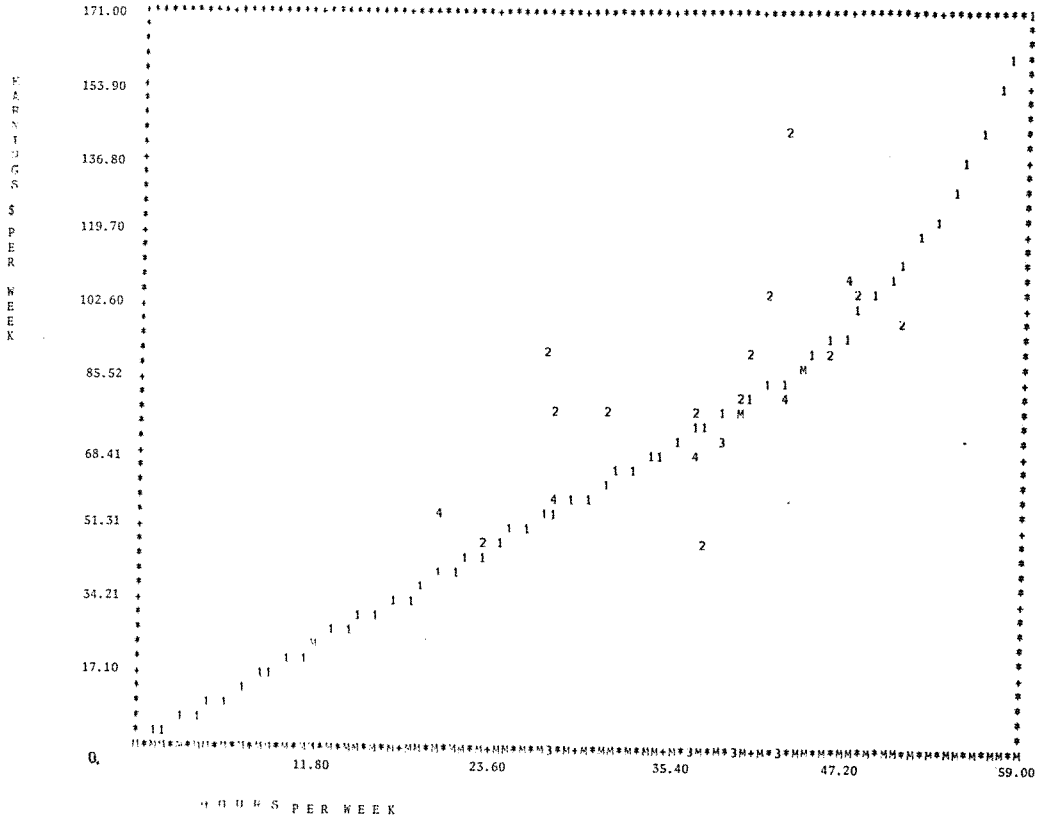
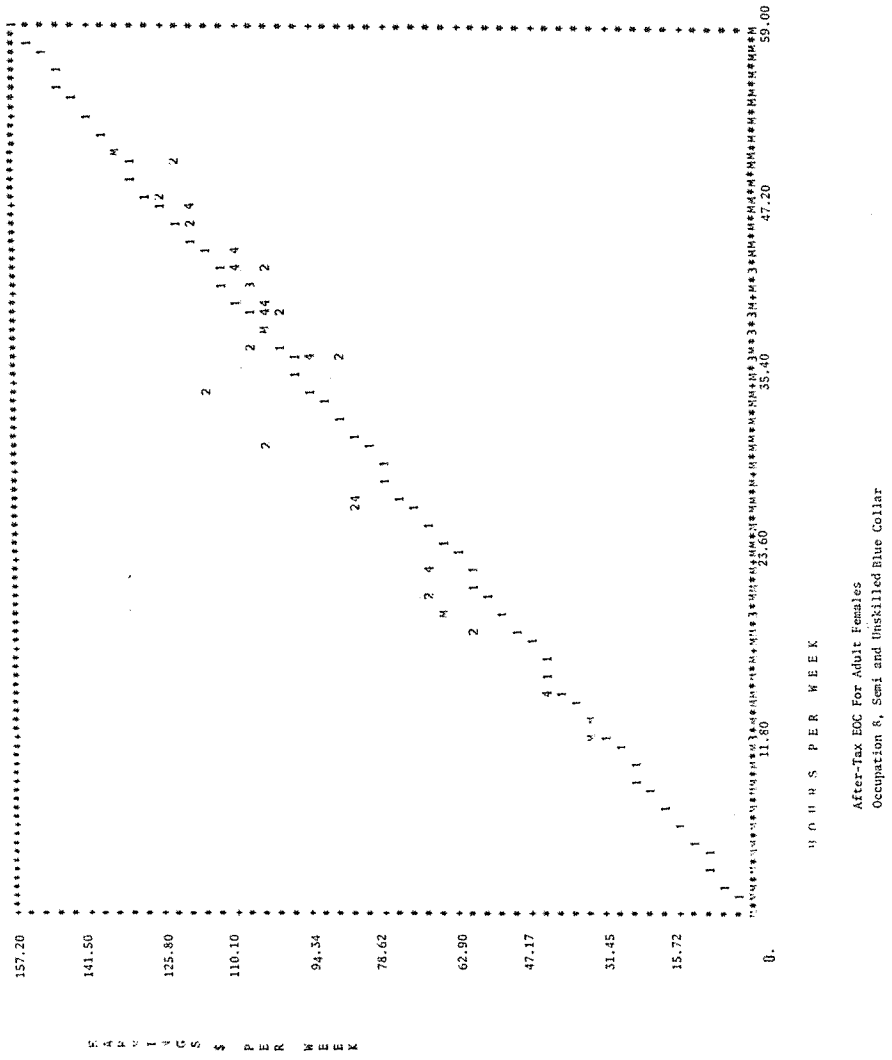


After-Tax EOC For Junior Females
Occupation 8, Semi and Unskilled Blue Collar



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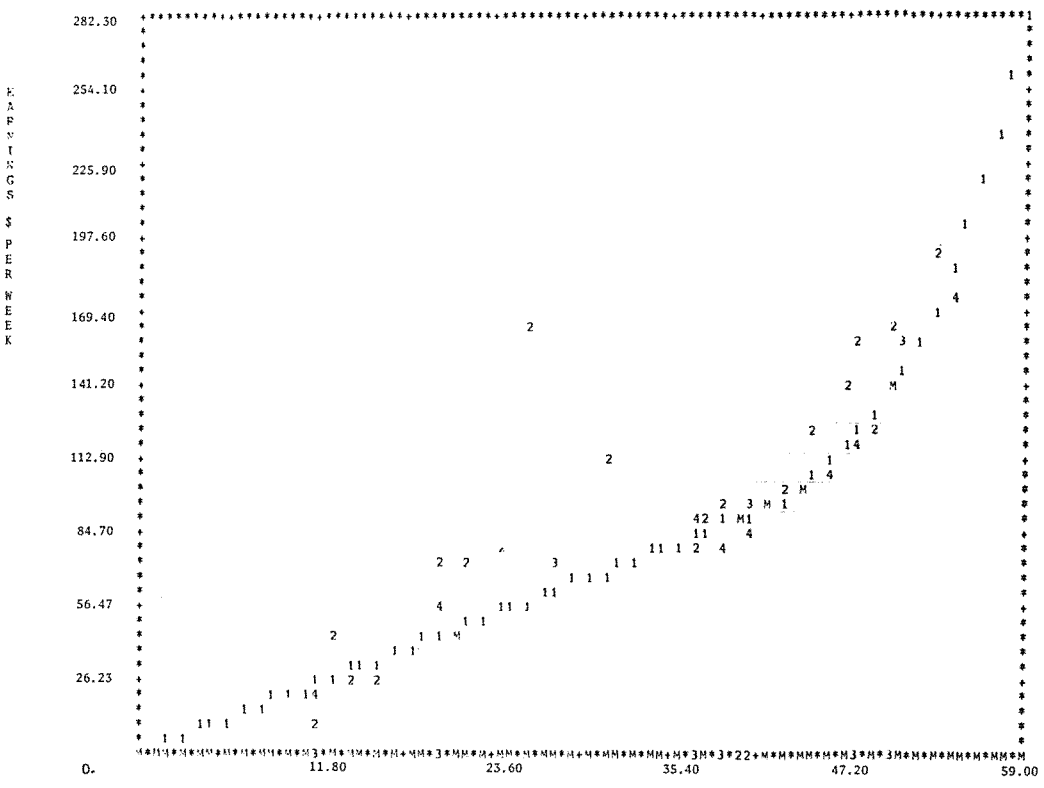

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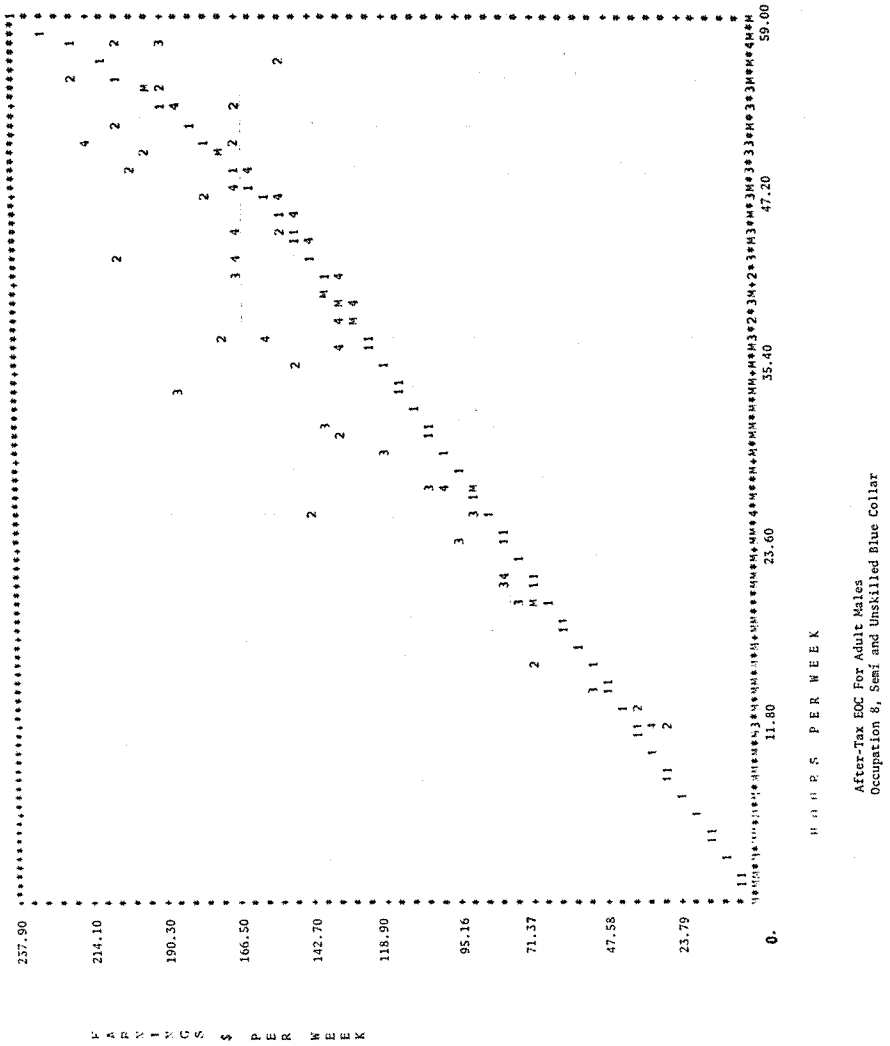

TABLES

APPENDIX

The observed values and fitted earnings opportunities curves for employees in occupation 8 Semi and Unskilled Blue Collar, classified by age and sex, are included in this appendix for the purpose of illustration.

It is important to note that the curves are not suitable for extrapolation outside the range of observed hours worked. It will be clear from an examination of the graphs that the extrapolation would lead to an overestimation of weekly earnings. Within the range of observed hours reasonable estimates of earnings can be obtained from the curve. However, outside the range, the earnings are greatly over-estimated.

In all the figures the following legend is used:

1 Fitted curve;

2 Observed values based on less than 500 persons;

3 Observed values based on 501 to 1000 persons;

4 Observed values based on over 1000 persons;

M Multiple observations at the same point.

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EFFECTS ON THE SUPPLY OF LABOUR HOURS BY EMPLOYEES OF CHANGES IN THEIR CONDITIONS OF EMPLOYMENT

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ABSTRACT

In this paper the hours offered for work by employees, classified by age, sex and IMPACT occupation groups, have been modelled as responding to changes in their conditions of employment. The conditions of employment of a representative adult and junior employee in each occupation and sex group are expressed in terms of three parameters of the respective wage offer curves faced by them. These three parameters are the basic hourly wage rate, the standard hours of work per week and an overtime progression parameter. Use is made of exogenously estimated marginal leisure preference parameters for different types of workers to estimate elasticities of supply of labour hours with respect to the parameters which characterize the conditions of employment.

1. INTRODUCTION

An individual's propensity to supply additional labour hours is the counterpart of his demand for leisure. Therefore in the empirical literature the supply of labour hours is modelled using the classical demand analysis framework in which a leisure demand equation is included with the system of commodity demand equations. The system is derived from the maximization of a utility function in which leisure hours consumed appear as one of the arguments. Betancourt (1973) extended Lluch's (1973)

* I am grateful to Alan Powell and Richard Filmer who worked with me on an earlier paper in which the theoretical framework of this paper was developed. Alan Powell provided guidance throughout the project and made valuable comments on earlier drafts of this paper. Denis Sams suggested a suitable functional form for the earnings opportunities schedule and helped with the related curve fitting program. Vince Manion compiled the taxation statistics and Alexandra Strzelecki provided assistance with computer programming. Tony Lawson made valuable comments on an earlier draft of this paper.

Extended Linear Expenditure System (ELES) by including the labour/leisure choice within a Twice Extended Linear Expenditure System (TELES). In that paper a representative worker's consumption, saving and labour supply behaviour were modelled. Abbott and Ashenfelter (1976) applied a similar model to U.S. time series data on consumption and hours worked. Using the same set of data Phlips (1979) further developed the model to endogenize the demand for money. The TELES model was applied to Australian time series data by Tulpulé (1980 a). A further development of the TELES model for several household types (TELESH) is reported in Tulpulé (1980 b).

In all these empirical studies the marginal hourly wage rate is treated as constant. In a situation where overtime is voluntary and where penalty rates of pay apply for the overtime worked, the marginal hourly wage rate does not remain constant but becomes a function of hours worked. In order to take into account such a situation a theoretical structure was developed by Powell, Tulpulé and Filmer (1977) using, as in all the above mentioned studies, the Klein-Rubin utility function[1]. In a recent paper Powell (1979) has shown how to endogenize the marginal wage rate using other forms of the utility function.

In this paper the model developed by Powell, Tulpulé and Filmer (1977) is estimated empirically using Australian cross sectional data on earnings and hours. The plan of the paper is as follows. The theoretical background is presented in Section 2 and a functional form for the earnings opportunities curves is discussed in Section 3. The data required for fitting the earnings opportunities curves are presented in Section 4; this is followed by their empirical estimation in Section 5. Estimates of occupation, age and sex specific elasticities of supply of labour hours with respect to the parameters of the earnings opportunities curves are given in Section 6. Section 7 includes some concluding remarks.

---

1 Empirical studies using utility functions other than the Klein-Rubin include Kiefer (1965 and 1977), Barnett (1979) and Abbott and Ashenfelter (1976).

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particular those occupations that have a relatively large number of married men would yield numerically very small estimates of elasticities with respect to their own wage rates.

It is possible and desirable to obtain data on the distribution of hours worked for workers classified by age, sex, marital status and occupation from the 1976 Population Census. These data are presently not available. Calculation of weighted averages would be a relatively easy exercise when these data are extracted.

While the effects of overtime progression are small for the IMPACT occupation groups, there may be some specific occupations where the effects are relatively large. In such situations the model presented here can be used to analyse the likely supply responses of changes in the conditions of employment. In order to estimate the number of hours that would be worked we need some knowledge of the demand schedule. An interaction between the two would provide an idea of the likely final effect of the changes in conditions of employment.

2. THEORETICAL BACKGROUND

The theoretical structure in this section closely parallels the work presented in a joint paper by myself, Alan Powell and Richard Filmer (1977). That paper developed a framework of demand analysis to deal with two problems:

> "(i) the effects on demand patterns and hours worked of the payment of a commodity-specific subsidy (such as a housing rent subsidy);
> (ii) modelling the supply of hours worked in a situation where, because overtime is voluntary and payment for such work is at a higher rate than payment for standard hours, the marginal wage received is endogenous."

The treatment in this paper is a simplified version of the above framework because here the attention is restricted to the second of the above two problems. A linear expenditure system with an endogenous wage rate for households containing one worker is developed first and then it is extended to cover households in which both the husband and wife work.

Earnings Opportunities Curves

An earnings opportunities curve (EOC) is a smooth curve fitted to data on after-tax earnings of a homogeneous group of workers (such as junior male workers in a particular occupation group) plotted against their weekly hours worked. For an individual worker in a given job the schedule of rates offered will be a staircase function containing several steps for ordinary time rate, time and a half rate, double time rate, etc.. The location and size of the steps will vary as a result of minor differences in awards, in the practices of employers concerning over-award payments, etc.; thus the earnings opportunities for a homogeneous group of workers can be represented approximately by a smooth curve G(H), where G, the after-tax weekly earnings, is a function of hours worked, H. Since the group of workers is, by supposition, homogeneous, in the longer run context any given individual, could, by changing jobs, relocate himself at any point on the smooth curve G(H). This function cannot, however, be influenced by an individual worker in the group, nor by a representative agent in the short run. Although union action may influence

the curve, in the short run it is reasonable to assume that the representative agent has no influence on the EOC itself. However he can determine the value of earnings, G, by deciding to work H hours per week. Hence the weekly earnings of an employee facing the EOC can be estimated from

$$(2.1) \qquad G(H) = \int_0^H \psi(h)dh \quad ,$$

where

$$(2.2) \qquad \psi(H) = \frac{\partial G(H)}{\partial H} \quad .$$

Thus $\psi(H)$ is the marginal wage rate schedule.

2.1 Households Containing One Worker

There will be different types of households that contain only one worker; however most of these are likely to be either single person households or households in which only the husband works. While the consumption and work behaviour of these different types of households will be influenced by their demographic characteristics, their behaviour can be modelled within the same theoretical framework.

The consumption, saving and work behaviour of a representative agent (worker) is generated by the maximization of the utility function[1]

$$(2.3) \qquad U = \sum_{i=1}^{n-2} \beta_i \ln (x_i-\gamma_i) + \beta_s \ln (s) + \beta_L \ln (L-\gamma_L),$$

subject to

1 The additive utility function (2.3) rules out complementarity. Therefore the commodity classification should avoid items like "Sporting and Recreational Equipment" which would be complementary with leisure time.

7. CONCLUDING REMARKS

In this paper a framework of demand analysis has been developed to study the labour supply responses of different types of workers in a situation where the marginal wage rate is endogenous. The representative worker in each group faces conditions of employment that are summarized in terms of three parameters of the earnings opportunities curve that he faces. Formulae for the elasticities of supply of labour hours have been developed for single worker households and households with two workers. The elasticity formulae can be used to study the effects of changes in the conditions of employment as represented by changes in the parameters of the earnings opportunities curves.

Application of this model to data from the ABS May 1976 Earnings and Hours Survey shows that for most types of non-managerial employees, due to progressive income tax scales the effect of before-tax overtime payments is almost completely neutralized. Thus in most cases the average after-tax hourly rate increases very little with overtime hours worked.

Elasticities of supply of labour hours with respect to the overtime progression parameters and standard hours parameters for most occupation, age and sex groups are very small. Therefore, in most applied econometric modelling work using a few occupation groups, it would not be necessary to treat the marginal wage rate as endogenous. However, the difference between the elasticities with respect to basic hourly wage rates for different age, sex and marital status groups are significant and it would be desirable to obtain weighted averages of elasticities with respect to the wage rate for each occupation group, using hours worked as weights. In

is, the married women would increase their supply of labour hours in response to an increase in the basic hourly wage rate. This is because of the relative strengths of the substitution and income effects. As the labour income of a married female is a relatively small proportion of the total household income, the income effect of a change in her basic hourly wage rate is relatively smaller as compared with single persons.

The elasticities with respect to the parameters of overtime progression are positive and in general are somewhat larger than the corresponding estimates for single adult females. The elasticities with respect to the standard hours parameters are negative and numerically greater than the corresponding estimates for single adult females.

$$(2.4) \qquad \alpha + G(T) = \int_{T-L}^{T} \psi(h)dh + \sum_{i=1}^{n-2} p_i x_i + s,$$

where above, and in the equations below, the notation is:

x_i = quantity of i^{th} good consumed;
γ_i = socially acceptable minimum level (subsistence level) of consumption of good i;
β_i = marginal propensity to consume good i out of 'full income', including the imputed value of voluntary leisure -- i.e., of leisure in excess of γ_L;
β_s = marginal propensity to save out of full income;
β_L = marginal propensity to consume leisure out of full income[1];
L = quantity of 'leisure' hours consumed;
γ_L = socially acceptable minimum leisure hours;
p_i = price of good i;
s = savings in dollars;
(T-H) = L = total leisure hours;
$\psi(h)$ = after-tax hourly marginal wage rate;
G(H) = after-tax weekly earnings;
T = maximum possible hours that can be worked if no time is spent on leisure;
H = hours worked; and
α = after-tax non-labour income.

The budget constraint can also be written as

$$(2.5) \qquad \underset{\text{(non-labour income)}}{\alpha} + \underset{\text{(labour income)}}{\int_{0}^{T-L} \psi(h)dh} + \underset{\text{(imputed value of leisure)}}{\int_{T-L}^{T} \psi(h)dh} = \underset{\text{(imputed value of leisure)}}{\int_{T-L}^{T} \psi(h)dh} + \underset{\text{(commodity purchases)}}{\sum_{i=1}^{n-2} p_i x_i} + \underset{\text{(savings)}}{s}.$$

Because T-L = H, the actual hours worked, substituting from (2.1) into (2.5) gives

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1 The parameters of U may be normalized in a variety of ways which are observationally equivalent. The normalization used here, which underlies the interpretation of the $\{\beta_i\}$, is that

$$\sum_{i=1}^{n-2} \beta_i + \beta_s + \beta_L = 1.$$

$$(2.6) \qquad \alpha + G(H) = \sum_{i=1}^{n-2} p_i x_i + s.$$

The Lagrangean is

$$(2.7) \qquad F = U + \lambda \left[\alpha + G(H) - \sum_{i=1}^{n-2} p_i x_i - s\right].$$

The first order conditions for a maximum consist of equation (2.6) and those equations obtained by setting $\frac{\partial F}{\partial x_i}$ (i=1,...,n-2), $\frac{\partial F}{\partial s}$ and $\frac{\partial F}{\partial L}$ equal to zero; viz.,

$$(2.8) \qquad \frac{\partial F}{\partial x_i} = 0 = \frac{\beta_i}{(x_i - \gamma_i)} - \gamma p_i \qquad (i=1,\ldots,n-2);$$

$$(2.9) \qquad \frac{\partial F}{\partial s} = 0 = \frac{\beta_s}{s} - \lambda;$$

$$(2.10) \qquad \frac{\partial F}{\partial L} = 0 = \frac{\beta_L}{(L-\gamma_L)} - \lambda\, \psi\, (T-L) = \frac{\beta_L}{L-\gamma_L} - \lambda\, \psi\, (H).$$

An expression for λ can be obtained by making use of the condition $\sum_{i=1}^{n-2} \beta_i + \beta_s + \beta_L = 1$, and summing over the n equations (2.8), (2.9) and (2.10):

$$(2.11) \qquad \lambda = 1/\{\Sigma p_i x_i + s - \Sigma p_i \gamma_i + (L-\gamma_L)\, \psi(H)\}.$$

Substituting from (2.6) into (2.11) yields

$$(2.12) \qquad \lambda = 1/\{\alpha + G(H) + L\psi(H) - \Sigma p_i \gamma_i - \psi(H)\gamma_L\} = 1/(Z - P'\Gamma),$$

where Z is a measure of 'full income', i.e., the sum of labour and non-labour income and an imputed value of leisure hours consumed, L, valued at the marginal hourly wage rate, ψ, which is the shadow price of leisure; hence

$$(2.13) \qquad Z = \alpha + G(H) + L\psi(H).$$

The vector P collects together all of the prices relevant to the system; viz.,

$$(2.14) \qquad P' = (p_1,\ldots,p_{n-2}, \psi(H)),$$

while

$$(2.15) \qquad \Gamma = (\gamma_1, \ldots,\gamma_{n-2}, \gamma_L).$$

rise in the shadow price of leisure is sufficiently large to swamp the income effect.

Standard Hours Per Week — All the elasticity estimates are negative, which suggests that, if there is a reduction in standard hours, then the employees would like to supply more work hours. When the standard hours are reduced, the overtime rates of payment apply at less hours than before. The resulting increase in the marginal wage rate, which is the shadow price of leisure, rises. Less leisure is demanded and more labour hours are supplied. In practice a reduction in standard hours would be accompanied by an increase in the basic hourly rate. The effects of the two changes would be in opposite directions. The net effect can be worked out from Tables 6.7 and 6.9.[1]

6.2 Elasticity Estimates For Adult Married Females

As mentioned earlier, these estimates are for the purpose of illustration only, as they are based on assumed levels of husband's income , family size, etc.. The main point to be noted is that the elasticities with respect to the basic hourly wage rate parameters are positive as against the negative values for single persons. That

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1 For example if the standard hours for unskilled blue collar workers are reduced by 1 per cent and at the same time basic hourly rate is increased by one per cent, the employees who were initially working 40 hours per week would reduce their labour hours by 0.05603 (-0.06181 + 0.00578) per cent.

Table 6.11 shows that in most groups the average hours worked per employee are less than 40 hours per week. Also in most cases a very large proportion of employees work less than 40 hours per week. In view of these data the elasticity estimates at higher levels of hours per week should be treated with caution. The three sets of elasticities are discussed below.

Basic Hourly Wage Rate It can be observed from Table 6.7 that, for H=35, i.e., for employees initially working at a level of hours below the standard hours per week, elasticities for males in all occupations have the same value; and the same is the case with females. The difference between males and females is due to the different marginal leisure preference parameters. The negative values (which are due to the income effects outweighing the substitution effects) indicate that if there is a one per cent increase in the basic hourly rate the supply of hours would be reduced slightly. At higher levels of hours worked the numerical value of this negative elasticity for each occupation increases gradually because the increase in the absolute value of the income effect outweighs the corresponding increase in the value of the substitution effect. This increase indicates that those employees that are already working at high levels of hours per week are likely to reduce their supply of labour in response to an increase in the basic wage rate as compared to those initially working fewer hours per week. The only exceptions to this general trend are junior males in occupations 5 and 8. In those cases, at higher levels of hours worked, the numerical value of the elasticity falls. In general in the case of junior workers the estimates at higher levels of hours worked should be treated with caution because there would be very few employees initially working at these levels of hours. A comparison of elasticity values of juniors and adults in the same occupation group indicates that the elasticities for juniors in general are numerically greater than for adults at higher levels of hours initially worked.

Parameter Of Overtime Progression All the elasticities are positive and small. In general elasticities for juniors are somewhat higher than for adults. The positive values indicate that if the overtime rates increase employees would increase their supply of labour by a small amount. When an increase in the overtime rate leads to an increase in the marginal wage rate, which is the shadow price of leisure, the demand for leisure falls and the supply of labour hours rises in response. This is because the income effect of the changes applies only to hours in excess of the standard hours. As the additional hourly amount is earned only on overtime hours, the income effect is small and the

Thus $P'\Gamma$ is the cost of the minimum needs bundle plus the cost of the minimum leisure requirement valued at the marginal wage rate.

By substituting for λ from (2.12) into (2.8), (2.9) and (2.10), one obtains the demand equations:

$$(2.16) \qquad x_i = \gamma_i + \frac{\beta_i}{p_i}(Z-P'\Gamma) \qquad , i=1,\ldots,n-2.$$

Similarly,

$$(2.17) \qquad s = \beta_s (Z-P'\Gamma),$$

and

$$(2.18) \qquad L = \gamma_L + \frac{\beta_L}{\psi(H)}(Z-P'\Gamma).$$

Elasticities With Respect to Parameters of Earnings Opportunities Curves

Because the wage rate is endogenous, there is no uniquely defined elasticity of labour supply with respect to the wage rate. A variety of responses in the demand for leisure is possible depending on how and why the average and marginal rates change. The exogenous factors that cause the average and marginal wage rates to change are shifts in the EOCs (i.e., changes in the parameters of these curves).

Let $(\mu_1,\ldots,\mu_N)$ be the N parameters of the EOC. The immediate result of this additional complication is that the previously defined total earnings and marginal earnings schedules are functionally related to the parameters of the EOC. Thus G(H) and $\psi(H)$ are now defined as $G(H,\underline{\mu})$ and $\psi(H,\underline{\mu})$ respectively. In the following discussion these functions are referred to as G and ψ respectively. The effect we want to investigate is generated by a small change, $\delta\mu_j$, in μ_j, the j^{th} parameter of the EOC. The effect on hours supplied can be studied via (2.18). Because L = T-H, (2.18) can be written as

$$(2.19) \qquad H = T - \gamma_L - \frac{\beta_L}{\psi}(Z-P'\Gamma).$$

When a parameter of the G(H) schedule, μ_j, changes by a small amount, $\Delta\mu_j$, the hours worked change by a small amount, ΔH. Taking differentials of (2.19) and rearranging we get[1]

$$(2.20) \qquad \frac{\Delta H}{\Delta \mu_j} \doteq \frac{\beta_L}{\psi}\left[\frac{\partial G}{\partial \mu_j} - \frac{\theta+G}{\psi}\left(\psi' \frac{\partial H}{\partial \mu_j} + \frac{\partial \psi}{\partial \mu_j}\right)\right],$$

where

$$(2.21) \qquad \theta = \alpha - \sum_{i=1}^{\eta-2} p_i\gamma_i .$$

Taking limits as $\Delta\mu_j \to 0$, and rearranging, the elasticity formula is obtained.

$$(2.22) \qquad \frac{\partial H}{\partial \mu_j}\frac{\mu_j}{H} = \frac{\left[\frac{(\theta+G)}{\psi}\frac{\partial \psi}{\partial \mu_j} - \frac{\partial G}{\partial \mu_j}\right]\frac{\mu_j}{H}}{\left[\frac{\psi}{\beta_L} - \frac{\psi'}{\psi}(\theta+G)\right]} .$$

Given knowledge of the earnings opportunities curve, G(H), the elasticity of hours worked with respect to changes in the conditions of employment can be estimated provided information is known on the behavioural parameter β_L (i.e., the marginal propensity to consume leisure), on subsistence expenditure, $\Sigma p_i\gamma_i$, and on the amount of non-labour income, α. Estimates of the β_L parameter for demographically disaggregated types of workers are given by Tulpulé (1980 b). It may be possible to make reasonable assumptions about the level of non-labour income for households with given levels of labour income. Given knowledge of household income, strong priors can be placed on the values of subsistence expenditure from studies of the Linear Expenditure System along the lines of international cross sectional analysis presented by Lluch, Powell and Williams (1977).

The elasticity formula in (2.22) is applicable to households containing one worker. Elasticity formulae for households in which both husband and wife work are obtained similarly.

1 For the intermediate steps see Powell, Tulpulé and Filmer, op.cit..

6.1 Elasticity Estimates for Single Employees

In Tables 6.7 to 6.9 estimates of elasticities of supply of labour hours with respect to the three parameters of the EOCs are shown for single persons. Each elasticity estimate gives the percentage change in hours offered when the value of a given parameter changes by one per cent. The estimates are derived for different values of H, the level of hours initially worked, ranging from 35 to 46 hours per week, for all occupation, age and sex groups. In some cases, the actual number of persons initially working at the higher levels of hours per week would be small. Estimates of the number of single non-managerial employees by hours worked are not available; however, a rough idea of the distribution can be obtained from the figures for all, i.e., married and single, employees in occupations included in Table 6.8 and are shown in Table 6.11.

TABLE 6.11 : DISTRIBUTION OF NON-MANAGERIAL EMPLOYEES BY HOURS WORKED AND AVERAGE HOURS PER WEEK

	Occupation	Percentage distribution by hours worked ≤40	40.1 to 45	45>	Average hours per week
	Adult Males				
1	Professional White Collar	86.94	5.86	7.20	38.80
2	Teachers and Lecturers	99.56	0.36	0.08	34.70
3	Skilled White Collar	83.43	8.40	8.17	38.75
4	Semi and Unskilled White Collar	85.95	8.74	5.31	38.26
5	Skilled Blue Collar - M and E	61.93	15.64	22.43	41.63
6	Skilled Blue Collar - Building	73.06	11.39	15.55	40.97
7	Skilled Blue Collar - Other	64.14	14.32	21.54	40.50
8	Semi and Unskilled Blue Collar	59.05	17.48	23.47	40.49
	Adult Females				
1	Professional White Collar	95.41	1.53	3.06	34.82
2	Teachers and Lecturers	99.74	0.00	0.26	32.92
3	Skilled White Collar	92.89	4.70	2.41	33.86
4	Semi and Unskilled White Collar	93.85	4.18	1.97	34.67
5	Skilled Blue Collar - Building	84.87	8.18	6.95	39.24
7	Skilled Blue Collar - Other	85.18	6.42	8.40	35.07
8	Semi and Unskilled Blue Collar	91.04	5.88	5.08	33.10
	Junior Males				
4	Semi and Unskilled Blue Collar	85.13	10.10	4.77	34.28
5	Skilled Blue Collar - M and E	77.30	13.61	9.09	40.06
6	Skilled Blue Collar - Building	83.99	7.19	8.82	39.92
7	Skilled Blue Collar - Other	63.70	12.33	23.97	38.30
8	Semi and Unskilled Blue Collar	71.90	16.40	11.70	37.83
	Junior Females				
3	Skilled White Collar	89.50	8.65	1.85	38.84
4	Semi and Unskilled White Collar	92.55	5.12	2.33	35.48
8	Semi and Unskilled Blue Collar	86.22	8.28	5.50	34.15

TABLE 6.10 : ELASTICITIES OF SUPPLY OF LABOUR HOURS WITH RESPECT TO THE PARAMETERS OF EOCS FOR ADULT MARRIED FEMALE NON-MANAGERIAL EMPLOYEES

Occupation	Hours worked* 35	40	42	44	46
Parameter μ_o (Basic Hourly Rate)					
1 Professional White Collar	.13592	.10728	.09772	.08899	.08099
2 Teachers and Lecturers	.12019	.09357	.08463	.07641	.06881
3 Skilled White Collar	.13673	.10804	.09861	.08984	.08161
4 Semi and Unskilled White Collar	.12003	.09366	.08497	.07652	.06829
5 Skilled Blue Collar - M and E	.13131	.11990	.11885	.09331	.03698
7 Skilled Blue Collar - Other	.13213	.10426	.09562	.08682	.07782
8 Semi and Unskilled Blue Collar	.12804	.10081	.09591	.08697	.07372
Parameter μ_1 (Overtime Progression)					
1 Professional White Collar		.00002	.00005	.00011	.00019
2 Teachers and Lecturers		.00006	.00018	.00036	.00060
3 Skilled White Collar		.00001	.00013	.00041	.00081
4 Semi and Unskilled White Collar		.00005	.00046	.00125	.00237
5 Skilled Blue Collar - M and E		.00411	.02545	.07038	.13313
7 Skilled Blue Collar - Other		.00002	.00056	.00178	.00361
8 Semi and Unskilled Blue Collar		.00001	.00203	.00772	.01698
Parameter μ_2 (Standard Hours)					
1 Professional White Collar		-.00053	- .00097	- .00138	- .00176
2 Teachers and Lecturers		-.00172	- .00294	- .00407	- .00512
3 Skilled White Collar		-.00092	- .00404	- .00693	- .00960
4 Semi and Unskilled White Collar		-.00414	- .01189	- .01909	- .02576
5 Skilled Blue Collar - M and E		-.20159	- .54336	- .95507	- 1.31699
7 Skilled Blue Collar - Other		-.00352	- .01765	- .03090	- .04325
8 Semi and Unskilled Blue Collar		-.00483	- .07529	- .14683	- .21629

* When $H < \mu_2$ the G(H) function does not include parameters μ_1 and μ_2.

2.2 Households in Which Both Husband and Wife Work

The problem involves respecification of the utility function and budget constraint. In the discussion that follows the Klein-Rubin form of utility function is retained. It is assumed that the consumption decisions and decisions about hours to be worked by the husband and wife are arrived at by the household after a compromise among the household members. It is also assumed that the earnings opportunities function for the two workers is given by simply adding together the two separate schedules for the two workers.

Denote the before-tax earnings of a husband and wife who work H_m and H_f hours per week by $g_1(H_m)$ and $g_2(H_f)$ respectively. Thus the total before-tax labour income of the household would be the sum of $g_1(H_m)$ and $g_2(H_f)$. However due to factors such as concessional deductions, dependence of social security payments on the incomes of the husband and wife, etc., the after-tax household earnings schedule $\tilde{G}(H_m, H_f)$ would look like

(2.23) $$\tilde{G}(H_m, H_f) = g_1(H_m) + g_2(H_f) - \tilde{T}(H_m, H_f, \tilde{\alpha}),$$

where $\tilde{T}$ is the household tax liability and $\tilde{\alpha}^*$ the household before-tax non-labour income.

While in theory the concept of joint tax liability is correct, in practice the two workers are taxed as individuals. The husband loses the dependency allowance when the wife joins the work force. However, for a household in which both husband and wife are already working, small changes in hours worked by one of them are unlikely to affect the marginal tax rate of the other, so that the effect on after-tax household income is adequately captured by the effect on the after-tax income of the party who changes his hours of work. With this system in mind, it is assumed that

(2.24) $$\tilde{G}(H_m, H_f) = G_1(H_m) + G_2(H_f).$$

Under this assumption, the family utility function, U^F, and budget constraint can be written as :

$$(2.25) \quad U^F = \sum_{i=1}^{n-2} \beta_i \ln (x_i - \gamma_i^F) + \beta_s \ln s + \beta_{Lm} \ln (L_m - \gamma_{Lm}) + \beta_{Lf} \ln (L_f - \gamma_{Lf}),$$

subject to

$$(2.26) \quad \tilde{G} + \tilde{\alpha} = \Sigma p_i x_i + s,$$

where the superscript F refers to family and the subscripts m and f refer to the husband and wife respectively.

The Lagrangean for this problem can be written and demand equations derived, as above. The demand equations for commodities and saving would be similar to (2.16) and (2.17). The two leisure demand equations for the husband and wife respectively are

$$(2.27) \quad L_m = \gamma_{Lm} + \frac{\beta_{Lm}}{\psi_m} \{\tilde{Z} - \tilde{P}'\tilde{\Gamma}\};$$

and

$$(2.28) \quad L_f = \gamma_{Lf} + \frac{\beta_{Lf}}{\psi_f} \{\tilde{Z} - \tilde{P}'\tilde{\Gamma}\},$$

where:

$$(2.29) \quad \psi_m = \frac{\partial \tilde{G}}{\partial H_m},$$

$$(2.30) \quad \psi_f = \frac{\partial \tilde{G}}{\partial H_f},$$

$$(2.31) \quad \tilde{Z} = (\tilde{\alpha} + \tilde{G} + L_m \psi_m + L_f \psi_f),$$

$$(2.32) \quad \tilde{P}' = (p_1, \ldots, p_{n-2}, \psi_m, \psi_f),$$

TABLE 6.9 : ELASTICITIES OF SUPPLY OF LABOUR HOURS WITH RESPECT TO THE STANDARD HOURS PARAMETER (μ_2) FOR DIFFERENT TYPES OF SINGLE NON-MANAGERIAL WORKERS

	Occupation	Hours worked* 35	40	42	44	46
	Adult Males					
1	Professional White Collar		-.00150	- .00371	- .00580	- .00777
2	Teachers and Lecturers		-.00151	- .00258	- .00359	- .00455
3	Skilled White Collar		-.00097	- .00231	- .00359	- .00479
4	Semi and Unskilled White Collar		-.00283	- .00909	- .01500	- .02058
5	Silled Blue Collar - M and E		-.01693	- .21960	- .44163	- .61646
6	Skilled Blue Collar - Building			- .28345	- .69228	-1.00866
7	Skilled Blue Collar - Other			- .00086	- .00168	- .00245
8	Semi and Unskilled Blue Collar		-.00578	- .22757	- .47867	- .67743
	Adult Females					
1	Professional White Collar		-.00028	- .00052	- .00075	- .00096
2	Teachers and Lecturers		-.00094	- .00163	- .00228	- .00288
3	Skilled White Collar		-.00049	- .00219	- .00378	- .00527
4	Semi and Unskilled White Collar		-.00230	- .00664	- .01072	- .01455
5	Skilled Blue Collar - Building		-.09916	- .23290	- .35126	- .42687
7	Skilled Blue Collar - Other		-.00191	- .00960	- .01684	- .02363
8	Semi and Unskilled Blue Collar		-.00265	- .04038	- .07679	- .11025
	Junior Males					
4	Semi and Unskilled White Collar		-.16550	- .51572	- .83788	- .93790
5	Skilled Blue Collar - M and E		-.16804	-1.24610	-2.62900	-2.08656
6	Skilled Blue Collar - Building		-.12085	- .73499	-1.45167	-1.53400
7	Skilled Blue Collar - Other		-.07912	- .24180	- .39810	- .50721
8	Semi and Unskilled Blue Collar		-.90729	-7.51319	-5.51930	-1.62437
	Junior Females					
3	Skilled White Collar		-.00402	- .00791	- .01155	- .01497
4	Semi and Unskilled White Collar		-.07486	- .25312	- .42340	- .53408
8	Semi and Unskilled Blue Collar		-.24166	- .71336	-1.07434	-1.03514

* When $H < \mu_2$, the G(H) function does not include parameter μ_2.

TABLE 6.8 : ELASTICITIES OF SUPPLY OF LABOUR HOURS WITH RESPECT TO THE PARAMETER OF OVERTIME PROGRESSION (μ_1) FOR DIFFERENT TYPES OF SINGLE NON-MANAGERIAL EMPLOYEES

Occupation	Hours worked*				
	35	40	42	44	46
Adult Males					
1 Professional White Collar		.00003	.00016	.00041	.00076
2 Teachers and Lecturers		.00005	.00016	.00033	.00055
3 Skilled White Collar		.00002	.00010	.00026	.00047
4 Semi and Unskilled White Collar		.00003	.00034	.00096	.00187
5 Skilled Blue Collar - M and E		.00004	.00611	.02379	.04975
6 Skilled Blue Collar - Building			.00626	.03304	.07487
7 Skilled Blue Collar - Other			.00002	.00009	.00019
8 Semi and Unskilled Blue Collar		.00000	.00593	.02489	.05332
Adult Females					
1 Professional White Collar		.00001	.00003	.00006	.00011
2 Teachers and Lecturers		.00003	.00010	.00021	.00035
3 Skilled White Collar		.00000	.00007	.00022	.00045
4 Semi and Unskilled White Collar		.00003	.00026	.00071	.00136
5 Skilled Blue Collar - Building		.00203	.01102	.02632	.04421
7 Skilled Blue Collar - Other		.00001	.00031	.00098	.00201
8 Semi and Unskilled Blue Collar		.00000	.00110	.00408	.00880
Junior Males					
4 Semi and Unskilled White Collar		.00253	.02151	.05775	.09130
5 Skilled Blue Collar - M and E		.00122	.04122	.15719	.18385
6 Skilled Blue Collar - Building		.00089	.02441	.08684	.13459
7 Skilled Blue Collar - Other		.00109	.00970	.02669	.04812
8 Semi and Unskilled Blue Collar		.01535	.32753	.39605	.16732
Junior Females					
3 Skilled White Collar		.00010	.00042	.00093	.00163
4 Semi and Unskilled White Collar		.00090	.00966	.02756	.04968
8 Semi and Unskilled Blue Collar		.00422	.03148	.07715	.10469

* When $H < \mu_2$, the G(H) function does not include parameter μ_1.

and

(2.33) $$\tilde{\Gamma} = (\gamma_1^F, \gamma_2^F, \ldots, \gamma_{n-2}^F, \gamma_{Lm}, \gamma_{Lf}).$$

All the terms that appear in (2.27) and (2.28) have the same interpretation in the context of households with two workers as the corresponding terms in (2.18) had in the context of households with one worker.

The formulae for the elasticity of hours worked with respect to a parameter of the earnings opportunity curve for the husband and for the wife will be the same as (2.22) but it is necessary to re-interpret the various terms in the elasticity formulae. The formula for the husband[1] is

(2.34) $$\frac{\partial H_m}{\partial \mu_j}\frac{\mu_j}{H_m} = \frac{\frac{\mu_j}{H_m}\left(\frac{\tilde{\theta}+\tilde{G}}{\psi_m}\frac{\partial \psi_m}{\partial \mu_j} - \frac{\partial \tilde{G}}{\partial \mu_j}\right)}{\left(\frac{\psi_m}{\beta_{Lm}} - \frac{\psi_m'}{\psi_m}(\tilde{\theta}+\tilde{G})\right)}.$$

The interpretation of the various terms on the right hand side of (2.34) is discussed below.

$\tilde{\theta}$ is the difference between the household's non-labour income and subsistence expenditure:

(2.35) $$\tilde{\theta} = \tilde{\alpha} - \sum_{i=1}^{n-1} p_i \gamma_i^F.$$

For most households $\tilde{\theta}$ is expected to be negative.

It is assumed that the household's after-tax labour income, $\tilde{G}$, is the sum of the after-tax labour income of the husband and wife:

(2.36) $$\tilde{G} = G_1(H_m) + G_2(H_f).$$

The parameters of $\tilde{G}$ include all the parameters of the two earnings opportunity curves.

A small change in the hours worked by the husband causes a small change in the labour income of the household:

1 An elasticity formula for the wife can be written by substituting the subscript m by f.

(2.37) $$\psi_m = \frac{\partial G}{\partial H_m} = \frac{\partial G_1}{\partial H_m}.$$

The change is the same as the change in the husband's labour income. ψ_m is a function of H_m only and its parameters include all or a subset of the parameters of G_1. Because ψ_m depends on G_1 only, ψ'_m includes all or a subset of the parameters of G_1.

(2.38) $$\psi'_m = \frac{\partial \psi_m}{\partial H_m} \quad .$$

It is assumed that the husband and wife face distinct earnings opportunities curves. The j^{th} parameter of $\tilde{G}$ appears only in the husband's earnings opportunity curve:

(2.39) $$\frac{\partial \tilde{G}}{\partial \mu_j} = \frac{\partial G_1}{\partial \mu_j}.$$

$\frac{\partial \tilde{G}}{\partial \mu_j}$ represents the change in the household's labour income due to a small change in a parameter of the husband's EOC. Similarly, $\frac{\partial \psi_m}{\partial \mu_j}$ represents the change in his marginal wage rate due to a small change in μ_j.

The elasticity formulae for workers in a two worker household are very similar to the formula for a one worker household. Numerical estimates of elasticities can be based on assumptions about the family subsistence expenditure, the leisure preference parameters and knowledge of the earnings opportunities curves for both workers. In empirical estimation it will be necessary to assume that the husband faces a given EOC when the wife is in a certain occupation group and vice-versa. These assumptions will be discussed later.

The discussion so far has not specified a functional form for the EOC. In order to make numerical estimates of the elasticities it is necessary to adopt a suitable functional form. This is discussed in the next section.

TABLE 6.7 : ELASTICITIES OF SUPPLY OF LABOUR HOURS WITH RESPECT TO THE BASIC HOURLY WAGE PARAMETER (μ_0) FOR DIFFERENT TYPES OF SINGLE NON-MANAGERIAL EMPLOYEES

	Occupation	Hours worked 35	40	42	44	46
	Adult Males					
1	Professional White Collar	-.06145	-.06157	-.06183	-.06218	-.06262
2	Teachers and Lecturers	-.06145	-.06159	-.06176	-.06197	-.06223
3	Skilled White Collar	-.06145	-.06153	-.06169.	-.06191	-.06218
4	Semi and Unskilled White Collar	-.06145	-.06165	-.06232	-.06325	-.06442
5	Skilled Blue Collar - M and E	-.06145	-.06253	-.08050	-.10987	-.14265
6	Skilled Blue Collar - Building	-.06145	-.06145	-.08456	-.13342	-.18770
7	Skilled Blue Collar - Other	-.06145	-.06145	-.06152	-.06163	-.06177
8	Semi and Unskilled Blue Collar	-.06145	-.06181	-.08083	-.11312	-.14941
	Adult Females					
1	Professional White Collar	-.08155	-.08158	-.08162	-.08167	-.08173
2	Teachers and Lecturers	-.08155	-.08166	-.08178	-.08192	-.08209
3	Skilled White Collar	-.08155	-.08160	-.08180	-.08206	-.08238
4	Semi and Unskilled White Collar	-.08155	-.08177	-.08232	-.08305	-.08393
5	Skilled Blue Collar - Building	-.08155	-.09142	-.11008	-.13238	-.15222
7	Skilled Blue Collar - Other	-.08155	-.08172	-.08261	-.08379	-.08523
8	Semi and Unskilled Blue Collar	-.08155	-.08177	-.08581	-.09138	-.09814
	Junior Males					
4	Semi and Unskilled White Collar	-.06145	-.07393	-.11246	-.16321	-.19480
5	Skilled Blue Collar - M and E	-.06145	-.07289	-.17485	-.35602	-.33153
6	Skilled Blue Collar - Building	-.06145	-.06969	-.12855	-.22567	-.26457
7	Skilled Blue Collar - Other	-.06145	-.06731	-.08509	-.10968	-.13435
8	Semi and Unskilled Blue Collar	-.06145	-.13112	-.80463	-.70572	-.26765
	Junior Females					
3	Skilled White Collar	-.08155	-.08197	-.08257	-.08331	-.08420
4	Semi and Unskilled White Collar	-.08155	-.08845	-.11057	-.13934	-.16527
8	Semi and Unskilled Blue Collar	-.08155	-.10496	-.16643	-.23069	-.24159

TABLE 6.6 : ASSUMED VALUES OF AFTER-TAX LABOUR INCOME PER WEEK OF HUSBANDS IN DIFFERENT OCCUPATIONS*

Occupation	After Tax Labour Income ($)
1 Professional White Collar	155.25
2 Teachers & Lecturers	148.47
3 Skilled White Collar	146.62
4 Semi & Unskilled White Collar	120.91
5 Skilled Blue Collar - Metal & Electrical	115.71
6 Skilled Blue Collar - Building	112.53
7 Skilled Blue Collar - Other	117.39
8 Semi & Unskilled Blue Collar	112.94

* Estimated from ABS (1979) and Taxation Statistics (1978) for the purpose of illustration only (see text).

Estimates of elasticities of supply of labour hours with respect to the three parameters of the EOCs for the single non-managerial employees classified by age, sex and occupation can now be calculated by making use of the assumptions and data discussed above. For married males all the elasticities will be zero because the estimated marginal leisure preference parameter is zero. For married females, estimates are given for the purpose of illustration only. The elasticity estimates are shown in Tables 6.7 to 6.9 for single persons and in Table 6.10 for married females.

3. A FUNCTIONAL FORM OF EARNINGS OPPORTUNITIES CURVES

For an individual worker the before-tax marginal wage rate schedule may look like a step function where the worker receives a given hourly wage rate for hours worked up to the weekly standard hours, then say a 25 per cent loading for the first few overtime hours, a 50 per cent loading for the next few overtime hours and so on. Such a step function may not be well approximated by a continuous earnings opportunities curve. However, as pointed out above, a worker has the opportunity of changing jobs. Due to minor variations in the conditions of employment between jobs[1], it is reasonable to assume that the envelope of the various offer curves available is a continuous function of hours worked. Without such an assumption it is extremely difficult to carry out empirical analysis at an aggregate level. The marginal before-tax earnings curve is expected to be upward sloping because of the existence of overtime penalty rates. The after-tax marginal earnings schedule is also assumed to be a continuous upward sloping curve; however, progressive marginal tax rates are expected to reduce the effect of overtime penalty rates. Thus the after-tax marginal earnings curve is expected to be less steep than the before-tax curve.

The functional form of the schedule proposed here is similar to the one discussed by Powell, Tulpulé and Filmer (1977, p. 64). However, unlike that functional form the present one ensures global differentiability in the neighbourhood of standard hours. With this functional form it is

1 For a narrowly defined group of employees the conditions are usually specified in the award. However the award sets only the minimum conditions. Some employers pay higher than the award hourly rate. Also the ordinary hours per week offered by some employers can be less than the standard hours specified in the award. Thus even within a narrowly defined occupation some variation in the conditions of employment is possible. Therefore it is reasonable to assume a continuous earnings opportunity curve for broad groups of employees.

possible to derive the elasticities of hours worked at all points on the earnings opportunities curve.

Examination of the data on earnings and hours for different types of workers suggests that the after-tax weekly earnings, G(H), for a worker who works H hours per week would be represented satisfactorily by the following functional form for most types of workers[1]:

(3.1) $G(H) = \mu_o H$, when $H \leq \mu_2$,

and

(3.2) $G(H) = \mu_o H + \mu_1 (H-\mu_2)^3$, when $H > \mu_2$,

where:

μ_o = after-tax hourly wage rate of the representative worker for up to standard hours per week[2];

μ_2 = standard hours[3] per week for a representative full time worker;

and

μ_1 = a parameter of overtime progression[2].

The G(H) schedule has three parameters which are specific to the worker type. For an individual worker the hourly wage rate and overtime penalty rates at different numbers of hours per week give the exact marginal wage rate schedule. However for the representative worker, who is an average of many individuals, the exact marginal wage rates are not known. Therefore the marginal wage rate schedule, $\psi(H)$, is obtained by differentiating G(H) with respect to H.

1 For the reasons discussed in the next section the analysis is restricted to non-managerial employees only.

2 Corresponding parameters of curves fitted to the before-tax data say μ_o^* and μ_1^* will be greater than μ_o and μ_1 respectively.

3 The term "Standard Hours" is loosely used to mark the beginning of over-time payment. In the ABS definition the equivalent term is "ordinary-time hours" and the term "standard" or "rostered" refers to an award condition.

TABLE 6.5 : ESTIMATES OF THE AVERAGE PROPENSITY TO CONSUME AND OF THE FRISCH PARAMETER FOR DIFFERENT TYPES OF HOUSEHOLDS

Household type	Average propensity to consume	Frisch parameter
Both husband and wife work (adult wife)	0.8590	-1.7717[a]
Single male worker	0.8841	-1.4028
Single female worker	0.8841	-1.5826

a Value based on all households with working husband and wife (see text).

Source: Tulpulé (1980 b).

The Frisch parameter for households with a working wife was estimated on the assumption that the average household size is 3.8131. This size is probably a good approximation for households where the wife is an adult. When the wife is a junior, it is likely that on the average the size would be much smaller than the average. Similarly the ω parameter and the average propensity to consume for such a household is likely to be different from the average. In view of the lack of information on these variables, elasticity estimates for junior married females are not given. As the number of employees in this category are likely to be small the exclusion is not significant.

With this much background we now have enough information to estimate elasticities of supply of labour hours for single persons. For married males the elasticities (with respect to their own conditions of employment) would be zero. For married females, information on the husband's labour-income is required in order to make the estimates. Information on the labour incomes of husbands whose wives are in different occupation groups is not readily available. The estimates given in this paper are based on one set of assumptions about the husband's income and are for the purpose of illustration only. However, the methodology can be applied to actual situations when data becomes available. For the adult married females it is assumed that their husbands are adults and earn the average non-labour income of the average non-managerial male employee in the same occupation as the wife. The assumed values of the after-tax, non-labour incomes of husbands in different occupations are shown in Table 6.6.

Table 6.3 by 0.05278/0.2690. Ratios of non-labour to labour income obtained by this procedure are shown in Table 6.4.

TABLE 6.4: RATIOS OF NON-LABOUR TO LABOUR INCOME FOR DIFFERENT TYPES OF HOUSEHOLDS OF NON-MANAGERIAL EMPLOYEES.

Household Type	Ratio
Both Husband & Wife Work	0.05286
Single Male Worker	0.04183
Single Female Worker	0.06255

Under the proportionality assumptions estimates of non-labour income, α, and therefore total income, y, can be obtained for given levels of labour incomes.

Estimates of subsistence expenditures ($\Sigma\ p_i\gamma_i$) are obtained by making use of the relationship between the subsistence expenditure and the Frisch parameter (ω) (Frisch, 1959), as follows:

$$(6.1) \qquad \Sigma\ p_i\gamma_i = \Sigma\ p_i x_i\ (1 + \frac{1}{\omega}),$$

where $\Sigma\ p_i x_i$ is the household's total expenditure on goods and services. Given the total income, estimates of total expenditure can be obtained by multiplying the income figure by the average propensity to consume. Estimates of average propensities to consume and of the Frisch parameter, ω, for different types of households, given in Tulpulé (1980 b), are shown in Table 6.5.

Thus,

$$(3.3) \qquad \psi(H) = \mu_o, \text{ when } H \leq \mu_2,$$

and

$$(3.4) \qquad \psi(H) = \mu_o + 3\mu_1\ (H - \mu_2)^2, \text{ when } H > \mu_2.$$

In the elasticity formula (2.22) the second derivative of $G(H)$, $\psi'(H)$ is also required.

$$(3.5) \qquad \psi'(H) = 0, \text{ when } \leq \mu_2,$$

and

$$(3.6) \qquad \psi'(H) = 6\mu_1\ (H - \mu_2), \text{ when } H > \mu_2.$$

The chosen form of $G(H)$, viz. (3.1) and (3.2), yields global differentiability in the neighbourhood of standard hours, μ_2. By substituting $H=\mu_2$ in (3.2), (3.4) and (3.6) it can be observed that the values of $G(H)$, $\psi(H)$ and $\psi'(H)$ obtained from the curves applicable for H greater than μ_2 and for H less than μ_2 are exactly the same when $H=\mu_2$. Thus $G(H)$, $\psi(H)$ and $\psi'(H)$ are continuous in the neighbourhood of standard hours.

4. DATA FOR EMPIRICAL ESTIMATION OF EARNINGS OPPORTUNITIES CURVES

In the estimation of after-tax EOCs data are required on the after-tax earnings received by homogeneous groups of workers working different number of hours per week. Data on the before-tax earnings of workers working different number of hours per week and data on income tax paid (derived from taxation statistics) by individuals earning different amounts of incomes will be used in fitting the EOCs. In practice the tax rate depends not only on the labour income but also on non-labour income, deductions, etc., which in turn depend on family characteristics and asset endowment. Thus it is possible for workers facing the same before-tax EOC to face different after-tax EOCs. This possibility is not considered in the present paper.

4.1 Before-tax Earnings and Hours Worked[1,2,3]

Since May 1974 comprehensive information on earnings and hours of employees has been collected annually by the Australian Bureau of Statistics (ABS). Prior to that similar but less comprehensive information was collected each year in October (e.g., see ABS (1974)). Aggregate tables for May 1976 were published by the ABS (1977). The Bureau provided special tabulations of data from the survey to the IMPACT Project (ABS, 1979). The tabulations included detailed information on earnings and hours of employees classified by sex, age (adult/junior), occupation, industry, size of firm , etc.. Preliminary

1 Throughout this paper the term 'Hours Worked' means 'Hours Paid For'. For most employees the 'Hours Paid For' is the sum of ordinary work hours and overtime hours. For some employees such as those on paid leave the data are not on actual hours worked but for paid hours.

2 All estimates of the numbers of persons which are less than 4000 and the corresponding earnings and hours estimates have been derived by the author and have no official status with the ABS. They are subject to very high sampling variability and should not be considered as statistics in their own right.

3 The Earnings and Hours Surveys were not designed to estimate the number of employees by industry or occupation. The estimates of the number of employees in each occupation should be treated with caution. The numbers, however, give an indication of the reliability of the estimates of parameters estimated from data on earnings and hours for different types of workers.

Non-labour income is also likely to depend on family characteristics because some Government transfer payments depend on factors such as the number and ages of children. In spite of these factors, for the purpose of the analysis in this paper, a simple assumption about the proportionality between labour and non-labour income is made. The proportions for different types of households for 1975-76 are shown in Table 6.3.

TABLE 6.3: ESTIMATES OF AVERAGE AFTER-TAX LABOUR AND NON-LABOUR INCOME FOR DIFFERENT TYPES OF HOUSEHOLDS, 1975-76

Household Type	After-tax Income ($)			Ratio Non-labour/ Labour Income
	Non-labour	Labour	Total	
Both Husband & Wife Work	3411.88	12664.20	16074.08	0.2694
Single Male Worker	1388.08	6509.97	7898.05	0.2132
Single Female Worker	1505.71	4722.99	6228.70	0.3188

Source: Tulpulé (1980 b).

The figures in Table 6.3 are based on all types of households including self-employed and managerial employees. Overall for all types of households, the non-labour income accounts for 21.2 per cent of total income; and the ratio of non-labour to labour income is 0.2690. For the non-managerial employees the proportions are likely to be much smaller. Information from taxation statistics can be used to obtain a rough idea of these proportions.

In 1975-76 according to the Commissioner for Taxation (1978), for all individual taxpayers the non-labour income (i.e., the difference between net income and wage and salary income) accounted for 18.059 per cent of total net income[1]. For wage and salary earners (occupations 1 and 2 in the taxation statistics) however the figure was only 5.014 per cent; and the ratio of non-labour income to wage and salary income was 0.05278. Assuming that this ratio is applicable for the non-managerial employees, estimates of the ratios for the three types of households are made by scaling the ratios in

1 This compares reasonably with the overall figure of 21.2 per cent for all households (Tulpulé , 1980 a).

wage rate is constant and independant of actual hours worked. That is, no allowance was made for overtime penalty rates. Despite these differences it is expected that the estimates of the marginal leisure preference parameters obtained therein would be first order parameters whose estimates would be only marginally affected by the more general specification adopted here. It isfurther assumed that the marginal leisure preference parameters estimated from the TELESH model are invariant with respect to other characteristics of the workers such as their occupation and age. With these assumptions the values of marginal leisure preference parameters shown in Table 6.2 are used for non-managerial employees in different occupation and age groups.

TABLE 6.2: ESTIMATES OF MARGINAL LEISURE PREFERENCE PARAMETERS FOR WORKERS CLASSIFIED BY SEX AND MARITAL STATUS*

Worker Type	Parameter Estimates
Married Male	0
Married Female	0.2743
Single Male	0.2760
Single Female	0.2879

* Source: Tulpulé (1980 b).

In view of the zero value of the marginal leisure preference for married males, it is clear from (2.22) and (2.34), that all elasticities for married males will be zero. Therefore estimates will be made for only the remaining three types of workers.[1]

It may be recalled from Section 2 that $\theta = \alpha - \Sigma p_i \gamma_i$; that is, θ is the difference between non-labour income (α) and subsistence expenditure ($\Sigma p_i \gamma_i$) of the household. In the Earnings and Hours survey, information on non-labour income is not collected. In making rough estimates of α it is assumed that for all types of non-managerial employees the non-labour income is proportional to the labour income. Although supporting evidence is not available, the assumption is expected to be reasonable for most non-managerial employees. (For the self employed persons and managerial employees there may be little relationship between labour and non-labour income.)

1. The non-response of the hours worked by married males to changes in the conditions of their employment does not rule out responses by them to changes in the conditions of employment of their spouses.

analysis of basic hourly rates and weekly earnings of employees shows that the age, sex and occupation classifications are sufficient to classify the non-managerial employees into reasonably homogeneous groups (see, Tulpulé, forthcoming).

The survey provides estimates of total earnings, i.e., the sum of ordinary earnings, overtime earnings and other payments for employees working different numbers of hours per week. Estimates of hours worked (or hours paid for) are obtained by adding together the number of ordinary time and overtime hours. While it is possible to use these survey data to construct the earnings and hours schedules for the non-managerial employees, it is not possible to do so for the managerial employees because, for them, information on ordinary hours and overtime hours worked is not collected. Instead, only the number of 'rostered' hours[1] is recorded. In the government sector many managerial staff and persons employed in some occupations such as teaching[2] are ineligible to receive overtime payments. Obviously in such a situation it will not be possible to subject the data to the analysis proposed in the previous section. Because of these limitations this paper deals only with non-managerial employees.

The special tabulations of the survey data include two tables, one for males and one for females, which give the number of employees (hereafter 'employees' refers to non-managerial employees) classified by a number of variables of which the following are used in estimating the G(H) schedule:

1 age,
2 occupation,
3 ordinary weekly hours of work,
4 overtime hours, and
5 total weekly earnings.

1 The rostered hours represent the standard for the occupation. The 'ordinary' hours can be less than the standard hours.
2 In the 1976 survey over three quarters of teachers and lecturers were classified as non-managerial employees. However their basic hourly wage was almost exactly the same as their average hourly wage indicating the non-availability of overtime payments.

In the special tabulations four age groups are identified: 15 years and under, 16-17 years, 18-20 years and 21 years and over. For the purpose of the analysis in this paper the employees are grouped into two age groups: adults, i.e., those aged 21 and over, and juniors, those aged 20 or less. The occupation groups are as follows:

1 Professional White Collar,

2 Teachers and Lecturers,

3 Skilled White Collar,

4 Semi and Unskilled White Collar,

5 Skilled Blue Collar - Metal and Electrical,

6 Skilled Blue Collar - Building,

7 Skilled Blue Collar - Other,

8 Semi and Unskilled Blue Collar, and

9 Other, Not Elsewhere Classified.

The above classification is the same as the IMPACT occupational classification[1], apart from two differences. Firstly, the teachers and lecturers form a separate group here whereas in the IMPACT classification they are allocated between groups (1) and (3) above. This departure from the IMPACT classification was necessitated by the coding of the survey data. The IMPACT occupation group 'Armed Services' was not covered by the Earnings and Hours Survey; and most 'Rural Workers' were excluded because the Agricultural sector is out of the scope of the survey.

1 For a detailed discussion on the design of the IMPACT occupational classification see Craigie (1979).

TABLE 6.1 : EXPRESSIONS FOR VARIOUS TERMS IN THE ELASTICITY FORMULA (2.22)

Term	Expression	
	$H \leq \mu_2$	$H > \mu_2$
G	$H\mu_0$	$H\mu_0 + \mu_1 (H-\mu_2)^3$
ψ	μ_0	$\mu_0 + 3 \mu_1 (H-\mu_2)^2$
ψ'	0	$6 \mu_1 (H-\mu_2)$
$\frac{\partial G}{\partial \mu_0}$	H	H
$\frac{\partial G}{\partial \mu_1}$	-	$(H-\mu_2)^3$
$\frac{\partial G}{\partial \mu_2}$	-	$-3 \mu_1 (H-\mu_2)^2$
$\frac{\partial \psi}{\partial \mu_0}$	1	1
$\frac{\partial \psi}{\partial \mu_1}$	-	$3 (H-\mu_2)^2$
$\frac{\partial \psi}{\partial \mu_2}$	-	$-6 \mu_1 (H-\mu_2)$

All the expressions in Table 6.1 can be evaluated at different values of H for employees in different age, sex and occupation groups by using the parameter values in Table 5.2. In addition estimates of θ and β_L are required to evaluate the elasticity of supply of labour hours. The β_L parameter represents the marginal propensity to consume leisure. Estimates of marginal propensities to consume leisure for Australian workers classified by sex and marital status are presented in Tulpulé (1980 b). These estimates were obtained by fitting a TELESH (Twice Extended Linear Expenditure System for several Household types) model to Australian National Accounts and Labour Force data for 1964-65 to 1975-76. In that study the Australian working population was divided into four types of households; viz. households in which only the husband works, those in which both husband and wife work, single person male households and single person female households. Unlike the present paper that paper assumed that the after-tax

6. ELASTICITIES OF SUPPLY OF LABOUR HOURS

Elasticity formulae for estimating the effect on the supply of labour of a change in the j^{th} parameter of an earnings opportunities curve were derived for single worker households (2.22) and for the male worker in households with two workers (2.34) in Section 2. These formulae are given below.

$$(2.22) \qquad \frac{\partial H}{\partial \mu_j}\frac{\mu_j}{H_m} = \frac{\frac{\mu_j}{H}\left[\frac{(\theta+G)}{\psi}\frac{\partial \psi}{\partial \mu_j} - \frac{\partial G}{\partial \mu_j}\right]}{\left[\frac{\psi}{\beta_L} - \frac{\psi'}{\psi}(\theta+G)\right]};$$

$$(2.34) \qquad \frac{\partial H_m}{\partial \mu_j}\frac{\mu_j}{H_m} = \frac{\frac{\mu_j}{H_m}\left[\frac{\tilde{\theta}+\tilde{G}}{\psi_m}\frac{\partial \psi_m}{\partial \mu_j} - \frac{\partial \tilde{G}}{\partial \mu_j}\right]}{\left[\frac{\psi_m}{\beta_{Lm}} - \frac{\psi_m'}{\psi_m}(\tilde{\theta}+\tilde{G})\right]}.$$

Formula (2.22) gives the percentage change in hours worked by a worker in a one worker household when the j^{th} parameter of the earnings opportunities curve that he faces changes by one per cent.

In order to make numerical estimates of these elasticities it is necessary to derive expressions for the terms in the formulae and obtain their values at given levels of hours initially worked, i.e., hours worked before the change in the parameter occurs. All the quantities in (2.22), except θ, and β_L can be derived from the knowledge of the G(H) curve. In addition, in (2.34) we need an estimate of the labour income of the second worker in the household.

For the form of the G(H) curve adopted in this paper the various expressions are summarized in Table 6.1 for $H \leq \mu_2$ and $H > \mu_2$.

The IMPACT occupational classification is based primarily on the principle of skill differentiation. This requires that within each occupation group there is homogeneity with respect to skill level. While it is impossible to achieve perfect homogeneity using only nine occupation groups, for reasons of practicality further disaggregation is not attempted. However when persons in each occupation group are classified by sex and age[1], within each group a reasonable degree of homogeneity is achieved. With this much disaggregation it is expected that persons within a group would face the same earnings opportunities.

Ranges of the standard hours, overtime hours and total earnings variables in the special tabulations are shown in Table 4.1.

1 The basic hourly wage within the 'junior' group varies considerably depending on the actual age. However for reasons of practicality the juniors are included in one age group.

TABLE 4.1 : RANGES OF VARIABLES IN SPECIAL TABULATIONS* OF EARNINGS AND HOURS SURVEY

Range No.	Ordinary hours per week for males and females
1	zero
2	0.1 - 15.0
3	15.1 - 25.0
4	25.1 - 30.0
5	30.1 - 37.5
6	37.6 - 39.5
7	39.6 - 40.0
8	40.1 - 45.0
9	45.1 - 51.0
10	51.1 and over

Range No.	Overtime hours per week	
	Males	Females
1	zero	zero
2	0.1 - 0.5	0.1 - 0.5
3	0.6 - 1.0	0.6 - 1.0
4	1.1 - 3.0	1.1 - 5.0
5	3.1 - 5.0	5.1 - 9.0
6	5.1 - 7.0	9.1 and over
7	7.1 - 9.0	
8	9.1 - 12.0	
9	12.1 and over	

Range No.	Total earnings per week ($)	
	Males	Females
1	zero	zero
2	0.01 and under 20	0.01 and under 20
3	20 " " 40	20 " " 40
4	40 " " 60	40 " " 60
5	60 " " 80	60 " " 80
6	80 " " 100	80 " " 100
7	100 " " 120	100 " " 120
8	120 " " 140	120 " " 140
9	140 " " 160	140 " " 160
10	160 " " 180	160 " " 180
11	180 " " 200	180 " " 200
12	200 " " 220	200 " " 220
13	220 " " 240	240 and over
14	240 " " 260	
15	260 " " 300	
16	300 " " 350	
17	350 and over	

* Source: ABS (1979).

TABLE 5.2: (Continued)

Occupation	Parameters of After-tax EOC μ_0	μ_1	μ_2	Residual sum of squares	Parameters of Before-tax EOC μ_0^*	μ_1^*	Residual sum of squares
ADULT FEMALES							
1. Professional White Collar[a]	3.4937	0.000014	37.84	0.1098	4.9878	0.005199	0.2604
2. Teachers and Lecturers[a,b]	3.5870	0.000031	37.46	0.0765	5.1383	0.001736	0.1128
3. Skilled White Collar[a]	3.2879	0.000061	39.44	0.1268	4.5672	0.013403	0.0727
4. Semi and Unskilled White Collar[a]	2.9234	0.000143	38.99	0.0284	3.6967	0.022322	0.0419
5. Skilled Blue Collar - Metal and Electrical	2.6573	0.003357	38.44	0.0338	3.2956	0.029401	0.0648
6. Skilled Blue Collar - Building[a,d]	2.5919	0.000051	38.44	0.1102	3.2116	0.005576	0.3610
7. Skilled Blue Collar - Other[a]	2.6861	0.000223	39.52	0.0422	3.3399	0.010058	0.0430
8. Semi and Unskilled Blue Collar[a]	2.6320	0.001012	39.86	0.0320	3.2064	0.030596	0.0219
All Occupations[a]	2.8882	0.001028	39.17	0.0265	3.7318	0.009449	0.0866
JUNIOR FEMALES							
1. Professional White Collar[c]	-	-	34.41	-	-	-	-
2. Teachers and Lecturers[c]	-	-	31.41	-	-	-	-
3. Skilled White Collar[a]	2.4254	0.000105	38.06	0.0564	2.9095	0.005172	0.1512
4. Semi and Unskilled White Collar	2.1426	0.003386	39.07	0.0304	2.4729	0.016703	0.0554
5. Skilled Blue Collar - Metal and Electrical[c]	-	-	35.40	-	-	-	-
6. Skilled Blue Collar - Building[c]	-	-	31.41	-	-	-	-
7. Skilled Blue Collar - Other	1.7863	0.037824	37.12	0.1301	1.9941	0.060685	0.2194
8. Semi and Unskilled Blue Collar	1.9949	0.006339	38.66	0.0347	2.2688	0.016929	0.0731
All Occupations	2.1333	0.002388	38.92	0.0168	2.4627	0.013995	0.0331

a The program does not converge within 120 iteration for after-tax data.
b The program does not converge within 120 iteration for before-tax data. When there is no convergence, the parameter values are those associated with the lowest residual sum of squares achieved in the actual computations.
c Estimation not possible due to small sample size. See Table 5.1.
d Elasticities are not estimated for these groups as they contain less than 5,000 persons.

TABLE 5.2: ESTIMATE OF PARAMETERS OF THE AFTER-TAX AND BEFORE-TAX EARNINGS OPPORTUNITIES CURVES FOR DIFFERENT TYPES OF NON-MANAGERIAL EMPLOYEES

Occupation	Parameters of After-tax EOC			Residual sum of squares	Parameters of Before-tax EOC		Residual sum of squares
	μ_0	μ_1	μ_2		μ_0^*	μ_1^*	
ADULT MALES							
1. Professional White Collar[a]	4.4620	0.000106	38.71	0.1209	5.6888	0.000100	0.2545
2. Teachers and Lecturers[a,b]	4.8212	0.000062	37.36	0.3904	6.1647	0.000561	0.9261
3. Skilled White Collar[a]	4.1156	0.000057	38.64	0.0890	5.2159	0.002331	0.1868
4. Semi and Unskilled White Collar[a]	3.6760	0.000242	39.13	0.1036	4.4849	0.003055	0.2083
5. Skilled Blue Collar - Metal and Electrical	3.5449	0.006076	39.81	0.0438	4.3437	0.019277	0.1370
6. Skilled Blue Collar - Building	3.5500	0.009117	40.24	0.0225	4.3319	0.027132	0.0619
7. Skilled Blue Collar - Other[a]	3.4695	0.000027	40.01	0.0555	4.2096	0.005526	0.1105
8. Semi and Unskilled Blue Collar	3.3084	0.006166	39.94	0.0354	4.0007	0.016432	0.0938
All Occupations	3.5382	0.002179	39.64	0.0230	4.3231	0.011383	0.0527
JUNIOR MALES							
1. Professional White Collar[c]	-	-	34.97	-	-	-	-
2. Teachers and Lecturers[c]	-	-	31.41	-	-	-	-
3. Skilled White Collar[d]	2.4542	0.026410	36.04	0.1420	2.7923	0.044637	0.2615
4. Semi and Unskilled White Collar	2.2867	0.005690	38.82	0.0546	2.5907	0.011668	0.0934
5. Skilled Blue Collar - Metal and Electrical	2.1739	0.010976	39.43	0.0630	2.4543	0.018086	0.1287
6. Skilled Blue Collar - Building	2.3252	0.008642	39.42	0.0851	2.6488	0.014953	0.1565
7. Skilled Blue Collar - Other	2.3428	0.003279	38.93	0.1196	2.6768	0.007801	0.2119
8. Semi and Unskilled Blue Collar	2.2565	0.017835	38.70	0.0293	2.5532	0.029033	0.0557
All Occupations	2.2538	0.013728	38.91	0.0123	2.5523	0.022835	0.0232

contd

It can be seen from Table 4.1 that the first four ranges of the variable 'standard hours' are very wide. If it is assumed that the standard hours of all employees within any one of these ranges are represented by the midpoint of the range, then the overall average of ordinary hours for all employees works out to be less than the actual average based on unit records. The main reason for this discrepancy is that the bulk of the employees within the 30.1 to 37.5 ordinary hours per week range are full time employees whose average ordinary hours per week are near the top end of the range. If it is assumed that the average for this range is 37 hours per week rather than the midpoint of 33.75 hours per week then for most occupations the average of ordinary hours calculated from the grouped data come out to be very close to the average obtained from unit records. In the first three ranges, there are relatively few employees and the assumed midpoints for these ranges and for the open ended top range have very little effect on the overall average of all ranges. Therefore in all ranges except 30.1 to 37.5, it is assumed that the average is at the midpoint of the range. For the top range different averages for males and females are assumed.

As the ranges of the variable 'overtime hours' are fairly small, the midpoint of each range is a good approximation to the average overtime hours in the range.

The total hours worked by groups of employees in a given ordinary hours and overtime hours range can now be calculated.

The total weekly pay ranges are also fairly narrow. By assuming that the average in each range is at the midpoint, for employees working a given number of hours per week (i.e., ordinary hours plus overtime hours) average weekly earnings can be calculated.

Thus the necessary data on hours worked and before-tax earnings are assembled in a suitable form for curve fitting. For each occupation, age and sex group now we have a number of observations that give for a given number of employees, total hours worked per week and total before-tax earnings per week. These data can be used to fit the before-tax EOCs. By applying an appropriate tax rate to each before-tax earnings figure sufficient information for statistical curve fitting of the function G(H) can be obtained.

4.2 Taxation Statistics[1]

In order to make estimates of after-tax earnings from the data on before-tax earnings per week, data on the average tax rates that would be applicable at each level of weekly earnings are required. The income tax is levied on the basis of an individual's total income including non-labour income in a financial year. The rate depends on 'taxable income' which is the net income less concessional deductions. These deductions are related to an individual's family situation such as number of dependents. Thus a married male with a working wife would pay the tax at a higher rate than one with the same level of labour income but with a non-working wife. In families where both husband and wife work the family non-labour income is

1 Data on tax rates applicable at different levels of labour incomes were derived by Vince Manion from the Report of Commissioner of Taxation (1978).

The μ_1^* parameters are in general significantly larger than the corresponding μ_1 parameters. In the case of adult workers the difference between the μ_1^* and μ_1 parameters are particularly large and most μ_1 parameters are almost zero. This indicates that the effect of overtime payments is almost completely cancelled out by the progressive tax rates. In the case of junior employees, whose earnings are at a lower rate, the tax rates are lower and consequently the effect of overtime payments are not reduced to the same extent as for the adult workers.

The μ_1 parameter for adult male professional white collar employees is slightly larger than the μ_1^* parameter. This is surprising. However in view of the non-convergence of the program the estimated value is not necessarily correct. It may be desirable to replace it by zero.

The sum of squares, SS, of the difference between the observed and fitted estimate of G(H) is given by

$$(5.1) \qquad SS = \sum_i w_i \, (O_i - G_i)^2,$$

where

O_i = observed average before-tax earnings of workers in the i^{th} cell,

G_i = corresponding fitted value of average earnings,

and

w_i = weight for the i^{th} cell.

The minimum of the sum of squares is determined by iterating the parameters μ_0 and μ_1 of the G(H) function using a search technique by Peckham (1970).

The parameter values of the after-tax earnings opportunities curves, μ_0, μ_1 and μ_2, obtained by this technique for different types of workers are shown in Table 5.2. Parameters of the before-tax earnings opportunities curves, viz. μ_0^* and μ_1^*, are also shown for the purpose of comparison. A comparison of the average hourly wage rates with the corresponding μ_0^* estimates shows that in general the two values are similar. For adult employees the μ_0^* estimates are slightly greater than the average hourly wage rate whereas for the juniors, the μ_0^* parameter is slightly smaller or about the same as the average hourly wage rate.

The μ_2 parameter for some junior employees is less than 35 hours. All these occupation groups have very few employees and therefore the estimates are based on very small samples. In these cases the μ_2 parameter values may be replaced by the corresponding estimate for adults.

likely to be included in the tax return of the worker whose marginal tax rate is lower. (In most cases the non-labour income is likely to have been included in the wife's tax return.) Thus employees facing the same before-tax EOC could face different after-tax curves.

In theory it is possible to derive several after-tax EOCs for workers facing the same before-tax curve. For reasons of practicality, this is not attempted. Instead, for different levels of annual net incomes of males and females data on the average tax rate available from published sources[1] are used. The average wage and salary income at each range of net income is estimated separately for males and females. It is then assumed that the average tax rate applicable at a given level of wage and salary income is also applicable at the equivalent level of weekly labour earnings. In estimating the average wage income in each range of net income the following procedure is adopted.

For each net income range the total net income and total wages and salaries are known for all individual taxpayers, and also for those whose main source of income is from wages and salaries[2]. The numbers of taxpayers in these groups are also available. By making use of these figures the average wage and salary per person in each net income group can be estimated. Aggregate data on net income and wages and salaries for males and females are also available. Separate initial estimates for males and females were

1 For a given level of net income, men on average attract a lower tax rate than women due to family related concessional deductions claimed by married men.

2 In the tax statistics three types of 'occupations' are defined. Taxation occupations 1 and 2 include taxpayers with wage and salary income, and property income of less than $400 and more than $400 respectively. Almost all wage and salary earners are included in these two groups.

obtained for each net income range under the assumption that in each income range the average wage and salary of men and women is the same. These initial estimates were scaled to achieve consistency with the separate aggregate estimates for males and females.

With these assumptions estimates of the average tax rate applicable at each level of net income and the corresponding level of wage and salary income have been derived. It is assumed that the same average tax rate is applicable whatever the source of income. The weekly net income and weekly wage and salary figures for each annual net income range are obtained by simply dividing the annual figures by 52.

These derived tax schedules are shown in Table 4.2. The tax rate applicable for each type of worker at each level of before-tax earnings is obtained by interpolation of the tax schedule. By applying the interpolated tax rate, estimates of after-tax earnings are made.

Comparison of tax rates at a given income level for males and females shows that in most ranges the wage and salary income of females is less than corresponding figures for males. This could happen if the male taxpayers are entitled to larger concessional deductions and if a large part of unearned income in a family is included in the tax return of the wife. This practice leads to a higher average tax rate for females at a given level of wage income.

estimates of the μ_1 parameter are expected to be less reliable. In general, estimates of μ_1 parameters based on less than 10,000 persons should be treated with caution.

Table 5.1 shows that in all occupation groups, the average hourly wage and average hours per week for females are lower than the corresponding figures for males. Similarly in most occupations the junior hourly wage and hours per week are lower than the corresponding figures for adults.

The parameter μ_2 of the earnings opportunities curve represents an estimate of average ordinary hours per week for full time employees. The special tabulations of data from the Earnings and Hours Surveys (ABS, 1979) give estimates of total ordinary hours for full time employees classified by age, sex and occupation. The μ_2 parameter for each group of employees is obtained by dividing the total of ordinary hours by the total number of employees in each group. As the estimates are based on unit records the estimated values of the μ_2 parameter are expected to be reasonably accurate for all age, sex and occupation groups except the ones based on small samples. Estimates based on a very small number of persons in the population, say less than 1000, however, could have large sampling errors.

In the G(H) function, with the μ_2 parameter fixed, there are now only two free parameters, μ_0 and μ_1, to be estimated for each occupation, age and sex group. The method used to obtain estimates of μ_0 and μ_1 minimizes the weighted sum of squares of the differences between the observed and fitted values of G(H), where the weights, w_i, are proportional to the square root of the numbers of workers for whom the data file on hours and earnings is created.[1]

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1 In order to keep the numbers small, for i^{th} observation based on N_i workers, the weight w_i is equal to $\sqrt{N_i}/\Sigma\sqrt{N_i}$. Thus the weights are normalised.

TABLE 5.1: (Continued)

Occupation	No. of Observations	No. of Workers ('000)	Average Hourly Wage $	Average Hours per Week
ADULT FEMALES				
1. Professional White Collar	14	11.5	4.84	34.82
2. Teachers & Lecturers	9	88.8	5.25	33.92
3. Skilled White Collar	29	85.9	4.57	33.86
4. Semi & Unskilled White Collar	37	533.2	3.64	34.67
5. Skilled Blue Collar - Metal and Electrical	11	5.0	3.01	39.24
6. Skilled Blue Collar - Building	8	1.5	2.95	39.21
7. Skilled Blue Collar - Other	24	27.0	3.20	35.07
8. Semi & Unskilled Blue Collar	37	362.6	3.07	33.10
9. Other, N.e.c.	15	2.1	2.88	36.53
1-9 All Occupations	184	1117.6	3.66	34.08
JUNIOR FEMALES				
1. Professional White Collar	3	0.5	2.96	31.41
2. Teachers and Lecturers	4	0.3	2.59	28.95
3. Skilled White Collar	13	10.0	2.97	38.84
4. Semi & Unskilled White Collar	30	213.0	2.47	35.48
5. Skilled Blue Collar - Metal and Electrical	1	0.3	3.18	39.75
6. Skilled Blue Collar - Building	1	0.1	3.08	40.55
7. Skilled Blue Collar - Other	9	3.3	2.42	39.92
8. Semi & Unskilled Blue Collar	23	31.2	2.41	34.15
9. Other, N.e.c.	5	0.4	3.08	32.94
1-9 All Occupations	89	259.0	2.49	35.49

Source: Based on ABS (1979).

TABLE 4.2 : NET INCOME, WAGES AND TAX RATES FOR MALES AND FEMALES, 1975-76

	Range of annual net income	Males		Females	
		Average[a] weekly income from wages and salaries	Average tax rate	Average[a] weekly income from wages and salaries	Average tax rate
	$	$	%	$	%
1	Under 3 000	32.52	2.76	33.46	2.91
2	3 000 - 3 499	57.52	5.44	56.33	5.70
3	3 500 - 3 999	67.31	7.61	66.08	8.20
4	4 000 - 4.499	78.06	8.98	76.35	10.10
5	4 500 - 4 999	88.52	10.30	86.00	11.72
6	5 000 - 5 499	99.67	11.45	96.50	13.36
7	5 500 - 5 999	109.85	12.64	105.56	15.05
8	6 000 - 6 499	119.65	13.66	113.33	16.59
9	6 500 - 6 999	129.21	14.48	120.52	17.87
10	7 000 - 7 499	139.17	15.27	127.40	18.93
11	7 500 - 7 999	148.33	16.06	133.63	19.85
12	8 000 - 8 499	157.46	16.73	138.06	20.64
13	8 500 - 8 999	166.75	17.44	143.35	21.37
14	9 000 - 9 499	176.17	18.07	147.13	21.98
15	9 500 - 9 999	185.27	18.65	155.33	22.53
16	10 000 - 10 999	198.12	19.65	154.87	23.56
17	11 000 - 11 999	215.77	21.33	157.23	25.10
18	12 000 - 12 999	233.85	22.82	157.54	26.53
19	13 000 - 13 999	250.44	24.16	)	
20	14 000 - 14 999	267.31	25.33	)	
21	15 000 - 19 999	297.87	28.56	)	
22	20 000 - 29 999	357.27	36.04	) 263.54	41.32[b]
23	30 000 - 49 999	449.75	45.97	)	
24	50 000 - 99 999	569.83	53.61	)	
25	100 000 and over	1 311.04	53.72	)	

a Weekly figures calculated by dividing the annual estimated by 52.
b Average wage and salary income in the derived tax schedule for females is $157.54 at the net income level range $12 000- 12 999. As the averages beyond this income range do not increase with net income, the figure for over $13 000 is only a rough estimate based on data for males.

Source: Derived from Taxation Statistics (see text).

5. EARNINGS OPPORTUNITIES CURVES FOR NON-MANAGERIAL EMPLOYEES

Earnings opportunities curves for non-managerial employees classified by age, sex and occupation are first fitted to data on before-tax earnings and hours worked. The before-tax earnings figures are then deflated by applying an appropriate tax rate to give estimates of after-tax earnings of non-managerial employees in different groups who work a given number of hours per week. By making use of the estimates of after-tax earnings and hours worked it is possible to estimate the parameters of the after-tax earnings opportunities curves.

Estimates of the overall averages of hours worked and earnings for employees in each age, sex and occupation group are in general expected to be reasonable. However, the estimates based on a small number of persons in the population could have large sampling errors. In such cases there will be few observations on earnings and hours for fitting the EOCs and each observation would be based on a relatively small sample. In view of these problems caution is needed in interpreting the results of the curve fitting exercise based on small samples[1]. Estimates of numbers of employees, number of observations available for curve fitting, average hourly wage rate and average hours worked per week are shown in Table 5.1 for non-managerial employees classified by age, sex and occupation.

There are 35,000 employees in the 'Other, n.e.c.' occupation classification. As this is a heterogeneous occupational group, the observations are not used for fitting the earnings opportunities curves. Also parameter estimates based on small samples are not used to calculate the elasticities. When there are more than 1000 persons in an occupation, age and sex group it is expected that the average hourly wage estimate is reasonably accurate. However as the observations on earnings and hours within such a group are based on much smaller samples, the

1 The parameters of the earnings opportunities curves are not given when there are less than 5000 employees in a group. In such cases most observations on earnings and hours are likely to have been based on very small samples. The term 'observation' does not refer to an individual in the sample but the point in the earnings and hours space which would be based on a number of individuals in the sample.

TABLE 5.1: NO. OF OBSERVATIONS, ESTIMATES OF NO. OF WORKERS, AVERAGE HOURLY WAGE AND AVERAGE WORK HOURS PER WEEK FOR DIFFERENT TYPES OF NON-MANAGERIAL EMPLOYEES

Occupation	No. of Observations	No. of Workers ('000)	Average Hourly Wage $	Average Hours per Week
ADULT MALES				
1. Professional White Collar	31	34.0	5.46	38.80
2. Teachers & Lecturers	16	62.5	6.36	34.70
3. Skilled White Collar	34	99.1	5.08	38.75
4. Semi & Unskilled White Collar	47	420.1	4.21	38.26
5. Skilled Blue Collar-Metal and Electrical	59	368.1	3.89	41.63
6. Skilled Blue Collar-Building	44	108.4	4.08	40.97
7. Skilled Blue Collar-Other	40	61.0	3.40	40.50
8. Semi & Unskilled Blue Collar	72	932.4	3.67	40.49
9. Other, N.e.c.	32	31.0	3.34	39.57
1-9 All Occupations	375	2116.8	3.99	39.97
JUNIOR MALES				
1. Professional White Collar	5	1.1	2.84	36.85
2. Teachers & Lecturers	1	0.1	3.08	12.00
3. Skilled White Collar	13	4.9	2.92	38.52
4. Semi & Unskilled White Collar	35	72.5	2.60	34.28
5. Skilled Blue Collar-Metal and Electrical	31	63.9	2.38	40.06
6. Skilled Blue Collar - Building	16	15.5	2.68	39.92
7. Skilled Blue Collar - Other	23	9.4	2.59	38.30
8. Semi & Unskilled Blue Collar	41	78.8	2.59	37.83
9. Other, N.e.c.	13	2.8	2.64	39.14
1-9 All Occupations	178	249.0	2.55	37.55

contd.