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ABSTRACT

What is the appropriate basis for the comparison of the costs of families with and without children, and how is this relevant to social policy? This paper discusses these issues and derives some simple equivalence scales for the relative costs of children. The method used, originally due to Rothbarth, rests on the comparison of expenditures on adult goods in families with and without children. Data from the 1984 Household Expenditure Survey suggest average costs of children (relative to couples) of around 20 percent. Whilst the data are suggestive of strong economies of scale and different impacts of child costs on mothers' and fathers' consumption, conclusions on these issues must await a larger sample.

1. INTRODUCTION – INTRA-FAMILY RESOURCE ALLOCATIONS

One of the central features of income support policy is that people living in families of different compositions receive differing levels of support. In general, this variation is less than would arise on a *per capita* basis, reflecting the existence of economies of scale and the different needs of persons with different characteristics (e.g. children vs adults). These relative levels can be summarised with the use of equivalence scales, describing the relative expenditure required of a family to reach the same level of well-being as some reference family type (e.g. a couple with no children).

The focus of this paper is on the estimation and interpretation of such equivalence scales for couples with children compared to those without – the costs of children.

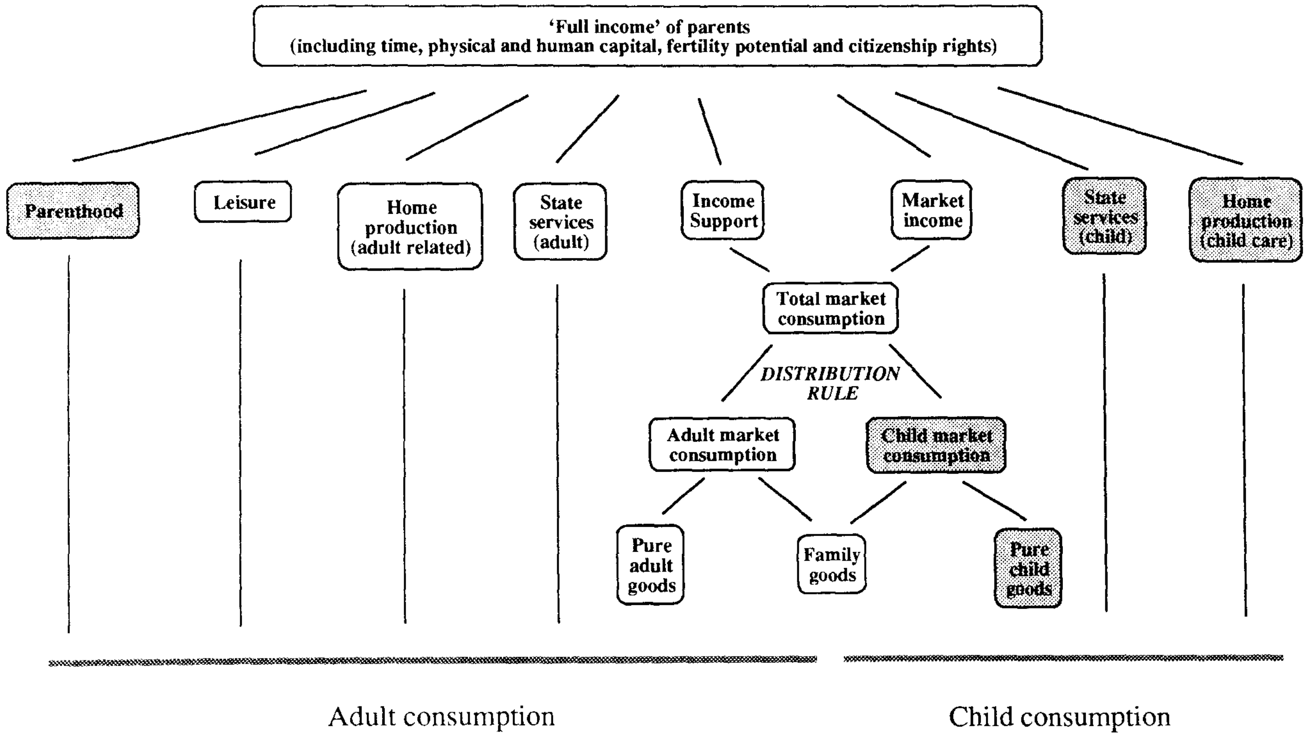
But what are the costs, and benefits, of children and why should they be a concern of social policy? As any parent will reveal, the costs associated with expenditures on children are relatively small compared to the 'expenditures' of time and effort in their upbringing. And yet many people choose to have children, and so for these people at least, the perceived benefits outweigh the costs. Should income support policy subsidise these decisions of parents?

Typically research on equivalence scales has ignored such wider concerns, restricting attention to market based consumption, and treating children as exogenously given. Such scales can be treated as simple descriptions of expenditure patterns, summarising the allocations of expenditures to child and adult consumption. For policy purposes, however, wider considerations of welfare gains and losses, extending beyond market consumption, are essential.

In general, there are two directions which can be taken to derive arguments for compensation. The argument most commonly advanced in the economic literature is that market imperfections may lead to parents not being able to realise the potential welfare gains of parenthood, and hence welfare may be raised by compensating parents for the additional expenditures incurred (and income foregone).

An alternative perspective can be gained by looking at the welfare of the children rather than the parents. Whilst this makes analysis somewhat more awkward, it is probably a more policy relevant perspective. The next section of the paper sets these two alternative approaches within the wider perspective of family resource allocations and

Figure 1 Intra-Family Resource Allocations



explores their implications for income support policy. Within the more restricted scope of the study of the allocation of market consumption within the household, the paper then describes and applies the Rothbarth, or adult good, method of equivalence scale estimation to recent Australian data.

The Costs and Benefits of Children

Whilst it is generally not feasible to empirically model the full scope of the relationship between children and family well-being, it is useful to at least analytically consider such a wider context. Figure 1 presents a simplified description of the allocation of welfare-relevant resources within households with children.

To incorporate the time costs of children it is necessary to examine the allocation of the 'full income' of the parents to different activities (children are assumed to have no income). This full income can be defined as the time available to the parents, resource flows stemming from their human and physical capital, their fertility potential and citizenship rights. The unshaded portions of the Figure describe the allocations that might be made in the absence of children. The adults' time is divided between leisure, home production and labour market activity, and they may obtain other resources via their citizenship and private property rights (human capital interacting with all of these).

For simplicity of presentation, the diagram also assumes that parents are a homogeneous unit. Some issues of the division of resources between husbands and wives are discussed later in the paper. Additionally, other resources such as transfers from extended family and friends are also omitted.

If a couple chooses to have children their welfare will presumably be increased via the 'joys of parenthood', but diminished via the additional time and monetary costs of the children. These monetary costs might be conceived in terms of a *distribution rule* (Gronau, 1986) allocating income between adult and child (market) consumption. This distribution rule represents what is commonly termed the *direct* costs of children, that is the amount spent on them. Studies of the *indirect* costs of children focus on the trade-off between time needed for childcare and opportunities for labour market involvement. Other costs, such as reduced parental leisure time are rarely considered. Overall however, given that most parents choose to have children, it might be assumed that the benefits usually outweigh the costs.

It might possibly be argued that social and economic policy should only be concerned with the monetary costs of children. From the broader perspective of welfare illustrated in Figure 1, there would seem to be limited merit in this restricted view, but it may be a convenient way of implementing a pro-natalist policy of encouraging fertility by compensating for the additional financial costs of those with children.

A more valid economic argument can be found in the existence of constraints on fertility and savings decisions. For income support policy, the most important aspect of these constraints is that the fertility decisions of recipients may have been made in quite different circumstances to which they now find themselves. Most people deciding to have children would not be expecting to be subsisting on minimal income support when they make that decision. Rather, unemployment, illness or family breakup leads to an unexpected loss of income – and they cannot give their children back (nor can the market provide adequate insurance against such eventualities). Under these circumstances it might seem reasonable to take family composition as an exogenous rather than a choice variable.

Such considerations have led to the conclusion that the primary application of equivalence scales should be for policies directed towards such low income groups. Muellbauer suggests that,

> This means that the kind of equivalence scales discussed and estimated in the literature, while rather relevant to determining sensible levels of unemployment benefit for different household types, are quite misleading for designing income and wealth-tax schemes which go up to the top of the income or wealth distribution. For a household whose earners are unemployed it makes sense to abstract from labour supply and savings decisions and also to regard the number of children as exogenous (Muellbauer, 1977, p.461)

The externally fixed labour supply of the unemployed, for example, would imply that such compensation should be primarily for direct rather than indirect costs.

However it is not clear that regarding children as exogenous, in itself, provides sufficient justification for compensation for the full direct costs of children. Some low income people may choose to have children, and even if they would not have made this choice in their current circumstances, they may still benefit from them.

On the other hand, constraints are faced by a wider group than just the low income population. Given the importance of fertility constraints (e.g. women's declining fertility with age), and (dis)savings constraints, it may be argued that most people are heavily constrained in their 'choice' between having children and additional market consumption. Pashardes argues that,

> even when children are seen as substitutes for commodities in the utility function of their parents, child benefit programs are justified in two cases: when household preferences are myopic or access to borrowing is restricted (1987, p.8)

Because financial markets do not permit people to spread the costs of children across their lifecycle (or people are not able to formulate long-term plans), aggregate welfare may be increased by the state providing benefits to those caring for children (and consequently taxing those who are not). Such payment should include compensation for both the direct and indirect costs of children (and indeed for other costs such as reduced parental leisure time).

To compensate in this way assumes that the benefits of parenthood are spread over the whole lifecycle, whilst the costs are confined to the period of child raising. Whilst the diversity of lifecyle patterns of fertility imply that the 'evening out' of this process can only be very approximate, such considerations do provide some basis for a general compensation for families with children. However to evaluate the appropriate magnitude of this (even for the average lifecyle) requires knowledge of the extent of savings constraints at different stages of the lifecycle. Whilst such constraints are clearly considerable, some savings and dis-savings opportunities do exist.[1] Hence evaluation of their welfare impact will be an extremely difficult exercise.

Children's Well-Being

However, these costs, benefits and constraints apply only to the *parents*. An alternative perspective can be gained from a consideration of the living standards of children. Indeed it may seem somewhat perverse to treat children as consumption goods of the parent without reference to the child's level of well-being - particularly given the goal of the 'elimination of child poverty' which is used to justify many child related transfer programs. To focus on children, however, presents particular problems. Not only is their direct consumption not observable, but their consumption decisions are generally

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1. For example, the *credit-foncier* method of housing finance may enable couples to save before they have children – though for others who have children before purchasing their house it may lead to quite undesired savings patterns.

made by others (their parents). Moreover children only appear in some families, and so comparison with other family types must involve some method of translating their consumption into adult equivalents.

As well as describing the costs and benefits of children to parents, we can also examine Figure 1 from the perspective of the welfare of their child(ren). That is, the part of family 'full income' allocated to the children is both the *costs of* and the *benefits to* children. These intra-family transfers include both market consumption, and more importantly the child-care services of the parents. Note however that the 'parenthood' benefits received by parents cannot be transferred to (or claimed from) the children.[2]

The intra-family distribution of resources cannot be directly observed, if only because of the prevalence of 'family goods' – goods jointly consumed by all members. And yet income support policy always directs help to children via assistance to their parents. Implicit in such policy is the assumption that 'parents know best' for their children. Whilst this assumption does not always carry over to the state-provided services, some such assumption is necessary for child related income support. We might formalise this assumption with the statement that, parents' allocations of resources between themselves and their children will, on average, conform to the general social consensus of the relative consumption needs of adults and children. In terms of this social norm, the level of economic well-being of the adults and children within each family might be said to be equal (on average – individual families might deviate from the norm). Adoption of this assumption typically provides the rationale for income support to children via their parents.[3]

This assumption of 'equal' utility levels within the family also provides the basis for comparisons between families with and without children. That is, if the parents are at the same level of well-being as a couple without children, then equalisation of well-being within the family implies that the children must also be this well-off.

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2. To the extent that children have obligations to their parents (e.g. for care in their old age) this is not true. However, the appropriate policy concern is the resources accruing to children when they are young, and so this is generally not relevant.

3. Though this is not necessarily so. The state might assume, for example, that parents systematically under-resource their children, but parental funding is still better than alternative policies. Similarly, there is not always a single social norm to be followed. In principle there might exist different norms among different population groups. If the dominant social group considers another group to devote insufficient resources to its children this may provide a case for over-compensating such families in order to achieve the desired level of resources for their children. In practice, such situations have more commonly been dealt with by attempts to direct resources through other channels (e.g. state provided services) rather than the parents.

It is not, however, easy to value the home production (childcare) services received by children from their parents. Indeed, except to enforce minimal levels of such care, this is an area social policy has generally avoided. Rather, transfer policies have been concerned primarily with the extent of market consumption of children. This restricted focus is continued here.

To make such a restriction involves an additional assumption that the division of income depends only on the total monetary income, and not on the allocations of non-monetary resources within the family. This latter assumption can be described as the distribution rule being 'separable' from the higher level allocations in Figure 1.

One example where this latter assumption might not hold is in the case of purchased childcare services. Consider for example two families with the same income, but with only one parent employed in the first family, whilst in the other both parents work in the market. The distribution rules in the two families would be expected to be very different, as the latter family may spend more on market purchased childcare. Similarly, the low levels of full income for sole parent families might be expected to lead to a very different distribution rule to that in married couple families with the same monetary income. The estimation method discussed in the next section allows the incorporation of such effects in a way which is, in principle, quite straightforward.

Such a focus on children's consumption can lead to quite different conclusions to that based on the consumption of parents. From this perspective, compensation to families with children could apply irrespective of any constraints on their parents' behaviour. Even if parents choose to have children knowing that their material standard of living may suffer, a policy based upon child compensation may still compensate this family for the additional 'costs' of the children.

However there is an important aspect in which compensation to children (via their parents) might differ from compensation to adults for the cost of children. The latter is typically made with reference to the parents' market income. If a family with a child and a family with no child both have the same income, a compensating policy would seek to add to the former family's income to give them equal levels of well-being. This thus enables the parents to be at the same level of well-being as a different sized family at the same level of market income.

From the point of view of the child, however, it is less obvious that their well-being should be compared with that of someone with the same level of family market (or full) income. This income, is after all, a property of their parents rather than themselves. Rather, it might be judged more appropriate for the income of the child to be compared with that of a minimum level for adults. Finally, from the point of view of the child, there does not seem to be any reason for compensation for the indirect costs (labour market time costs) facing their parents.[4]

Thus we return to the conclusion of Muellbauer quoted above, that full compensation for the costs of children may only be justified at minimum income levels, though the justification now is in terms of child consumption, rather than parental constraints. For higher income families *partial* compensation can be justified as compensation for the welfare reducing effects of savings constraints.

Finally, income support for families with children can be justified on grounds other than individual welfare and equity. For example, a decision to invest in future generations at the expense of the current generation of adults may lead to greater payments to families with children. In this case, the assessment of relative needs forms an important baseline from which to make such decisions.

2. ESTIMATING THE DISTRIBUTION RULE – THE ROTHBARTH METHOD

Whilst this broader perspective of the monetary and non-monetary allocations of family resources forms the backdrop for the estimation of the costs of children presented here, the focus of the remainder of this paper will be on the estimation of the distribution rule, allocating market consumption between children and adults. Whilst the distribution rule concept has the advantage of making clear the differences between child and adult consumption and utility, it is entirely consistent with the cost function approach within which equivalence scales are typically formulated. This latter approach seeks to find the relative income levels required for families of different composition to reach the same level of well-being.

As is clear in Figure 1, for families with no children, adult (market) consumption will be equal to total (market) consumption. When children are present, adult consumption will be reduced in line with the distribution rule. Thus the cost of reaching a given level of adult consumption will be a function of the distribution rule for each family type. If the

4. However, this does not rule out compensation to children in family types that have low full incomes - such as sole parent families.

welfare flowing from market consumption only is considered, and it is assumed that adult and child welfare levels are equated within the family, then it is appropriate to describe the relative costs of reaching a given utility level in terms of the distribution rule.

In terms of typical equivalence scale notation, the relative needs of a family with children may be described as $1+\delta$ times those of the reference family. This same relationship may be expressed in distribution rule notation as the children requiring $\delta/(1+\delta)$ of their family's income and the adults in families with children requiring $1/(1+\delta)$. If the family with children has an income of $1+\delta$ times the reference family, it will have relative adult consumption of $(1+\delta)/(1+\delta)=1$ – i.e. adult consumption of the same level as for the reference family. The distribution rule is thus simply an alternative parameterisation of the equivalence scale comparing the family types.

Implicit in any attempt to estimate equivalence scales, then, is an estimation of the distribution rule of resource allocation within the family. However, the distribution rule cannot be directly observed. Rather, some indirect method is needed to disentangle the consumption patterns of parents and children in the household.

The adult goods method, originally due to Rothbarth (1943), uses the expenditure on goods consumed exclusively by adults as a means of identifying the adult portion of family resource allocation. Child consumption is then identified as the residual. Implicitly, the method uses expenditure on such pure adult goods as the welfare index with which families of different child composition can be compared.

Within the wide ranging literature on equivalence scales, a consensus seems to be emerging of this method being the most feasible and theoretically appropriate way of separating adult and child costs (see Cramer, 1969, Gronau, 1986 and Deaton and Muellbauer, 1986). Even if no welfare justification of the sort described in the previous sections is made, the distribution rule thus estimated may be of interest as a descriptive measure of market resource allocation within the household. For such a use there are two key assumptions required. The first is that pure adult goods can be correctly identified as such. The second is that consumption of pure adult goods is assumed to be *separable* from that of consumption of the child and 'family good' consumption.

The latter assumption requires further explanation. The rationale for the adult goods method is that the presence of children has an effect akin to a reduction in income on the amount available for adult consumption. The family is considered to make two steps in allocating its total expenditures to different commodities. First, resources are allocated between the consumption of the parents' and their children, and then within these two categories allocations are made to particular commodities. The first stage of this process reflects the costs of (or benefits to) children in the family, but cannot be directly observed.

Once the amount available for adult consumption is given, it is assumed that the allocation of a portion of that consumption to the pure adult good will be the same irrespective of the proportion of their budget allocated to children, and indeed whether or not the family contains children. This assumption of separability is the key identifying restriction of the adult goods method.

In terms of the wider picture of resource allocation of Figure 1, this assumption requires that expenditure on pure adult goods be independent of any of the higher allocations of full income described in that Figure. The example given in the previous section of trade-offs between market income and child-care would violate this assumption. In this case the distribution rule should be estimated separately for groups thought different in terms of these trade-offs.

In terms of a narrower focus upon expenditures it is again not too hard to find examples where the assumption of separability would be violated. Parents might be expected to reduce their consumption of the adult good 'going to the theatre to view adult-only movies' for (at least) two reasons; they will have less total income available for adult expenditures, and the effective price (including in this case childcare) of the good will have risen. To apply the adult good method it is necessary to assume that for the goods chosen, these price-like effects are negligible. One partial test suggested by Deaton, Ruiz-Castillo and Thomas (1985) is to compare the distribution rule estimates obtained from different adult goods. Violations of separability of one of the goods can thus be identified.

Given the identification of a suitable adult good or goods, the estimation method proceeds as follows. For families without children, all consumption is assumed to be adult consumption[5], and the relationship between total expenditure and pure adult consumption found for these families can be applied to families with children to calculate the implicit total level of adult consumption in these households. This can then

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5. Thus purchases for the children of other adults are not included as child costs. Also, this method ignores costs incurred in anticipation of having children (e.g. extending a house to build a children's bedroom).

be compared with the total consumption of those households to estimate the proportion devoted to child consumption.

For the case with a single comparison family type with children, this process can be described more formally as follows. (This presentation largely follows that of Gronau, 1986). Assume a simple linear distribution rule for families with children,

$$x^a = \delta_0 + \delta_1 y$$

or

$$x^c = -\delta_0 + (1-\delta_1)y \qquad (1)$$

with the amount of expenditure on adults, x^a, depending upon the level of total income or consumption, y. The residual amount allocated to the children is given by x^c. (The constraint that $x^a+x^c=y$ gives the parameters of the second equation). A linear distribution rule of this type can encompass a proportionate equivalence scale, where child costs are a fixed proportion of income (in which case $\delta_0 = 0$ and $0 < \delta_1 < 1$), or an additive scale, where child costs are at a constant level (in which case $\delta_0 < 0$ and $\delta_1 = 1$).

For families without children, where $x^a = y$, the expenditure on the pure adult good, q, can be modelled as,

$$q = \alpha_0 + \alpha_1 x^a$$

or

$$q = \alpha_0 + \alpha_1 y \qquad (2)$$

(More general forms can be used as long as they are monotonic in x^a). Using the assumption of separability, we can assume the same consumption pattern for families with children - except that now expenditure on the pure adult good is allocated from the adult expenditure component. Substituting the expression for x^a in (1) into equation (2), we get for families with children,

$$q = \alpha_0 + \alpha_1(\delta_0 + \delta_1 y)$$

or,

$$q = (\alpha_0+\alpha_1\delta_0) + (\alpha_1\delta_1)y \qquad (3)$$

Letting the dummy variable, k, equal one when children are present, (2) and (3) can be combined as,

$$q = \beta_0 + \beta_1 k + \beta_2 y + \beta_3 y.k \tag{4}$$

where $\beta_0 = \alpha_0$, $\beta_2 = \alpha_1$, $\beta_1 = \alpha_1\delta_0$ and $\beta_3 = \alpha_1(\delta_1\text{-}1)$. The distribution rule parameters can thus be obtained as,

$$\begin{aligned} \delta_0 &= \beta_1/\beta_2 \\ \delta_1 &= 1 + \beta_3/\beta_2 \end{aligned} \tag{5}$$

If families with and without children exhibit the same marginal propensity to spend on adult goods, but families with children spend less (at a given level of income) β_3 will equal zero, and β_1 will be negative indicating the reduced consumption of the pure adult good in families with children. To convert this difference into a measure of the total income needs, this must be then inflated by the factor $1/\beta_2$ – the relationship between expenditure on the pure adult good and total income. Alternately, when there are no fixed costs ($\beta_1 = 0$), the proportionate cost of children is reflected in the lower marginal propensity to consume adult goods in the family with children ($\beta_3 < 0$, and hence $\delta_1 < 1$).

As noted above, the equivalence scale for the comparison family is directly related to the distribution rule, and is obtained by finding the relative income level at which parental consumption in the two families is equal. For the reference family with no children, adult expenditure is equal to income. For the comparison family, adult expenditure is given by the distribution rule in (1). Equating these, and letting y* equal the income of the reference family and γy^* the income required by the comparison family to reach the same adult good expenditure, we get,

$$y^* = \delta_0 + \delta_1(\gamma y^*)$$

or,

$$\gamma = (1 - \delta_0/y^*)/\delta_1 \tag{6}$$

When the distribution rule is strictly proportional, with no fixed costs, $\delta_0 = 0$, and $\gamma = 1/\delta_1$. Otherwise, the equivalence scale obtained will depend upon the reference income level chosen.

3. ESTIMATION

For the estimation of these equivalence scales data on expenditure on pure adult goods and total expenditure (or income)[6] are required for a variety of family types. The data for this analysis are drawn from the 1984 Household Expenditure Survey (HES), Half Sample File, covering a representative sample of 4492 private households in all regions of Australia except the Northern Territory.

This study has concentrated upon estimation of the costs of children in a relatively homogeneous population of married couple income units[7]. The sample has thus been restricted to households comprising a single married couple income unit, with the head aged below 65 years, and with any dependants present aged less than 15 years. The last restriction has been imposed to ensure a clear distinction between adult and child consumption. This sub-sample comprises 1790 households, 705 with no dependants, 344 with one, 538 with two and 203 with three.[8]

The main estimation difficulty posed by the adult good method is the identification of a suitable pure adult good or goods. Despite the recording of over 400 detailed commodity items in the HES, there are few commodities which can be unambiguously ascribed to the consumption of adults alone. The commodities which are available are listed in Table 1. These comprise adult clothing, alcohol, tobacco, gambling, and 'adult food' (defined here as game, tea and coffee). The use of tobacco expenditure is particularly problematic as tastes for this commodity vary widely, with many households consuming none at all. To a lesser degree a similar problem applies to alcohol. The 'adult food' chosen here may also pose problems as some children may consume these commodities.

Equation (5) implies that estimation of the distribution rule requires commodities that have a significant relationship with total consumption (otherwise β_2 will be poorly

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6. The theory presented here does not distinguish savings from any other commodity. As such the conclusions are assumed to be identical irrespective of whether total expenditure or income is used. The analysis here is based upon total current (i.e. non-capital) expenditure.

7. Extension to multiple income unit and sole parent households may become more feasible with the release of the second half of the 1984 HES data.

8. The number of children was calculated by summing the number of children aged under 5 with the number aged 5 to 14. Because the former variable was restricted to the range (0,1,2+) the numbers of children may be underestimated in some families. No adjustment has been made for the sample design (the main feature of which is an over-sampling of the smaller States).

Table 1 Potential Adult Goods

Commodity Group	Mean Expenditure $p.w.	Percent with non-zero expenditure %	Correlation with total expenditure of couples with no children
Adult Clothing	13.7	63.0	.35
Men's Clothing	5.0	31.0	.27
Women's Clothing	8.7	52.1	.27
Alcohol	12.2	73.0	.30
Tobacco	5.5	46.9	.15
Gambling	3.6	67.7	.09
Adult Food	1.4	66.2	.02

(N = 1790)

defined). The zero order correlations shown in Table 1, together with the levels of expenditure, suggest that the most stable estimates are likely to be obtained from clothing and alcohol. For all these goods, however, the short length of the survey period[9] meant that many households did not have any expenditure. For clothing in particular, it is very unlikely that no purchases implied no consumption. Rather, clothing is a durable good (with respect to a two week period) and should ideally be modelled as such.

In general, OLS estimation of relationships involving limited dependent variables may lead to biased estimates of the underlying consumption patterns. Whilst the work of Green (1981) suggests that the parameter ratios may still be approximately consistent, a model which fits the error structure of the data is clearly to be preferred. The estimator commonly used in such circumstances is the Tobit regression model (Tobin, 1958). This model can be defined as,

$$\begin{aligned} q \quad &= x'\beta + u \qquad \text{if RHS} > 0 \\ &= 0 \qquad\qquad\quad \text{otherwise} \end{aligned} \tag{7}$$

where $x'\beta$ is the linear regression model as per equation (4), and $u \sim N(0,\sigma^2)$. Whilst this model can be used to estimate purchase probabilities and the expected purchase given some purchase, our interest here is confined to the influence of the independent variables on the overall expected level of expenditures of families of different types. This is given as (see Maddala, 1983),

$$\delta E(q)/\delta x_j = \Phi(x'\beta/\sigma)\beta_j \tag{8}$$

Where E denotes the expectation operator, and Φ the normal cumulative distribution function. Thus the expected consumption level is a non-linear function of the independent variables, with the influence of such variables higher for higher levels of the independent variables. Since the parameters of the distribution rule are given by the ratios of the partial derivatives of the consumption function, the $\Phi(x'\beta/\sigma)$ terms 'drop out' and the distribution rule can be found, as for the OLS estimates, from the ratios of the parameter estimates.

There are a number of ways in which such a model could be extended, though these are not attempted here. The Tobit model specifies both the probability of purchase and the

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9. Two weeks for most households, four weeks for rural dwellings.

amount purchased as being fixed functions of the same independent variables and parameters. For some commodities such as tobacco, it would be reasonable to expect the decision to consume at all to be based on quite different factors than the decision of the quantity to purchase in a given period. Cragg (1971) describes a 'double hurdle' model which permits these patterns to differ.

Atkinson, Gomulka and Stern (1984a,b) find this more general model to provide additional explanatory power in the case of tobacco consumption, but not for alcohol. This probably reflects the much larger numbers of non-smokers compared to tea-totallers. For alcohol consumption, however, Atkinson et. al. reject the assumption of the normal distribution of errors in the Tobit model in favour of the more general gamma-Tobit model. This model is not explored here as the lower sample size would be likely to make such an exploration unprofitable.

Because earlier work (e.g. Gronau 1986) has used OLS models, these are also presented for comparison. In fact the work of Green (1981) implies that when the predictor variables are multivariate normal the OLS parameter estimates will be consistent estimates of the expected values under the Tobit model. This result will hold approximately when multivariate normality is violated (as is the case here with dummy variables). A comparison of the values of the Tobit and OLS parameter estimates can be made by multiplying the Tobit parameters by the proportion of positive observations (an estimate of $\Phi(x'\beta/\sigma)$ at the mean value of x).

Initial Estimates

Estimates of a model generalising equation (4) to families with one, two and three children are presented in Tables 2 and 3. The implied distribution rules are calculated following equation (5) and the equivalence scales as per equation (6). These are evaluated at the mean expenditure level of couples with no children ($374p.w.). These estimates are presented here for adults clothing, men's clothing, women's clothing and alcohol. The estimates using an OLS error structure are presented in Table 2, and those using a Tobit model in Table 3.

The inclusion of both additive and multiplicative terms in the regressions make the regression and distribution rule estimates difficult to interpret. For the most part, the additive terms are not statistically significant, and indeed for some cells actually imply an increase in adult good expenditure with the presence of children. The marginal effects of children vary similarly, though in general families with children devote less of

Table 2 Simple Adult Good Equivalence Scale Estimates, OLS Estimation

	Dependent Variables							
	Adult Clothing		Men's Clothing		Women's Clothing		Alcohol	
Regression Parameters	est.	t	est.	t	est.	t	est.	t
constant	-1.2	-.7	-2.2	-2.2	1.0	.8	2.7	2.1
1 child	-4.4	-1.3	1.9	.9	-6.2	-2.5	2.1	.8
2 children	-2.9	-1.1	0.5	.3	-3.5	-1.7	.5	.2
3 children	-3.8	-1.0	-.7	-.3	-3.1	-1.1	-3.6	-1.2
y ($00s)	5.0	12.8	2.2	9.3	2.79	9.7	2.96	9.9
y * 1 child	-.16	-.2	-.83	-1.7	.67	1.1	-1.26	-1.9
y * 2 children	-1.3	-2.0	-.74	-1.9	-.53	-1.1	-.94	-1.9
y * 3 children	-1.0	-1.2	-.27	-.6	-.73	-1.2	.01	.0
R^2	0.15		.07		.11		.09	
Distribution rule for adult consumption								
fixed component (δ_0)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
1 child	-88	72	88	92	-224	103	70	88
2 children	-59	59	24	76	-124	82	16	72
3 children	-77	79	-32	106	-111	106	-121	105
marginal component (δ_1)								
1 child	.97	.16	.62	.22	1.24	.23	.58	.20
2 children	.74	.12	.66	.16	.81	.16	.68	.15
3 children	.80	.15	.88	.22	.74	.20	1.0	.21
Equivalence Scale								
(y*=$374)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.28	.09	1.24	.19	1.29	.09	1.41	.22
2 children	1.56	.12	1.42	.17	1.64	.15	1.40	.15
3 children	1.51	.14	1.24	.15	1.76	.23	1.32	.13
Weighted average cost per child	.23		.14		.29		.17	

Table 3 Simple Adult Good Equivalence Scale Estimates, Tobit Estimation

	Dependent Variables							
	Adult Clothing		Men's Clothing		Women's Clothing		Alcohol	
Regression Parameters	est.	t	est.	t	est.	t	est.	t
constant	-14.3	-5.8	-33.7	-12.2	-12.1	-5.7	-4.5	-2.6
1 child	-7.8	-1.5	6.6	.12	-12.4	-2.8	3.2	.9
2 children	-6.8	-1.6	-1.2	-.3	-8.7	-2.4	-1.3	-.5
3 children	-10.5	-1.8	-1.7	-.3	-10.9	-2.1	-5.2	-1.3
y ($00s)	6.39	11.4	4.76	8.1	3.88	8.1	3.81	9.7
y * 1 child	.50	.4	-1.75	-1.4	1.73	1.7	-1.45	.9
y * 2 children	-.94	-1.0	-.89	-.9	.02	.0	-.71	-1.1
y * 3 children	-.27	-.2	-.20	-.2	.06	.1	.15	.2
σ	30.4		29.6		25.8		21.6	
$\Phi(x'\beta/\sigma)$[1]	.56		.28		.47		.65	
Distribution rule for adult consumption								
fixed component (δ_0)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
1 child	-121	85	138	112	-318	136	83	89
2 children	-107	70	-24	99	-223	110	-34	77
3 children	-165	96	-35	134	-280	146	-137	108
marginal component (δ_1)								
1 child	1.08	.19	.63	.26	1.45	.30	.62	.20
2 children	.85	.14	.81	.20	1.00	.21	.81	.16
3 children	.96	.18	.96	.26	1.01	.26	1.04	.21
Equivalence Scale								
(y*=$374)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.23	.09	1.00	.21	1.27	.10	1.25	.18
2 children	1.51	.11	1.31	.15	1.59	.14	1.34	.12
3 children	1.50	.13	1.14	.17	1.72	.20	1.31	.12
Weighted average cost per child	.21		.08		.27		.14	

Notes

(1) The predicted probability that purchase occurs, given mean x. Multiplying the parameter estimates with this fraction gives $\delta E(q)/\delta x_j$.

each extra dollar to these adult goods. Whilst multicollinearity between the additive and multiplicative terms means that many parameters are only marginally significant, with the exception of the men's clothing equation, the group of six parameters as a whole are very significant.[10]

The equivalence scales at mean income are easier to interpret. Very broadly, they are as would be expected, with children having a positive effect on relative income needs. Only for women's clothing, however, do the estimates follow the expected pattern of increasing with family size. The high standard errors associated with all estimates suggest that this divergence could well be due to sample fluctuations. Such imprecision of the estimates may also be responsible for the different estimates with the different dependent variables. All estimates, for example, are within two standard errors of each other.

Generally the OLS estimates are similar to the Tobit estimates (except for men's clothing). In all cells, however, the Tobit method estimates lower child costs than the OLS method. Surprisingly the standard errors for the two methods are much the same. For the Tobit method, the average relative costs per child (weighted by the inverse of the standard errors per child for each family size) across the different size families are 21%, 8%, 27% and 14% for adult clothing, men's clothing, women's clothing and alcohol respectively. The corresponding estimates from the OLS equations are 23%, 14%, 29% and 17%.

Estimates for a simpler model again are presented in Table 4. Dropping the β_1 terms from equation (4) defines δ_0 to be zero and constrains the equivalence scales to be invariant with total expenditure. These constrained scales are, in general, very similar to those in Tables 2 and 3 (though they would be expected to vary away from mean expenditure).

Additional Exogenous Influences

Whilst the differences between the goods may be a result of sampling error, one clear possibility is that they may result from omitted variables influencing consumption patterns. These variables could take two types. First there are other predictors of consumption of the adult goods within each family type. Various demographic and

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10. For the Tobit model, the Wald χ^2 statistics (with 6 degrees of freedom) were 40.7, 7.9, 40.6 and 16.1 for the four dependent variables respectively.

Table 4 Proportional Cost Equivalence Scale Estimates.

	Dependent Variables							
	Adult Clothing		Men's Clothing		Women's Clothing		Alcohol	
Equivalence Scale – OLS model								
	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.26	.10	1.24	.15	1.26	.12	1.37	.16
2 children	1.54	.12	1.43	.16	1.61	.16	1.40	.14
3 children	1.48	.14	1.23	.16	1.71	.24	1.28	.15
Weighted average cost per child	.22		.15		.27		.17	
Equivalence Scale – Tobit model								
	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.18	.09	1.08	.14	1.20	.13	1.23	.13
2 children	1.47	.12	1.32	.16	1.53	.16	1.33	.12
3 children	1.44	.15	1.11	.15	1.67	.25	1.26	.14
Weighted average cost per child	.19		.08		.23		.14	

socio-economic characteristics of the family would be expected to have an influence, as might higher order functions of total consumption. For example, working women may require more clothing than those not working. Given the fact that women with children have a lower rate of workforce participation, this may explain the apparently greater costs of children for women compared to men shown in Tables 2 and 3. That is, children may lead to women spending less on clothes because they are not working, rather than because children consume more of their budget.

Second, the distribution rule may vary significantly between household types. Children's ages, for example, are generally believed to influence expenditures. As well, the costs associated with children may vary with the workforce participation of the parents (e.g. through childcare costs). This would appear in the data as a larger difference in the adult good consumption of families with working mothers with and without children, compared to the effect of children on the consumption of families with non working mothers.

This section extends the previous model by incorporating a number of such personal characteristics. The variables used here are; age of the household head (minus 35), the square of this variable, dummy variables indicating employment status of the head and spouse (full-time[11], part-time, not employed), housing wealth/tenure (owners, established purchasers, recent purchasers and renters[12]), and a variable flagging white collar employment of the head.[13]

In principle such variables could be incorporated as additional constant terms in equation (2) or in interaction with income. Similarly, the variables judged to be relevant to the distribution rule could appear as interactions with the number of children, or as interactions with both number of children and income. Rather than risk 'overfitting' the data by including all these terms, this section considers a more parsimonious model incorporating these personal characteristics as additive components in the regression. Given the discussion of the possible impact of female labour force patterns on the distribution rule, these labour force variables are then entered in interaction with the

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11. Including self-employed workers (full-time or part-time). The omitted categories in the dummy variable specification are full-time employment for the head and not employed for the spouse.

12. Rent-free are included with owners. Recent purchasers are defined as those purchasers paying more than 75% of their mortgage repayments as interest (rather than principal). The reference category is established purchasers.

13. White collar employment defined as employed in; professional, technical and related; administrative, executive and managerial; clerical or sales occupations.

number of children. Consideration of the impact of the age of children is delayed to the next section.

Tables 5 and 6 show the results of adding the vector of personal characteristics to the basic OLS and Tobit models. The age of the head has a significant influence upon the consumption of both adult clothing and alcohol. Clothing expenditure decreases with head's age, though with a turning point at around age 49 (in the Tobit model). (Recall that the sample is restricted to those under age 65). The pattern for alcohol is roughly the opposite, with consumption increasing up to age 45.

Families with the head in white collar employment had significantly greater expenditures on clothing, and in households where the head was not employed the Tobit model recorded a significant drop in alcohol consumption, (even while controlling for total consumption). When the spouse was employed either full-time or part-time, clothing expenditures increased, predominantly for women's clothing, but also for men's.[14] Alcohol consumption also increased.

Compared to established purchasers, home owners spent more and renters less on clothing. This is what might be expected from the wealth effects of housing. Alcohol consumption, however, was lowest among home owners.

None-the-less, despite these significant effects the estimated equivalence scales in Tables 5 and 6 are generally very similar to those of Tables 3 and 4. The main change is in the estimates based on alcohol consumption, where the new estimates imply a much greater cost of children. They still retain, however, some of the paradoxical decreasing costs with family size exhibited in the earlier tables. As before, the OLS and Tobit results are very similar, and again the Tobit method generally gives higher estimates for child costs than the OLS.

The hypothesis that the difference between the men's and women's clothing estimates is due to the omission of female labour force variables from the model is not vindicated as these differences also appear in Tables 5 and 6.

A test for the influence of female labour force status on the distribution rule was carried out by adding a set of interaction variables of spouse full-time and part-time employment with family size. Whilst this provided some tentative indication of increased costs

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14. Almost 99 percent of the sample had a male head and female spouse.

Table 5 Equivalence Scale Estimates Controlling for Personal Characteristics, OLS Estimation

	Dependent Variables							
	Adult Clothing		Men's Clothing		Women's Clothing		Alcohol	
Regression Parameters								
	est.	t	est.	t	est.	t	est.	t
constant	-3.5	-1.3	-4.6	-3.0	1.1	.6	4.9	2.5
1 child	-2.7	-1.0	2.5	1.1	-6.2	-2.3	1.4	.5
2 children	-2.1	-.7	1.5	.8	-3.6	-1.6	-.91	-.4
3 children	-2.9	-.7	.6	.2	-3.4	-1.1	-5.2	-1.7
y ($00s)	4.76	11.7	2.15	8.7	2.61	8.6	2.5	8.0
y * 1 child	-.14	-.2	-.81	-1.6	.67	1.1	-1.25	-1.9
y * 2 children	-1.3	-2.0	-.76	-.7	-.54	-1.1	-.81	-1.6
y * 3 children	-.99	-1.2	-.32	-.7	-.67	-1.1	.18	.3
head age - 35	-.20	-.2.5	-.15	-2.9	-.06	-.9	.17	2.7
$(\text{age} - 35)^2/100$	.65	1.3	.62	2.1	.03	.1	-.69	-1.8
head emp pt	-3.5	-.9	-2.8	-1.2	-.3	-.3	-3.5	-1.2
head not emp	.2	.1	.0	.0	.2	.1	-2.3	-1.7
spouse emp ft	2.8	2.1	1.3	1.6	1.5	1.5	2.7	2.7
spouse emp pt	3.7	2.5	1.9	2.0	1.9	1.6	1.1	.9
hd white collar	3.1	2.6	.9	1.3	2.2	2.5	1.1	1.2
home owner	3.0	2.0	2.4	2.5	.7	.6	-2.9	-2.4
recent purch	-2.4	-1.6	-.6	-.7	-1.7	-1.5	-.8	-.7
renting	-2.5	-1.5	-.1	-.1	-2.4	-2.0	1.5	1.2
R^2	.17		.09		.12		.10	
Equivalence Scale								
(y*=$374)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.25	.10	1.10	.20	1.31	.11	1.69	.40
2 children	1.54	.14	1.27	.19	1.73	.20	1.61	.23
3 children	1.46	.16	1.09	.18	1.82	.28	1.45	.17
Weighted average cost per child	.21		.08		.32		.24	

Table 6 Equivalence Scale Estimates Controlling for Personal Characteristics, Tobit Estimation

	Dependent Variables							
	Adult Clothing		Men's Clothing		Women's Clothing		Alcohol	
Regression Parameters								
	est.	t	est.	t	est.	t	est.	t
constant	-17.6	-4.7	-35.0	-8.4	-13.2	-4.1	.17	.1
1 child	-6.2	-1.2	5.6	.9	-11.0	-2.3	1.4	.4
2 children	-5.4	-1.2	-1.3	-.3	-7.8	-2.0	-4.3	-1.4
3 children	-9.1	-1.5	-1.1	-.2	-10.4	-1.9	-8.3	-2.0
y ($00s)	6.00	10.3	4.53	7.4	3.57	7.2	3.15	7.7
y * 1 child	.38	.3	-1.45	-1.1	1.52	1.5	-1.39	-1.7
y * 2 children	-1.07	-1.2	-.79	-.8	-.14	-.2	-.44	-.7
y * 3 children	-.22	-.2	-.11	-.1	.11	.1	.46	.6
head age - 35	-.30	-2.6	-.38	-2.9	-.13	-1.2	.18	2.2
$(\text{age} - 35)^2/100$	1.1	1.6	.85	1.0	.50	.8	-.92	-1.9
head emp pt	-3.0	-.5	-8.0	-1.2	1.3	.3	-4.1	-1.1
head not emp	-1.5	-.6	-.2	-.1	-1.4	-.6	-4.0	-2.2
spouse emp ft	5.7	3.0	3.6	1.7	3.9	2.3	3.3	2.5
spouse emp pt	7.5	3.4	4.4	1.8	5.2	2.7	1.8	1.2
hd white collar	4.2	2.5	1.2	.6	3.6	2.4	1.6	1.3
home owner	4.1	1.8	5.0	1.9	1.2	.6	-4.7	-3.0
recent purch	-3.1	-1.4	-2.8	-1.2	-2.5	-1.3	-1.6	-1.1
renting	-6.2	-2.6	-3.2	-1.2	-6.3	-3.0	.7	.5
σ	30.1		29.3		25.6		21.4	
$\Phi(x'\beta/\sigma)$	0.56		.28		.47		.65	
log-likelihood	-5899.0		-3220.9		-4882.0		-6230.1	
Equivalence Scale								
(y*=$374)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.20	.11	0.98	.24	1.28	.12	1.57	.34
2 children	1.51	.14	1.30	.20	1.65	.19	1.58	.19
3 children	1.46	.15	1.09	.21	1.72	.23	1.48	.16
Weighted average cost per child	.20		.06		.28		.24	

among families with one child and with the mother in the workforce, for none of the dependent variables could a joint null hypothesis of all these interaction terms being zero be rejected.

Because of the distributional assumptions underlying the Tobit model, these estimates might be expected to be particularly sensitive to outlying observations. This data set had two particularly notable outlying cases with very high levels of men's clothing and alcohol (around $250 and $350 per week respectively). The estimates of Tables 5 and 6 were repeated omitting these two observations, but few differences were observed other than a slight decrease in the estimated costs of children for the alcohol equation (i.e. the household with the high expenditure on alcohol had no children).

Quadratic Functions of Total Expenditure

In principle there is no reason why either the consumption function or distribution rules should follow any particular algebraic form. Whilst the difficulty of separately identifying the additive and marginal components of the distribution rule would suggest that there would be little to be gained in this sample by estimating a more complicated distribution rule, extension to the consumption function would seem quite reasonable.

Probably the simplest extension is to test for the existence of a consumption function that is quadratic in total expenditure. However to generalise equation (3) in this way, whilst maintaining a linear distribution rule, requires the imposition of non-linear constraints upon the parameters of the estimating equation.[15] Rather than do this, this section tests the implications of simply adding quadratic terms to the estimating equation. By not imposing constraints, this allows the distribution rule to take a more general form than the simple linear form. Maintaining the simplification of a single comparison family type, equation (5) is generalised to

$$q = \beta_0 + \beta_1 k + \beta_2 y + \beta_3 y.k + \beta_4 y^2 + \beta_5 y^2.k \qquad (9)$$

where the vector of personal characteristics is incorporated into the constant term. The equivalence scale can then be derived directly as the relative total expenditure required of a family with children to reach the same level of adult good consumption as the family with no children and a level of total expenditure y*. That is, we equate,

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15. This point seems to have been overlooked by Gronau (1986).

$$\beta_0 + \beta_2 y^* + \beta_4 y^{*2} = \beta_0 + \beta_1 + (\beta_2+\beta_3)\gamma y^* + (\beta_4+\beta_5)\gamma^2 y^{*2}$$

This is then solved for γ to yield,

$$\gamma = \frac{-(\beta_2+\beta_3) \pm \sqrt{\{(\beta_2+\beta_3)^2 - 4(\beta_4+\beta_5)(\beta_1-\beta_2 y^*-\beta_4 y^{*2})\}}}{2y^*(\beta_4+\beta_5)} \tag{10}$$

The distribution rule can also be derived as a function of income and income squared. Table 7 presents Tobit estimates of equations (9) and (10) using the same vector of personal characteristics as in Tables 5 and 6. (To save space the parameter estimates for these variables are omitted).

Since the model of Table 6 is nested within that of Table 7, a comparison of the log-likelihoods of the equations can be used as a test of the significance of the quadratic terms as a group. In all equations, except that for men's clothing, they improve the fit significantly. To illustrate the impact of the quadratic terms, the equivalence scales are calculated both at the mean level of total expenditure of couples ($374 p.w.) and at the mean level of expenditure of couples receiving a pension or benefit ($250)[16]. Table 8 presents the corresponding equivalence scales derived from the OLS estimation.

In all but one cell, the Tobit quadratic model implies a lower child cost at the mean than the corresponding linear model of Table 6, though the difference is generally small. However the anomalies noted earlier between the different cells remain. The weighted average cost per child is estimated at 18, 4, 26 and 15 percent for the four goods respectively.

When the scale is calculated for expenditure levels more typical of income support recipients, a variable set of changes is seen with child costs increasing in some cells and decreasing in others. Whilst the weighted average of proportionate costs per child in the Tobit model are suggestive of some increase in costs at lower incomes, the reverse pattern is evident in the OLS model. Interestingly, at this level of reference expenditure the equivalence scale increases steadily with family size for all commodities except men's clothing – which still takes implausible values.

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16. Note that this is well above the level of income support received by such families (around $190 per week in 1984), as many of these families are significantly dis-saving. See Bradbury (1989) for a more detailed discussion of the distinction between income and expenditure for low income families.

Table 7 Equivalence Scale Estimates with Quadratic Consumption Function, Tobit Estimation

	Dependent Variables							
	Adult Clothing		Men's Clothing		Women's Clothing		Alcohol	
Regression Parameters								
	est.	t	est.	t	est.	t	est.	t
constant	-27.0	-6.1	-39.2	-7.7	-22.5	-5.9	-8.3	-2.6
1 child	6.1	.7	-.3	-.0	6.3	.8	2.9	.5
2 children	-1.6	-.2	2.1	.3	-9.0	-1.5	-6.3	-1.3
3 children	-5.0	-.5	-4.9	-.4	-4.5	-.5	-12.3	-1.9
y ($00s)	9.55	8.7	6.09	5.1	7.06	7.5	6.48	7.7
y * 1 child	-4.39	-1.3	1.67	.4	-5.46	-1.8	-1.36	-.6
y * 2 children	-2.21	-.9	-1.93	-.8	.76	.4	.68	.4
y * 3 children	-1.55	-.5	1.47	.4	-1.90	-.7	2.32	1.0
y^2 ($\$00s^2$)	-.23	-3.8	-.09	-1.5	-.22	-4.4	-.23	-4.1
y^2 * 1 child	.36	1.2	-.35	-.10	.56	2.2	-.09	-.4
y^2 * 2 children	.04	.3	.07	.4	-.12	-.8	-.12	-1.0
y^2 * 3 children	.06	.3	-.14	-.6	.11	.6	-.18	-1.1
	(personal characteristics omitted)							
σ	29.9		29.3		25.3		21.1	
$\Phi(x'\beta/\sigma)$	.56		.28		.45		.65	
log-likelihood	-5890.6		-3218.4		-4868.4		-6209.0	
Equivalence Scale at Mean Expenditure								
(y*=$374)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.23	.12	.94	.16	1.37	.14	1.40	.32
2 children	1.44	.14	1.29	.20	1.45	.16	1.36	.14
3 children	1.41	.15	1.06	.17	1.66	.24	1.31	.13
Weighted average cost per child	.18		.04		.26		.15	
Equivalence Scale at Mean Pensioner/Beneficiary Expenditure								
(y*=$250)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.18	.19	.88	.28	1.43	.24	1.12	.24
2 children	1.44	.18	1.24	.32	1.56	.18	1.43	.16
3 children	1.49	.20	1.13	.28	1.78	.28	1.49	.16
Weighted average cost per child	.19		.04		.30		.18	

Table 8 Equivalence Scale Estimates with Quadratic Consumption Function, OLS Estimation

	Adult Clothing		Men's Clothing		Women's Clothing		Alcohol	
Equivalence Scale at Mean Expenditure								
(y*=$374)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.37	.12	1.04	.18	1.50	.12	1.58	.45
2 children	1.59	.16	1.44	.26	1.68	.21	1.43	.20
3 children	1.56	.19	1.11	.20	1.95	.28	1.30	.14
Weighted average cost per child	.27		.09		.38		.17	
Equivalence Scale at Mean Pensioner/Beneficiary Expenditure								
(y*=$250)	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
0 children	1.00	-	1.00	-	1.00	-	1.00	-
1 child	1.27	.24	.97	.27	1.59	.27	1.19	.28
2 children	1.48	.22	1.03	.87	1.61	.23	1.36	.20
3 children	1.46	.29	1.06	.38	1.89	.43	1.45	.17
Weighted average cost per child	.21		.01		.36		.16	

The Impact of Children's Ages

It is generally accepted that, at least in terms of direct costs, younger children cost less than older. This belief has been generally confirmed by equivalence scale studies which have examined the impact of age (Whiteford, 1985). Unfortunately the public use file from the HES only allows the disaggregation of the under 15 year old group into those aged under 5, and those aged 5 to 14. This section tests whether child costs are significantly different across these ages.

The small sample size suggests that a more constrained approach to testing is warranted than that used in the previous section. To treat each combination of children's ages separately would imply an excessive number of family types to be tested - magnifying further the estimation problems already encountered. Hence the model here is restricted to that where each child of a given age contributes a fixed amount to family needs, and these amounts are added to arrive at the equivalence scale for that family type. This necessarily ignores the possibilities of economies of scale, but as the previous section indicated, the sample size is insufficient to clearly identify these.

In order to further simplify estimation, the model is restricted to that where the distribution rule is proportional - that is, the equivalence scale is defined to be independent of the level of total consumption. Letting m indicate the total number of children aged under 15 and n indicate the number under 5, the distribution rule can be written as,

$$x^a = (1+\varepsilon_1 m+\varepsilon_2 n)^{-1} y$$

or

$$x^c = [1 - (1+\varepsilon_1 m+\varepsilon_2 n)^{-1}]y = [(\varepsilon_1 m+\varepsilon_2 n)/(1+\varepsilon_1 m+\varepsilon_2 n)]y \qquad (11)$$

where ε_1 represents the relative costs of each child, and ε_2 is the additional (negative) cost of children aged under 5. When $m=n=0$, $x_a=y$ and $x_c=0$. If a family with m and n children of the respective ages is given an income of $(1+\varepsilon_1 m+\varepsilon_2 n)$ times that of a childless family it will then have the same level of adult expenditure as that family. Child expenditure will be a proportion $(\varepsilon_1 m+\varepsilon_2 n)$ of y.

If consumption of the pure adult good is a linear function of x^a then this distribution rule will imply a total expenditure consumption function of

$$q = \beta_0 + \beta_1(1+\varepsilon_1 m+\varepsilon_2 n)^{-1} y \qquad (12)$$

where additional environmental variables may be incorporated into the constant term. This model is non-linear in the parameters, and so only (non-linear) least-squares estimates have been made here. Whilst a non-linear generalisation of the Tobit model might be more appropriate, the approximate correspondence between the OLS and Tobit estimates noted in the previous section suggest that sampling error would be of much greater significance than this specification error.

Estimation results are presented in Table 9 using the same personal characteristic variables as Table 5. The estimated impact of these variables is much the same as before, and as might be expected the estimated cost per child is very similar to the weighted average of costs in Table 5. The results are inconclusive as to the impact of age on child costs. For adult clothing, the estimates imply a cost for the younger group of about half that of the older, but this difference is not significant. The lower costs for younger children are reflected in both the components of adult clothing, but alcohol again provides a divergent result with a (non-significant) additional cost for the younger children. (That is, parents of younger children reduce their alcohol consumption more.)

Finally, the last line of Table 9 describes the estimates for ε_1 when ε_2 is omitted from equation (12). That is, it is an estimate of the overall average cost per child assuming a linear consumption function, proportionate child costs and no economies of scale. For this most constrained model, children cost 19, 9, 26 and 21 percent of a married couple for adult clothing, men's clothing, women's clothing and alcohol respectively.

4. INTERPRETATION AND CONCLUSIONS

Before turning to a summary and interpretation of the results of the previous sections, it is worthwhile reviewing the key assumptions of the adult good method, and the impacts of likely violations of these. As noted in Section 2 the two key assumptions of the method are, that adult goods are correctly identified as such, and that consumption of adult goods depends only the amount of total adult (market) consumption and not on the existence or the consumption patterns of children. The presence of children is assumed to effect adult good consumption only via an 'income effect' on the total consumption of adults.

The ways in which this assumption might be violated can be summarised as either taste or price effects, though the distinction is not clear-cut. Taste effects may occur if the presence of children changes the parents' tastes for the adult good. Thus, for example,

Table 9 Effect of Children's Age – Non-Linear Least Squares Model

	Dependent Variables							
	Adult Clothing		Men's Clothing		Women's Clothing		Alcohol	
Regression Parameters								
	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
constant	-5.95	1.7	-3.99	1.04	-2.05	1.29	3.94	1.34
head age - 35	-.17	.08	-.13	.05	-.04	.06	.15	.07
$(age - 35)^2/100$	.73	.46	.53	.28	.23	.35	-.51	.36
spouse emp ft	3.33	1.31	1.44	.78	1.94	.98	2.65	1.02
head emp pt	-3.28	3.8	-2.83	2.31	-.44	2.84	-3.72	2.95
spouse emp pt	4.14	1.5	1.91	.92	2.24	1.13	1.11	1.18
head not emp	.21	1.8	.07	1.08	.15	1.33	-2.26	1.39
hd white collar	3.08	.12	.79	.72	2.27	.88	1.22	.92
home owner	3.19	1.5	2.43	.94	.76	1.15	-2.78	1.20
renting	-2.06	1.6	.08	.97	-2.13	1.19	1.63	1.25
recent purch	-2.34	1.5	-.70	.91	-1.64	1.11	-.87	1.16
β_1 (y,$00s)	5.00	.32	1.97	.19	3.02	.24	2.60	.25
ε_1 (cost per child)	.22	.06	.12	.06	.29	.09	.19	.08
ε_2 (additional cost for under 5s)	-.10	.08	-.13	.08	-.08	.12	.15	.16
average cost per child	.19	.05	.09	.06	.26	.08	.21	.08

they may choose to reduce their alcohol consumption as an example to their children. Any such taste change which leads to a reduction in consumption of the adult good will lead to the method over-estimating the costs of children. More generally, the method assumes that (holding personal characteristics constant) parents and non-parents have the same tastes for adult goods.

As well as taste changes the presence of children in the family can also effect the relative prices of commodities. Whilst we might not expect the price of clothing or alcohol to be directly effected by the presence of children, changes in the relative prices of complements or substitutes may have an impact on adult good consumption. For example, the time costs of children are likely to raise the effective price of parents' leisure time. If consumption of the adult good is associated with leisure activities, then consumption may be reduced. Of the two commodities used here, alcohol is likely to be the most liable to bias in this way. Put simply, the parents don't have time to go drinking. Again, this would tend to lead to the method over-estimating child costs.[17]

On the other hand, some price effects could work the other way. As Gorman first noted, the presence of children is likely to raise the cost of goods shared with children – 'a penny bun costs three pence when you have a wife and child'[18]. In this case, relative price changes could lead to parents substituting towards adult goods, and hence the method under-estimating child costs. Finally, if the parents are maximising total utility within the family, they may tend to substitute towards 'family goods'[19] such as consumer durables, and away from other goods, including adult goods. This will lead to an over-estimation of child costs.

Without a more general model, it is not possible to provide estimates of the likely magnitudes of these effects. And indeed, even when attempts have been made to explicitly incorporate price effects it has been difficult to reach useful conclusions (Muellbauer, 1977). Whilst the cross-price effects described above may tend to offset one another, for alcohol at least the taste changes and time-complementarity examples given above seem quite plausible. Hence we might expect to see some over-estimation of child costs when alcohol is used as the adult good. On the other hand, similarly plausible examples are difficult to find for adult clothing.

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17. Though if parents simply switch to drinking at home this will not be a problem.

18. Quoted in Deaton and Muellbauer, 1980, p.197.

19. These can be defined analogously to public goods. That is, as goods for which the consumption of one member of the family does not reduce the available consumption of another.

Are such speculations reflected in the results of the previous section? The short answer to that question is that we cannot really say. Any likely variations are clearly swamped by sampling error in this relatively small sample. If we confine ourselves to the average cost per child, there is some variations across the commodities. The Tobit estimates (in Tables 6 and 7) generally give an average cost per child of around 20 percent for both the adult clothing and alcohol models (the OLS estimate for clothing is somewhat higher in Table 8).

But the largest variation in results is between men's and women's clothing – with the former describing costs of around 4-9 percent and the latter costs of around 26-38 percent. Whilst hypotheses were advanced in terms of these differences following from patterns of female labour force participation, these were not supported by the data. An alternative hypothesis may be that children really do cost more for mothers than for fathers – with the former making greater sacrifices in their own consumption. However this must remain a very tentative hypothesis as sampling error cannot be discounted as an explanation of this difference. A Wald test of there being a difference between the costs in terms of men's or women's clothing in the simplified model of Table 9 (i.e. without the age differences) produces a χ^2_1 statistic of 3.61 – compared to the 95% critical point of 3.84.

If that model is further constrained such that the cost per child is the same for each commodity an estimate of 20 percent is obtained. This most constrained model might serve as a 'best estimate', but given an approximate 95% confidence interval of 11 to 28 percent, it is clear that sampling error dwarfs any possible specification error in the models used here.

For results any more detailed than this, conclusions are even more problematic. One might suspect that the persistently perverse patterns in alcohol expenditure (decreasing child cost with family size, and increasing costs for younger children) may be due to some taste or price effects[20], but any such conclusions must remain tentative. The results in Tables 2 to 8 suggest that there may be strong economies of scale (many estimates actually suggest a *reduction* in costs for the third child), but again these results are unlikely to be statistically significant.

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20. For example, the additional apparent costs for younger children may reflect their higher time costs as described above.

Whilst the adult goods method has much to recommend it, especially when compared with the alternatives which are either poorly based in theory, or requiring large amounts of data, it should be clear from the above that the data requirements of this method are still quite substantial. The sample size of the present survey is clearly inadequate to provide estimates of child costs which are precise enough for policy applications. This restriction far outweighs any likely specification error arising from the less than ideal models for handling zero expenditures, or the errors arising from taste or price effects. In the present case, an obvious solution would be to pool the data presented here with that from the (as yet unreleased) second half of the 1984 Household Expenditure Survey.[21] Whilst this would be unlikely to answer all the questions raised by the data here, it should assist in resolving some of them.

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21. It might also be noted that the effective sample size could be increased be increasing the survey period for the recording of adult goods. Whether this can be done whilst maintaining data quality is not known.

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