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

WANTS AND WORKING WIVES :

HOUSEHOLD DEMAND AND SAVING IN AUSTRALIA

by

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WANTS AND WORKING WIVES :

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1. INTRODUCTION

The most noticeable change in the structure of the work force in Australia over the past decade or so has been the increase in the number of working wives. Labour force participation rates for married women have risen from around 27 percent in 1966 to around 42 per cent in 1976. Economic analyses of this phenomenon have tended to concentrate on the labour supply side. In contrast, this paper looks at the consumer demand aspects and examines whether households where both husband and wife work exhibit different patterns of consumption and saving from households where only the husband is employed.

The approach adopted is to fit linear demand systems to household budget data collected in the 1966-8 Macquarie University Survey of Consumer Expenditures and Finances. The analysis is confined to married couples and married couples with non-working children. In order

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* All the computer work reported here was efficiently handled by Ellen Hope.

to isolate influences on demand and saving other than those due to the presence of a working wife, the sample is first partitioned according to the age and occupation of the household head. Then within each of the homogeneous groups linear demand systems are estimated separately according to whether the wife is employed or not.[1]

The plan of the paper is as follows. In section 2 we consider two related sets of expenditure equations based on the Klein-Rubin utility function : the Linear Expenditure System (LES) and the Extended Linear Expenditure System (ELES). In the former, expenditure on a commodity is a linear function of total consumption expenditure; in the latter, income is the independent variable. In each case family size is introduced as an additional explanatory variable. The relationship between the coefficients of the two expenditure systems is examined and appropriate methods of estimation are discussed, bearing in mind that income data in budget studies is usually measured with error. It is shown that instrumental variable estimation of LES is equivalent to ordinary least squares estimation of ELES. In section 3 we discuss the data and empirical estimates of LES, which are in effect estimates of linear Engel curves. In section 4 we outline alternative methods of obtaining estimates of the Klein-Rubin "subsistence" parameters from the Engel curve estimates. Values are obtained using a priori estimates from time-series data of the expenditure elasticity of the marginal utility of expenditure. The final section summarizes the key findings and makes suggestions for further research.

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1. The data relate to working wives rather than working spouses.

using (A11) we obtain :

$$\sum_i \hat{\delta}^*_{ji} = \delta^{**}_j , \qquad (A12)$$

as expected, i.e., the OLS estimate of the coefficient of x_j in the ELES aggregate consumption function is identical to the sum of the OLS estimates of the coefficients of x_j in each of the individual expenditure equations.

Finally, we derive relationships for the "subsistence" parameters, γ^*_{ji} , in terms of IV estimates of Engel curves. Note that :

$$\hat{\delta}^*_{ji} = \hat{\gamma}^*_{ji} - \hat{\beta}^*_i \sum_k \hat{\gamma}^*_{jk} \qquad (A13)$$

$$\hat{\delta}^{**}_j = (1 - \hat{\mu}) \sum_k \hat{\gamma}^*_{jk} . \qquad (A14)$$

Substituting (A13) and (A14) into (A10) and using $\hat{\beta}^*_i = \hat{\mu} \tilde{\beta}_i$ yields

$$\hat{\gamma}^*_{ji} = \tilde{\delta}_{ji} + \tilde{\beta}_i \sum_k \hat{\gamma}^*_{jk} \qquad (i = 1, \ldots, n) \quad (j = 1, \ldots, m) . \qquad (A15)$$

However OLS estimation of (A1) produces

$$W' v_i^* = W' [y \vdots X] \begin{bmatrix} \hat{\beta}_i^* \\ \cdots \\ \hat{\delta}_i^* \end{bmatrix}$$

$$= \hat{\beta}_i^* W'y + (W'X) \hat{\delta}_i^* \qquad (A7)$$

Equating coefficients in (A6) and (A7) we derive the key results :

$$\hat{\beta}_i^* = \hat{\mu} \tilde{\beta}_i \qquad (A8)$$

$$\hat{\delta}_i^* = \hat{\delta}^{**} \tilde{\beta}_i + \tilde{\delta}_i \quad . \qquad (A9)$$

For the typical element of (A9)

$$\hat{\delta}_{ji}^* = \hat{\delta}_j^{**} \tilde{\beta}_i + \tilde{\delta}_{ji} \qquad \begin{pmatrix} i=1,\ldots,n \\ j=1,\ldots,m \end{pmatrix} \quad . \qquad (A10)$$

If x_j is family size, then $\hat{\delta}_j^{**}$ is expected to be positive and thus the OLS estimate of the coefficient of family size in ELES will tend to exceed the corresponding LES IV estimate (for all goods).

Notice that if we add the (A4) expressions over commodities i.e. calculate $\sum_i W' v_i^* = W' v$, and equate coefficients on the left and right hand sides of the resulting equation we obtain :

$$\sum_i \tilde{\beta}_i = 1 \quad \text{and} \quad \sum_i \tilde{\delta}_{ji} = 0 \qquad \text{(for all j)} \quad . \qquad (A11)$$

These results show that IV estimates of LES ensure that the budget constraint holds. If we now sum (A10) over commodities and substitute

2. METHODOLOGICAL CONSIDERATIONS

In this section we consider demand systems derived from the Klein-Rubin (1947-48) utility function

$$U = \sum_{i=1}^{n} \beta_i \, \ell n(q_i - \gamma_i) \qquad (1)$$

where q_i represents the quantity demanded of the i^{th} good and β_i, γ_i are parameters. Atemporal maximization of (1) subject to the budget constraint yields Stone's (1954) Linear Expenditure System, LES. Inter-temporal maximization of (1) subject to a wealth constraint in the manner developed by Lluch (1973) yields the Extended Linear Expenditure System, ELES. In the former the explanatory variables in the demand equations are prices and total expenditure, in the latter total expenditure is replaced by income.[1] In both models additional explanatory variables, such as family size, may be conveniently introduced by allowing them to influence, in a linear manner, the "subsistence" parameters, γ_i, i.e.,

$$\gamma_i = \sum_{j=0}^{m} \gamma_{ji} x_{jh} \quad , \qquad i = 1, \ldots, n \ , \qquad (2)$$

where x_{jh} is the value of explanatory variable x_j (j = 1, ..., m) for household h and $x_{0h} = 1$ for all h, i.e., γ_{0i} is the intercept term.

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1. In Lluch's most general formulation the income variable is current income plus discounted expected future changes in labour income.

In a cross-section context, assuming all consumers face common prices, ELES and LES collapse to the following linear equations after incorporating (2)[1] :

<u>ELES</u>

$$v_{ih} = \beta_i^* y_h + \sum_j \delta_{ji}^* x_{jh} + u_{ih} \quad (3)$$

where

$$\delta_{ji}^* = \gamma_{ji}^* - \beta_i^* \sum_i \gamma_{ji}^* \quad , \quad (4)$$

and

<u>LES</u>

$$v_{ih} = \beta_i v_h + \sum_j \delta_{ji} x_{jh} + \varepsilon_{ih} \quad (5)$$

where

$$\delta_{ji} = \gamma_{ji}^* - \beta_i \sum_i \gamma_{ji}^* \quad . \quad (6)$$

Additional notation for variables is as follows:

v_{ih} is expenditure on good i by household h, $v_h = \sum_i v_{ih}$ is total household expenditure, y is household income, and u_i and ε_i are error terms. The asterisks on the γ_{ji} indicate that they measure substistence expenditures in terms of prices ruling during the survey period, i.e., $\gamma_{ji}^* = p_i \gamma_{ji}$. It is clear from (5) that β_i (i = 1, ..., n) is the marginal budget share for the i^{th} good and from (3) that β_i^* is the marginal propensity to consume the i^{th} good. Thus $\Sigma \beta_i = 1$ and $\beta_i^* = \mu \beta_i$, where μ is the aggregate marginal propensity to consume.

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1. See Belandria (1971), Howe (1974), Powell (1973, 74) and Williams (1975) for details.

(i=1,...,n), and the following vectors of parameters :

$$\delta_i^* = \begin{bmatrix} \delta_{0i}^* \\ \delta_{1i}^* \\ \vdots \\ \delta_{mi}^* \end{bmatrix} , \quad \delta^{**} = \begin{bmatrix} \delta_0^{**} \\ \delta_1^{**} \\ \vdots \\ \delta_m^{**} \end{bmatrix} , \quad \text{and} \quad \delta_i = \begin{bmatrix} \delta_{0i} \\ \delta_{1i} \\ \vdots \\ \delta_{mi} \end{bmatrix} .$$

Finally, let W be an H x (m+2) data matrix defined as

$$W = [y \vdots X] .$$

Now IV estimates of LES are given by

$$W'v_i^* = W' [v \vdots X] \begin{bmatrix} \tilde{\beta}_i \\ \cdots \\ \tilde{\delta}_i \end{bmatrix}$$

$$= (W'v)\, \tilde{\beta}_i + (W'X)\, \tilde{\delta}_i \, , \quad (A4)$$

and OLS estimates of the ELES aggregate consumption function (A2) by

$$W'v = W' [y \vdots X] \begin{bmatrix} \hat{\mu} \\ \cdots \\ \hat{\delta}^{**} \end{bmatrix} . \quad (A5)$$

Substituting (A5) into (A4) yields

$$W' v_i^* = W' [y \hat{\mu} + X \hat{\delta}^{**}] \tilde{\beta}_i + (W'X) \tilde{\delta}_i$$

$$= (\hat{\mu} \tilde{\beta}_i) W'y + W'X [\hat{\delta}^{**} \tilde{\beta}_i + \tilde{\delta}_i] \quad . \quad (A6)$$

APPENDIX

Here we derive the general relationships between OLS estimates of ELES and IV estimates of LES, where in obtaining the IV estimates income is used as an instrument for total expenditure and all other variables act as their own instruments.

The expenditure equations to be considered are :

$$v_{ih} = \beta_i^* y_h + \sum_{j=0}^{m} \delta_{ji}^* x_{jh} \quad (A1)$$

ELES

$$v_h = \mu y_h + \sum_{j=0}^{m} \delta_j^{**} x_{jh} \quad (A2)$$

LES

$$v_{ih} = \beta_i v_h + \sum_{j=0}^{m} \delta_{ji} x_{jh} \quad (A3)$$

where notation is as in section 2 of the text.

Define the following data vectors and matrix :

$$v_i^* = \begin{bmatrix} v_{i1} \\ v_{i2} \\ \vdots \\ v_{iH} \end{bmatrix}, \; v = \begin{bmatrix} v_1 \\ v_2 \\ \vdots \\ v_h \end{bmatrix}, \; y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_h \end{bmatrix}, \; X = \begin{bmatrix} x_{01} & x_{11} & \cdots & x_{m1} \\ x_{02} & x_{12} & \cdots & x_{m2} \\ \vdots & \vdots & & \vdots \\ x_{0H} & x_{1H} & \cdots & x_{mH} \end{bmatrix}$$

Adding up the ELES expenditure equations (3) yields the aggregate consumption function

$$v_h = \mu y_h + \sum_j \delta_j^{**} x_{jh} + u_h \quad (7)$$

where

$$\mu = \sum_i \beta_i^* \quad (8)$$

$$\delta_j^{**} = \sum_i \delta_{ji}^* = (1 - \mu) \sum_i \gamma_{ji}^* \quad (9)$$

and

$$u_h = \sum_i u_{ih} .$$

Elimination of y from (3) and (7) (ELES) yields LES (5), or more precisely the deterministic part of LES.

The conventional objection raised against estimating (5)(LES) by ordinary least squares (OLS) is that simultaneity problems arise from the presence amongst the explanatory variables of the sum of the dependent variables.[1] The conventional objection to estimating (3) (ELES) by OLS is that in a cross-section context income is measured with error. Liviatan (1961) has suggested that the solution to these problems is to estimate (5) by the method of instrumental variables (IV), using measured income as the proxy for total expenditure. This is the approach adopted

1. See Summers (1959) and Liviatan (1961).

here. We allow any other included variables to act as their own instruments. Liviatan's approach is equivalent to unscrambling the coefficients of the LES estimating equations from OLS estimates of ELES. This is the method adopted in this paper. Denoting OLS estimates by "^" and IV estimates by "~" it can be shown (see appendix) that :

$$\tilde{\beta}_i = \hat{\beta}^*_i / \hat{\mu} \qquad (10)$$

and

$$\tilde{\delta}_{ji} = \hat{\delta}^*_{ji} - \hat{\delta}^{**}_j \tilde{\beta}_i \ . \qquad (11)$$

In the next section we report IV estimates of LES (5). The question of unscrambling values of the subsistence parameters, γ^*_i, from such estimates is left to section 4.

3. ENGEL CURVE ESTIMATES

The 1966-8 Macquarie Survey of Consumer Expenditures and Finances was carried out in two stages.[1] First, expenditure and income information was obtained from about 5,500 urban households. Second, detailed financial information was obtained from about half of the original households. The income data collected at the second round is the more comprehensive and reliable and it is primarily for this reason that we limit the data base to households included in both stages.[2] In addition, it

1. For descriptions of the survey, definitions of variables, etc., see Drane (1969, 1970/1), Podder (1971), and Podder and Kakwani (1975).

2. The first round data has been used by Podder (1971) to estimate Engel curves. The only disaggregation by consumers is on a regional basis.

either use inconsistent estimates of the "subsistence-sum" parameters, or to obtain estimates of such parameters from outside the sample. The difficulty with the latter approach is that little hard information exists on how these parameters vary with socioeconomic and demographic factors.[1] What is required for more reliable estimates of "subsistence" expenditure is more accurate data on the average and marginal propensity to save for different types of consumers in the community. Within the context of ELES/LES, knowledge of these two parameters enables an estimate to be obtained of the Frisch parameter, and thus of total "subsistence" expenditure.

Nevertheless, there is sufficient evidence from the Engel curve results to conclude that labour force participation rates for married women are as important a determinant of consumption patterns as age and occupation of the household head.

1. Findings for low income countries are contained in Williams (1975) and Lluch, Powell and Williams (1977).

household characteristics have also been considered, namely, age of head, occupation and family size. The findings suggest that it is important to allow for interaction effects between different household characteristics. For example, a (positive) working-wife effect is observed amongst older households in estimates of the marginal budget shares for clothing and recreation, but no such effect is apparent for young households. The family-size effect on housing expenditure depends on whether the wife is working or not, but again only for older households. Conversely, the presence of a working wife raises the average propensity to save for young households but has little effect on saving by older households. Expenditure on durables by young households is markedly higher if the wife is working.

Estimates of "subsistence" expenditure exhibit systematic movements across different household types. "Subsistence" expenditure on housing and durables tends to be higher if the wife is working. "Subsistence" expenditure on food is most closely related to the mean income of the household group and increases markedly with family size. For most other goods family-size effects on subsistence expenditure are relatively unimportant : the exceptions are clothing and other. In the Engel equations an increase in family size, for constant total expenditure, always results in increased expenditure on food and an offsetting reduction in expenditure on most other goods.

The estimates of "subsistence" expenditure have been derived by interpreting Engel curve estimates within the framework of demand systems based on the Klein-Rubin utility function. In the usual case of there being measurement error in income it is necessary in the derivation to

enables us to use imputed values for consumption of owner-occupied houses and motor vehicles. The expenditure system is estimated only for households consisting of married couples or married couples with non-working children and where the household head is employed. This leaves 1508 sample households for analysis.

There is evidence that consumption and savings patterns are related to the age of the household.[1] It therefore seems desirable to test whether working wives have a disparate effect on household consumption behaviour at different stages of the life cycle. The sample is thus subdivided into "young" and "old" households according to whether the household head is less than 35 years of age or 35 years and over. The break-point was chosen primarily because families at this stage in the life cycle would not have children beyond the secondary school level. Since families where the head is not working are excluded, the upper age class is effectively 35-65 years. Households in this age class are further sub-divided by occupation of the household head into white collar workers (executive, professional, semi-professional, clerical and sales) and blue collar workers (skilled technical, semi-skilled and labourers). Preliminary analysis indicated that such a distinction was important for the upper age group but not for young households.[2] These subdivisions also make the linearity assumption of the model more palatable.

The three groups defined above are each divided into two according to whether the wife is working or not. This yields six basic household

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1. See, in particular, Lluch, Powell and Williams (1977), Williams (1975).
2. See Williams (1976). The findings may reflect greater social homogeneity at younger ages or may just be an income effect, i.e., income differentials are greater in the upper age group.

types for which the model is fitted separately. Household size effects are allowed for by making "subsistence" expenditure a linear function of the number of children, i.e.,

$$\gamma_i^* = \gamma_{0i}^* + \gamma_{1i}^* x \qquad (12)$$

where x is the number of children in the household.

A nine commodity classification of expenditure is used : food, cigarettes and alcohol, clothing, housing, durables, medical goods, transport,[1] recreation and other. The income variable is personal disposable income including imputed rent. Both the expenditure and income definitions correspond fairly closely to those used in the Australian National Accounts.

Characteristics of the sample are given in table 1. As expected, households with working wives have higher mean incomes and total expenditure than do comparable households where the wife is not working. The average propensity to save varies directly with income, being highest for old white collar households at around 0.10. A specific working-wife effect is evident only for young households where the average propensity to save is higher if the wife is working. Average budget shares for food and housing are lower if the wife works, whereas the average budget shares for cigarettes and alcohol, clothing, and other (which includes education) are higher. Finally, average family size is smaller where the wife is working, particularly amongst young households.

1. Includes imputed value of services provided by motor vehicles. The imputations were constructed from the market value of cars owned by households. A consumption rate of 20 per cent a year was assumed based on the findings of Swan (1971), p. 15, and Industries Assistance Commission (1974), p. 40.

(iii) The estimates for housing are both small and highly insignificant ("t-values" all less than unity), implying that "subsistence" expenditure on housing is independent of family size.

(iv) The coefficients are determined with more precision for households where the wife does not work. Other than this no strong working-wife effects are apparent.

In concluding this section a word of warning is needed. The absolute values of γ_{0i}^* reported here are dependent on assumed values of ω, and the absolute values of γ_{1i}^* depend on estimates obtained from OLS estimation of the ELES aggregate consumption function. In both cases the estimates are approximations. In particular, one should not attach too much importance to small differences in absolute values of "subsistence" expenditures. The ratios of "subsistence" expenditures on individual goods to total "subsistence" expenditure are probably less sensitive to the assumptions used than are the absolute values.

5. CONCLUDING REMARKS

The relationships between the two linear demand systems, LES and ELES, have been explored and used to obtain instrumental variable estimates of Engel curves and estimates of "subsistence" expenditures for six "representative" consumers. While emphasis has been given to the effect of a working wife on consumption (and savings) behaviour, other

Table 7

ESTIMATES OF FAMILY-SIZE "SUBSISTENCE" COEFFICIENT, γ^*_{1j}, IN 1966-7 PRICES, AUSTRALIA [1)]

Commodity	Household Type [2)] 1	2	3	4	5	6
Food	152.0	150.7	170.7	127.1	111.2	124.3
	(13.1)	(28.6)	(20.1)	(30.2)	(10.0)	(18.9)
Cigs.	10.4	9.3	8.7	-29.0	0.1	-14.5
	(6.5)	(12.6)	(16.6)	(18.4)	(5.5)	(15.8)
Clothing	14.1	8.7	46.0	20.4	21.9	27.1
	(9.8)	(24.0)	(17.2)	(46.5)	(5.7)	(20.7)
Housing	-11.0	-18.6	24.2	23.6	9.5	-15.7
	(11.8)	(28.7)	(25.2)	(25.8)	(16.2)	(20.0)
Durables	-7.0	-21.2	58.0	-70.1	11.2	-27.8
	(32.1)	(75.7)	(34.1)	(68.7)	(16.5)	(27.1)
Medical	12.8	18.3	34.7	-40.9	5.5	16.4
	(9.8)	(17.8)	(12.7)	(37.1)	(9.7)	(17.4)
Transport	-23.1	-10.1	24.7	-31.2	11.2	-28.1
	(12.0)	(27.8)	(16.5)	(35.7)	(10.3)	(24.7)
Recreation	5.7	-19.0	17.5	-12.7	-11.7	8.8
	(13.7)	(38.4)	(31.9)	(61.4)	(8.8)	(20.8)
Other	11.4	23.6	55.2	51.3	28.1	8.8
	(6.9)	(56.9)	(24.6)	(27.8)	(5.3)	(19.0)
Sum	165.3	141.7	439.7	38.4	186.9	99.4
	(67.9)	(177.6)	(140.6)	(188.9)	(40.1)	(97.2)

1) Yearly amounts in dollars.
Standard errors are given in parentheses.

2) See Table 1 for code.

Table 1

CHARACTERISTICS OF DATA, MACQUARIE HOUSEHOLD SURVEY, AUSTRALIA, 1966-8

	Household Type [1)] 1	2	3	4	5	6
No. observations	464	101	282	74	447	140
Mean no. children	2.05	0.89	2.02	1.81	1.96	1.66
Annual Av. Income ($)	3999	4886	5558	6279	4034	4430
Annual Av. Exp. ($)	3940	4448	5020	5573	3857	4243
Av. Prop. Save	.015	.090	.097	.112	.044	.043
Average Budget Shares						
Food	.290	.254	.261	.246	.324	.293
Cigs., Alc.	.042	.046	.045	.049	.046	.056
Clothing	.062	.074	.079	.091	.066	.079
Housing	.171	.157	.166	.148	.166	.148
Durables	.141	.178	.119	.117	.096	.101
Medical	.080	.069	.075	.078	.081	.077
Transport	.117	.107	.108	.114	.113	.130
Recreation	.060	.043	.084	.086	.062	.057
Other	.036	.072	.063	.071	.046	.058

1) Code:
1. Head < 35, wife not working
2. Head < 35, wife working
3. Head ≥ 35, white collar, wife not working
4. Head ≥ 35, white collar, wife working
5. Head ≥ 35, blue collar, wife not working
6. Head ≥ 35, blue collar, wife working

The IV estimates of LES (equation (5)) are given in tables 2 - 4 : the constant terms in table 2, marginal budget shares in table 3, and the coefficients for family size in table 4. In estimation personal disposable income is the instrument for total expenditure and family size acts as its own instrument.

Since family size is measured as number of children, the estimates in table 2 are of the Engel curve intercepts for married couples. Negative values for these imply that the average budget share increases with "income." This phenomenon is most pronounced for clothing and recreation. Durable goods and housing exhibit a specific working-wife effect : the intercept term is always higher for working wives. The reverse is true for transport and, for old households, recreation. The derivation and discussion of "subsistence" parameters is left for section 4.

Of the 54 estimates of marginal budget shares in table 3, all but one lie in the required range of 0 to 1. The exception is a small negative value for cigarettes and alcohol (group 5) but this is not significantly less than zero at the 5 per cent level (all but one of the β_i-estimates for this commodity are insignificant).[1] Overall, 34 of the estimates of β_i are significantly different from zero at the 5 per cent level. All estimates for transport are significant, as are all the estimates for household type 3 (old, white collar households, wife not working).

1. In appendix A it is shown that IV estimates of β_i using LES are equivalent to OLS estimates using ELES. In Williams (1977) it is shown that in the absence of a family size variable estimates of the asymptotic standard errors of $\hat{\beta}_i$ obtained from IV estimation of LES are identical to those obtained from OLS estimation of ELES. Since on the assumption that the errors are classically and normally distributed ELES estimates are maximum likelihood estimates it follows that the IV estimates are asymptotically efficient and normally distributed. Introduction of a family size variable should not affect this result. Thus we may test for significance using the normal distribution.

(iii) A working-wife effect is apparent for housing and durables : "subsistence" expenditures are always higher for working-wife households, although in the case of durables the estimates are not well determined.

Estimates of the family-size coefficient, γ_{1i}^*, (see equation (12)) are given in table 7, together with estimates of asymptotic standard errors.[1] These coefficients measure the effect on "subsistence" expenditures of an additional child. Values are expected to be positive if the "subsistence" interpretation is to hold. The following points may be made on the basis of table 7 :

(i) An additional child produces a substantial increase in "subsistence" expenditure on food : the point estimates range from around $110 to $170 per child per year in 1966/7 prices ("t-values" all exceed 4).

(ii) Clothing and other (which includes education) are the only two remaining commodities where the estimates are all positive and determined with some precision. The point estimates for these two goods tend to be lower for young households, reflecting the younger age of children.

1. Calculated as
$\text{var}\ \gamma_{1i}^* = \text{var}\ \delta_{1i} + 2\ \Sigma\ \gamma_{1j}^*\ \text{cov}\ (\delta_{1i}\beta_i) + (\Sigma\ \gamma_{1j}^*)^2\ \text{var}\ \beta_i + \beta_i^2\ \text{var}\ \Sigma\ \gamma_{1j}^*$.
Thus the variance of $\Sigma\ \gamma_{1j}^*$ is allowed for but covariances between $\Sigma\ \gamma_{1j}^*$ and δ_{1i}, β_i are ignored.

may be interpreted as estimates of "subsistence" expenditure for married couples with no children. Key findings are as follows :

(i) The estimates of "subsistence" expenditure on food are large and well determined ("t-ratio" always exceeds 4). Values vary from $659 per household per year (in 1966-7 prices) to $970 per household. The percentage of total "subsistence" expenditure accounted for by food tends to decrease with income : it is highest (55 per cent) for group 5 (old, blue collar, wife not working) and lowest (33 per cent) for group 4 (old, white collar, wife working). The exception to this tendency is group 1, but the low ratio here (36 per cent) is probably explained by the young average age of the children.

(ii) Some negative γ^*_{0i}-estimates occur in four commodity classes - - clothing, durables, recreation and other - - but only in one of these classes (other) are the estimates significantly less than zero at the 5 per cent level. Of course if the γ-parameters are negative they lose a "subsistence" interpretation; they also imply own-price elasticities greater than unity.[1]

1. See Powell (1974), p. 38.

Table 2

INSTRUMENTAL VARIABLE ESTIMATES OF THE ENGEL CURVE INTERCEPT δ_{oi}, AUSTRALIA, 1966-8 [1)]

Commodity	Household Type [2)] 1	2	3	4	5	6
Food	477.3 (109.0)	661.5 (182.2)	505.8 (70.2)	614.6 (231.3)	908.0 (303.9)	656.7 (239.3)
Cigs.	126.0 (62.4)	170.3 (91.0)	-30.0 (80.1)	241.7 (173.9)	289.2 (163.1)	208.0 (227.5)
Clothing	-177.8 (62.1)	-52.0 (134.4)	-104.3 (56.0)	-630.0 (259.8)	69.1 (169.3)	-355.8 (198.7)
Housing	428.5 (102.7)	547.5 (201.9)	179.2 (80.2)	618.3 (241.1)	-416.8 (336.3)	77.1 (210.1)
Durables	-772.8 (190.4)	-451.4 (400.7)	-12.0 (163.5)	431.1 (648.3)	-399.5 (434.9)	248.4 (383.7)
Medical	-35.9 (73.9)	117.8 (118.7)	70.1 (53.8)	-318.7 (228.5)	-289.5 (211.3)	-260.8 (161.3)
Transport	224.1 (103.2)	18.7 (146.6)	187.1 (70.7)	-39.8 (243.3)	-175.9 (239.6)	-125.5 (255.7)
Recreation	-174.1 (110.4)	-37.3 (246.9)	-382.6 (100.6)	-924.0 (353.8)	-81.0 (243.1)	-410.4 (204.6)
Other	-95.3 (53.9)	-975.3 (231.9)	-413.3 (71.0)	6.7 (247.5)	96.4 (163.9)	-37.7 (258.1)

1) Standard errors are given in parentheses.

2) See Table 1 for code.

Table 3

INSTRUMENTAL VARIABLE ESTIMATES OF MARGINAL BUDGET SHARES, β_i, AUSTRALIA, 1966-8 [1)]

Commodity	Household Type [2)] 1	2	3	4	5	6
Food	.0980 (.0289)	.0769 (.0405)	.1108 (.0144)	.0959 (.0409)	.0351 (.0868)	.0927 (.0573)
Cigs.	.0056 (.0166)	.0058 (.0202)	.0578 (.0165)	.0150 (.0307)	-.0324 (.0466)	.0128 (.0545)
Clothing	.1093 (.0165)	.0861 (.0299)	.0990 (.0115)	.1997 (.0459)	.0404 (.0483)	.1586 (.0476)
Housing	.0746 (.0272)	.0392 (.0449)	.1468 (.0165)	.0299 (.0426)	.2976 (.0960)	.1415 (.0503)
Durables	.3727 (.0505)	.2921 (.0890)	.1197 (.0336)	.0628 (.1145)	.2138 (.1242)	.0559 (.0919)
Medical	.0905 (.0196)	.0401 (.0264)	.0575 (.0111)	.1501 (.0404)	.1697 (.0603)	.1376 (.0386)
Transport	.0791 (.0274)	.1080 (.0326)	.0734 (.0145)	.1331 (.0430)	.1693 (.0684)	.1777 (.0612)
Recreation	.1105 (.0293)	.0866 (.0549)	.1857 (.0207)	.2596 (.0625)	.0987 (.0694)	.1566 (.0490)
Other	.0596 (.0143)	.2652 (.0515)	.1493 (.0146)	.0538 (.0437)	.0079 (.0468)	.0665 (.0618)

1) Standard errors are given in parentheses.

2) See Table 1 for code.

Table 6

ESTIMATES OF "SUBSISTENCE" EXPENDITURES BY AUSTRALIAN HOUSEHOLDS WITH NO CHILDREN, γ_{oi}^*, IN 1966-7 PRICES[1)]

Commodity	Household Type [2)] 1	2	3	4	5	6
Food	658.7 (58.6)	814.8 (104.6)	693.5 (49.7)	866.8 (129.5)	970.3 (150.9)	848.3 (208.2)
Cigs.	136.4 (33.6)	181.9 (52.2)	67.9 (56.7)	281.2 (97.4)	231.7 (81.0)	234.5 (197.9)
Clothing	24.5 (33.5)	119.6 (77.1)	63.4 (39.7)	-104.8 (145.5)	140.9 (84.1)	-28.0 (172.8)
Housing	566.6 (55.2)	625.6 (115.9)	427.9 (56.8)	696.9 (135.0)	111.7 (167.0)	369.6 (182.7)
Durables	-82.9 (102.4)	130.8 (230.0)	190.8 (115.9)	596.3 (363.0)	-19.8 (215.9)	363.9 (333.7)
Medical	131.6 (39.8)	197.7 (68.1)	167.5 (38.2)	76.1 (127.9)	11.9 (104.9)	23.6 (140.3)
Transport	370.5 (55.5)	233.9 (84.1)	311.4 (50.1)	310.3 (136.3)	124.8 (119.0)	241.8 (222.3)
Recreation	30.4 (59.4)	135.3 (141.7)	-68.0 (71.3)	-241.3 (198.1)	94.3 (120.7)	-86.7 (177.9)
Other	15.0 (29.0)	-446.8 (133.1)	-160.4 (50.4)	148.2 (138.6)	110.4 (81.4)	99.8 (224.4)
Sum	1850.8	1993.3	1694.0	2629.7	1776.2	2066.8

1) Yearly amounts measured in dollars.
Standard errors are given in parentheses.

2) See Table 1 for code.

Table 5

ESTIMATES OF THE MARGINAL PROPENSITY TO CONSUME, μ, TOTAL "SUBSISTENCE" EXPENDITURE, $\Sigma\gamma_j^*$,[1] AND THE FRISCH PARAMETER, ω.

	Household Type [2]					
	1	2	3	4	5	6
1. Mean Total Exp. ($)	3940	4448	5020	5573	3857	4243
ELES Estimates[3]						
2. MPC , μ	.2810 (.0351)	.3326 (.0636)	.5023 (.0399)	.3126 (.0689)	.0667 (.0219)	.3233 (.0735)
3. $\Sigma\gamma_{oj}^*$	5379 (248)	4103 (547)	3588 (538)	5183 (756)	3478 (134)	3988 (530)
4. $\Sigma\gamma_{1j}^*$	165.3 (67.9)	141.7 (177.6)	439.7 (140.6)	38.4 (188.9)	186.9 (40.1)	99.4 (97.2)
5. $\Sigma\gamma_j^*$	3917	4229	4477	5253	3844	4153
6. ω	-170.3	-20.4	-9.2	-17.4	-302.4	-47.4
Independent Estimates						
7. ω	-2.25	-1.91	-2.06	-1.94	-2.25	-2.11
8. $\Sigma\gamma_j^*$	2189	2119	2583	2700	2143	2232
9. $\Sigma\gamma_{oj}^*$	1851	1993	1694	2630	1776	2067

1) $\Sigma\gamma_j^* = \Sigma\gamma_{oj}^* + x\Sigma\gamma_{1j}^*$, where x is number of children in the household.

2) See Table 1 for code.

3) Standard errors in parentheses.

Table 4

INSTRUMENTAL VARIABLE ESTIMATES OF FAMILY SIZE COEFFICIENT, δ_{1i}, AUSTRALIA, 1966-8 [1]

	Household Type [2]					
Commodity	1	2	3	4	5	6
Food	135.79 (11.98)	139.83 (24.88)	122.02 (13.60)	123.37 (24.14)	104.61 (18.96)	115.13 (17.03)
Cigs.	9.44 (6.86)	8.44 (12.42)	-16.74 (15.52)	-29.59 (18.15)	6.12 (10.17)	-15.76 (16.19)
Clothing	-3.95 (6.83)	-3.49 (18.35)	2.50 (10.86)	12.69 (27.12)	14.35 (10.56)	11.29 (14.14)
Housing	-23.32 (11.28)	-24.11 (27.57)	-40.39 (15.54)	22.50 (25.17)	-46.16 (20.98)	-29.79 (14.95)
Durables	-68.58 (20.92)	-62.57 (54.71)	5.35 (31.69)	-72.52 (67.67)	-28.74 (27.13)	-33.35 (27.31)
Medical	-2.20 (8.12)	12.57 (16.20)	9.37 (10.44)	-46.70 (23.85)	-26.25 (13.18)	2.73 (11.48)
Transport	-36.14 (11.34)	-25.44 (20.01)	-7.56 (13.71)	-36.30 (25.40)	-20.44 (14.94)	-45.74 (18.19)
Recreation	-12.60 (12.13)	-31.28 (33.71)	-64.13 (19.51)	-22.68 (36.93)	-30.16 (15.16)	-6.72 (14.65)
Other	1.55 (5.93)	-13.94 (31.66)	-10.42 (13.77)	49.22 (25.84)	26.64 (10.22)	2.20 (18.36)

1) Standard errors are given in parentheses.

2) See Table 1 for code.

A number of specific working-wife effects are evident amongst the β_i-estimates. The marginal budget share for transport is always higher for working-wife households than for comparable households where only the husband works. For old households the β_i-estimates for clothing and recreation are much higher where the wife works. Conversely, the presence of a working wife always yields lower estimates of the marginal budget shares for housing and durables. However, the intercept terms for these two goods are higher for working-wives[1] and the net effects are to give (i) mean expenditures for housing which are not unduly sensitive to the wife's occupational status[2] and (ii) mean expenditures for durables which are higher for working wives, particularly amongst young households where the presence of a working wife is estimated to raise expenditure on durables by about 40 per cent. The β_i-estimates for durables are higher for both types of young households than for any of the old household classes.

The only other apparent patterns in table 3 are those found in comparing white and blue collar workers : the marginal budget shares for recreation are higher for white collar workers, whereas the β_i-estimates for housing and transport are higher for blue collar workers. Estimates of the marginal budget share for food tend to be around 0.10 with no noticeable pattern. The β_i-estimates for "other" tend to be irregular, but there is a particularly high value (0.26) for young households where the wife is working.

1. The family-size effect reinforces the difference for housing, in the case of durables it acts to narrow the differences in the intercepts to some extent.

2. The average budget shares for housing are lower when the wife works but this is offset by higher mean total expenditure.

The first half of table 5 contains ELES estimates of the marginal propensity to consume, μ, the "subsistence-sum" coefficients, and the "Frisch parameter," ω. Estimates of the MPC are all significantly different from zero at the 5 per cent level but are low in magnitude : the highest value is 0.50 for class 3 (head $\geqslant$ 35, white collar, wife not working). Estimates of total household "subsistence" expenditure evaluated at mean family size, $\Sigma\ \gamma_j^*$, are very close to actual mean household expenditure, although they never exceed actual expenditure. This means that while estimates of the "Frisch parameter" all have the correct negative sign, they are unacceptably high in magnitude. Data limitations and the model's simple treatment of the consumption-saving choice appear to rule out the option of relying solely on ELES estimates to unscramble estimates of the "subsistence" parameters. Rather, we use the second of the options outlined above : <u>a priori</u> estimates of ω .

Rows 7-9 of table 5 contain estimates of the "Frisch parameter" obtained using (15). Estimates of total household "subsistence" expenditure, $\Sigma\ \gamma_j^*$, and total "subsistence" expenditure for couples without children, $\Sigma\ \gamma_{0j}^*$, are derived using (13) and (16), respectively. The obtained values of total household "subsistence" expenditure are in each case about one-half of actual expenditure. The information contained in rows 4 and 9 of table 5 is now used in (6) to obtain estimates of the "susbsistence" parameters for individual commodities.

Estimates of the intercept term in the linear expression for "subsistence" expenditures, equation (12), are given in table 6, together with approximate estimates of asymptotic standard errors.[1] These terms

1. Approximate since $\Sigma\ \hat{\gamma}_{0j}^*$ is assumed to have zero variance. Thus the calculation used is $\text{var}\ \gamma_{0i}^* = \text{var}\ \delta_{0i} + 2\ \Sigma\ \gamma_{0j}^*\ \text{cov}(\delta_{0i}\beta_i) + (\Sigma\ \gamma_{0j}^*)^2\ \text{var}\ \beta_i$, which will understate the true values to some extent.

Since in this paper we use information on "income" levels rather than total contributions to GNP it is necessary to modify equation (14). This is done by forcing the ω-estimate to be - 2.16 when evaluated at mean per capita total expenditure for the whole sample. The latter figure is \$1095, so to replace X by v/f, where f is household size, requires the scale factor to be lowered such that

$$\omega \quad = \quad - 26.8 \ (v/f)^{-.36} \quad . \tag{15}$$

Values of ω for each of the six household types will be smaller or larger than 2.16 in absolute value according to whether per capita total expenditure is larger or smaller, respectively, than the overall mean.

Combining (15) and (13) enables estimates to be obtained of total "subsistence" expenditure, $\Sigma \gamma_j^*$.[1] Recall, however, that these values are a linear function of the number of children in the household - - see equation (12). An additional piece of information is required in order to unscramble both the intercept and slope coefficient of this function. In the absence of a suitable alternative we take the ELES estimates of the family-size coefficient, $\Sigma \gamma_{1j}^*$, and obtain the intercept sum from

$$\Sigma \gamma_{0j}^* \quad = \quad \Sigma \gamma_j^* \ - \ \bar{x} \ \Sigma \gamma_{1j}^* \quad , \tag{16}$$

where $\bar{x}$ is the mean number of children per household in a given group. The estimates of γ_{0i}^* and γ_{1i}^* (i = 1, ..., n) are then obtained from (6) using IV estimates of β_i .

1. An alternative approach is to incorporate <u>a priori</u> estimates of ω , and therefore of $\Sigma \gamma_j^*$, into the estimation routine. Such an approach is used by Ryan (1976).

This probably reflects the high expenditure on education. In summary, then, working-wife effects amongst the β_i-estimates are at least as pronounced as those of age and occupation, and more important than pure income effects : ranking β_i-estimates according to mean income of the classes yields no patterns.

The family size coefficients in table 4 measure the effect on expenditures of an additional child, assuming a given level of total consumption expenditure. It follows that the estimates for a given household type sum to zero over commodities. The δ_{1i} coefficients are determined with considerably less precision than are the β_i coefficients. The exception is food, where all the δ_{1i}-estimates are significant at the 5 per cent level. Only one quarter of the remaining 48 coefficients are significant. Precision of estimates is directly related to the sample size with best results being obtained for household type 5 : head $\geqslant$ 35 and blue collar worker, wife not working.

The most apparent pattern in the estimates of δ_{1i} is that they are large positive for food and generally negative for the eight other commodities : the main exception being the positive values for clothing amongst old households. The implication is that at a given level of "income" large families spend more on food and less on other commodities, particularly recreation and transport. The point estimates suggest that for each additional child expenditure on food increases by around \$110 - \$140 per year, in 1966/7 prices (the highest estimates occur for young households, the lowest estimates for old, blue collar households).

The coefficients of family-size are not excessively influenced by the presence of a working wife. Indeed, the two sets of δ_{1i} coefficients for young households (columns 1 and 2, table 4) are remarkably similar. For old households in which the wife is not working an additional child is estimated to lower expenditure on housing by around $45 in 1966/7 prices; for working wives the effect is either less pronounced (blue collar workers) or in the opposite direction (white collar workers).

In order to obtain estimates of the family-size effects on "subsistence" expenditures further information is required. We now turn to this general problem of unscrambling estimates of the γ^*_{ji} terms from the δ_{ji} estimates.

4. "SUBSISTENCE" EXPENDITURES

It is not possible to obtain estimates of individual "subsistence" expenditure coefficients, γ^*_{ji}, from the coefficients of Engel curves without utilizing additional outside information.[1] This is because for each set of Engel curves enforcement of the budget constraint makes one equation redundant : for all variables other than total expenditure the estimated coefficients sum to zero over commodities. Thus there are only (n - 1) independent (linear) equations for each set of n variables γ^*_{0i} and γ^*_{1i} (i = 1, ..., n). One additional piece of information is required for each explanatory variable (including the constant) other than total expenditure.

1. See Howe (1974), Muellbauer (1974, 1975), Powell (1973, 1974) and Kakwani (1976).

If measurement error in income is thought to be relatively unimportant then all the additional information required to unscramble the estimates of "subsistence" coefficients may be obtained from the OLS estimates of the ELES aggregate consumption function (7). It is likely, however, that income is underestimated in the survey and therefore ELES estimates will be inconsistent, although the magnitude of the biases is still an open question.

Another option available in unscrambling is to use independent estimates of the expenditure elasticity of the marginal utility of expenditure, ω, which under LES/ELES is related to total "subsistence" expenditure for the household, $\Sigma \gamma^*_j$, in the following way :

$$\Sigma \gamma^*_i = v(1 + \omega^{-1}) \quad . \qquad (13)$$

An estimate of ω may be derived from Lluch, Powell and Williams (1977). Here, using time-series data to estimate LES/ELES for different countries, ω was found to vary with per capita GNP, X, (in 1970 US dollars) in the following manner :

$$\omega = -36 X^{-.36} \quad . \qquad (14)$$

The relevant value of X for this paper is per capita GNP in Australia in 1966/7 measured in 1970 US dollars. Using estimates derived from the World Bank Atlas the appropriate value is X = 2486. This provides an ω-estimate of - 2.16, which is similar to values obtained in other studies using Australian time-series data.[2]

1. The method used is that adopted in Lluch, Powell and Williams (1977), Chapters 3 and 4 : project the estimate of GNP per capita in 1970 (in US dollars) back to the base year using average rates of growth. Both figures are taken from World Bank Atlas, 1972.

2. See Powell (1966), Tran Van Hoa (1968), Lluch and Powell (1975), and Lluch and Williams (1975).