Relative cost of children: the case of rural Maharashtra, India

Amita Majumder [a,*], Manisha Chakrabarty [b]

[a] *Economic Research Unit, Indian Statistical Institute, 203 B.T. Road, Kolkata 700108, India*
[b] *Department of Economics, University of Bonn, Adenaueralle 24-42, 53113 Bonn, Germany*

Received 1 February 2002; received in revised form 1 August 2002; accepted 1 November 2002

Abstract

Conventionally, measurement of *cost of children* by iso-prop method [Int. Stat. Inst. Anal. 9 (1895) 1] involves equating budget share on *food* of the two households compared. In this paper we use an alternative necessary commodity, viz., *adult good* (as suggested by Blackorby and Donaldson [The Measurement of Household Welfare, Cambridge University Press, Cambridge (1994)]) in place of *food* and measure the *relative cost of a child* using iso-prop method in a single equation framework as well as in a demand system framework. The demand system, proposed herein, is a rank-two Quadratic Logarithmic (QL) system. Household level consumption expenditure data for the rural sector of Maharashtra, India, are used in this study. The results indicate that the nature of the commodity along with the effect of children on consumption of that particular commodity, plays a major role in determining child cost.

JEL classification: D12; J13; J16

Keywords: Child cost; Equivalence scales

1. Introduction

Children are not born with cash supplements. However, they must be fed, clothed, and therefore, parents have to adjust their expenditure pattern in order to meet this extra burden. This adjustment is a measure of the *cost of children* which is an issue of central importance in policy related matters like poverty, income distribution, income-maintenance programs, child benefit programs, etc. The question of 'what is the *cost of a child*?' is related to the issue of welfare preservation query, viz., 'how much income does it take to preserve the prechild standard of living?'

The *relative cost of children index* is given by the ratio of the expenditure of a compared household (with children) to that of a childless reference household having the same utility level. This cost is equivalent to the *general equivalence scale*. In this paper we adopt a utility-based demand system approach to estimate the *relative cost of children index* which is *exact*, i.e., independent of the unobservable utility level.[1] We also estimate the child cost in a single equation framework.

To measure the relative cost we use the well-known iso-prop method, which was originated by Engel (1895). This method looks at the expenditure share on a subset of commodities, often chosen to be necessities (Engel, 1895, chose the commodity to be *food*). The expenditure share is assumed to be inversely related to the welfare level of the household and households are considered to be at the same welfare level whenever these shares are equal. The *cost of a child* is measured by the amount of compensation that is required to be paid to the parents to restore this share to its prenatal level.

There are several theoretical and structural problems in the calculation and interpretation of *equivalence scales*. Pollak and Wales (1979) are the first ones who recognised one of the fundamental problems of identification of *equivalence scale*. They argued that welfare comparison across households require *unconditional equivalence scales* which is based on a household's decision on having children, treated endogenously. But what the traditional budget data allow us to calculate is the *conditional equivalence scales*. This question of identifiability of household *equivalence scale* has been addressed by Muellbauer (1974), Deaton and Muellbauer (1986), Fisher (1987), Lewbel (1989), Deaton, Ruiz-Castillo, and Thomas (1989), Blundell and Lewbel (1991), Dickens, Fry, and Pashardes (1993) and Blackorby and Donaldson (1994). The problem of identifiability of *equivalence scale* is also associated with the data set and functional specification. *Equivalence scales* can not be recovered from demand behaviour in a single cross-section study in case of a *rank-two* demand system, with budget shares linear in log-expenditure (such as the AIDS or the Translog demand system) (Blackorby & Donaldson, 1994; Muellbauer, 1974; Pashardes, 1995; Phipps, 1998). Introduction of price variation also cannot solve this problem due to limited covariance between prices and demographic characteristics in a rank-two demand system (Dickens et al., 1993; Ray, 1983). Deaton et al. (1989) suggested parameter restriction such as *Demographic Separability* (DS) as a remedial measure. On

[1] The 'independent of utility level' property has been termed *independent of base* (IB) by Lewbel (1989) and *equivalence scale exactness* (ESE) by Blackorby and Donaldson (1994).

the other hand, a *rank-three* demand system or a *rank-two* model that allows for non-linear log-expenditure effects on the budget share enables estimation of identifiable IB/ESE scales without the restriction of DS (Pashardes, 1995).

In this paper we propose a *rank-two* Quadratic Logarithmic (QL) system, that is used for measurement of child cost. The formulation is based on: (i) an exploratory analysis of the form of Engel curve using nonparametric regression technique; and (ii) the rank test of Lewbel (1991) and Gill and Lewbel (1992) (see Majumder & Chakrabarty, 1998). The system is a member of the class of demand systems characterised by Blackorby and Donaldson (1994), under which the *relative cost of children* is *exact* and which permits estimation of the cost using iso-prop method.[2]

The paper is organised as follows: Section 2 deals with specification of the model, Section 3 describes the data used in this analysis; Section 4 presents the estimation results; and finally, Section 5 draws the conclusions.

2. Model specification

2.1. Theoretical background of the model

Blackorby and Donaldson (1994) provided closed form characterisation of the utility function in terms of the expenditure/cost function for the iso-prop method. They introduced two general classes of *cost of children* indices, one being the *relative cost of children* index, which regards the cost as equal in percentage terms for all households. They also showed that the iso-prop method is related to the *relative index*, but the two do not correspond exactly. In what follows, we briefly discuss their characterisation.[3]

Suppose the preference of a household is represented by a utility function $u = u(q_g, q_{g^*}, d)$ where q_g is a vector of *adult goods* (or alternatively, necessities), q_{g^*} is a vector of all other goods, $d = (d^a, d^c)$ is the vector of demographic characteristics with d^c: vector describing the characteristics of children and d^a: vector of all other types of household characteristics.

Let $C(u, p_g, p_{g^*}, d)$ be the expenditure function that gives the minimum expenditure necessary to attain utility level u at prices $p = (p_g, p_{g^*})$ for a household with demographic characteristics d. Let d^{ar} be the demographic characteristic vector for the reference household which has no children. The *relative cost of*

[2] This approach of measurement of *cost of children* is new in the Indian context. *Equivalence scales* in a system framework have been estimated by Pashardes (1995) for UK family expenditure data and by Lancaster and Ray (1998) for Australian data.

[3] In this paper we concentrate on the *relative cost of children* index. The other class of index is the *absolute cost of children index*, which is related to the Rothbarth (1943) measure of child cost. The Rothbarth measure is given by the compensation which has to be paid to the parents to restore the level of expenditure on *adult goods* to its prenatal level.

children index is given by the ratio:

$$\frac{C(u, p_g, p_{g^*}, d^{ar}, d^c)}{C(u, p_g, p_{g^*}, d^{ar})} \tag{2.1}$$

for a children composition vector d^c, holding the reference utility level and price level constant.

Blackorby and Donaldson (1994) showed that for this measure to be *exact* (that is, independent of the utility level which is unobservable), the expenditure function must be of the form:

$$C(u, p_g, p_{g^*}, d) = C(u, p_g, p_{g^*}, d^{ar})R(p_g, p_{g^*}, d^{ar}, d^c), \tag{2.2}$$

where $R(p_g, p_{g^*}, d^{ar}, d^c)$ is the *relative cost of children* and is homogeneous of degree zero in all prices (p_g, p_{g^*}).

The iso-prop method of measuring *child cost* is related to this *relative index*. It looks at the expenditure share on some subset of commodities (often chosen to be necessities such as *food*) and regards different types of households to be at the same utility level whenever the shares are equal. Thus, the iso-prop method requires that:

$$\frac{\sum_{i\in q_g} p_i q_i(u, p_g, p_{g^*}, d^{ar}, d^c)}{C(u, p_g, p_{g^*}, d^{ar}, d^c)} = \frac{\sum_{i\in q_g} p_i q_i(u, p_g, p_{g^*}, d^{ar})}{C(u, p_g, p_{g^*}, d^{ar})}, \tag{2.3}$$

where g represents a group of necessary items. Blackorby and Donaldson (1994) showed that for (2.3) to hold the expenditure function must be of the form:

$$C(u, p_g, p_{g^*}, d) = D(u, p_g, p_{g^*}, d^a)F(u, p_g, p_{g^*}, d^a, d^c), \tag{2.4}$$

where F is homogeneous of degree of zero in p_g.

Blackorby and Donaldson noted that if $F(u, p_g, p_{g^*}, d^a, d^c)$ in (2.4) is independent of u and $R(p_g, p_{g^*}, d^{ar}, d^c)$ in (2.2) is homogeneous of degree zero in p_g, then combining (2.2) and (2.4) the *exact relative cost of children* index can be estimated by iso-prop method (with a suitable choice of the commodity with respect to which the cost will be measured) using the expenditure function of the form:

$$C(u, p_g, p_{g^*}, d) = C(u, p_g, p_{g^*}, d^{ar})R(p_g, p_{g^*}, d^{ar}, d^c), \tag{2.5}$$

where $R()$ is homogeneous of degree zero in p_g (and hence in p_{g^*}).

For the case of one item in group g, (2.5) reduces to:

$$C(u, p_g, p_{g^*}, d) = C(u, p_g, p_{g^*}, d^{ar})R(p_{g^*}, d^{ar}, d^c), \tag{2.6}$$

where $R()$ is homogeneous of degree zero in p_{g^*} (see Browning, 1988, 1992).

Now, to work with a particular form of the expenditure function, we look at the possible Engel curve forms that might be suitable for our data. The general form of budget share equation consistent with our earlier empirical findings based on non-parametric regression (see Majumder & Chakrabarty, 1998)[4] can be represented by:

$$w_i = A_i(p) + B_i(p)\ln y + E_i(p)(\ln y)^2, \tag{2.7}$$

where w_i denotes budget share of ith commodity, y is the total expenditure and $A_i(p)$, $B_i(p)$ and $E_i(p)$ are any differentiable function of prices. To determine the rank of the demand system we performed the rank test of Lewbel (1991), and Gill and Lewbel (1992). The results pointed to a rank-two system, i.e., the rank of the coefficient matrix with the ith row $[A_i(p) : B_i(p) : E_i(p)]$ turned out to be two. Banks, Blundell, and Lewbel (1997) have characterised the indirect utility function for *rank two* systems, the resulting expenditure function of which is given by:

$$C(u, p) = a(p)\exp\left(\frac{b(p)}{\lambda(p) + (1/\ln v)}\right), \tag{2.8}$$

where v denotes utility level, $a(p)$ is homogeneous of degree 1 in prices, $b(p)$ is homogeneous of degree zero in prices and $\lambda(p)$ is a function of $b(p)$.

In what follows we combine the above results to formulate demand systems incorporating demographic variables whereby the *relative cost of children* will be independent of the utility level and the *cost* may be estimated using iso-prop method. The next subsection is devoted to formulation of such systems.

2.2. Proposed models

We consider one *adult good* (which has been found to be a necessary item in Majumder & Chakrabarty, 1998) in group g and combining (2.6) and (2.8) we propose the following formulation:

$$C(u, p_g, p_{g^*}, d^a) = a_2(p_g, p_{g^*}, d^a)(e^{b(p_g, p_{g^*})/(\lambda(p_g, p_{g^*})+1/\ln v)}),$$

and

$$R(p_{g^*}, d^a, d^c) = a_1(p_{g^*}, d^a, d^c). \tag{2.9}$$

Thus, $(a_1(\cdot)\cdot a_2(\cdot))$ correspond to $a(p)$ in (2.8). Keeping in mind our data structure, we consider M children categories and K social/occupational groups of population. The social and demographic variables augmented system is described by the following particular form of $a_1(\cdot)$, $a_2(\cdot)$, $b(p_g, p_{g^*})$ and $\lambda(p_g, p_{g^*})$.

$$a_1(p_{g^*}, d^a, d^c) = e^{(\alpha_c/2)}\prod_{i\in g^*}(p_i)^{\delta_i}, \qquad \sum_{i\in g^*}\delta_i = 0,$$
$$a_2(p_g, p_{g^*}, d^a) = e^{(\alpha_a/2)}\prod_{i\in g\cup g^*}(p_i)^{\xi_i}, \quad \sum_{i\in g\cup g^*}\xi_i = 1,$$

[4] This empirical analysis has been performed on the same data set we shall be using here.

where

$$\alpha_a = 1 + \sum_{k=1}^{K} \nu_{0k}(d_{15+}^{a} - 2)\, D_k,$$

and

$$\frac{\alpha_c}{2} = \frac{\alpha_a}{2} + \sum_{j=1}^{M}\sum_{k=1}^{K} \nu_{jk} d_j^c D_k,$$

$$b(p_g, p_{g^*}) = \prod_{i \in g \cup g^*} (p_i)^{\beta_i}, \quad \sum_{i \in g \cup g^*} \beta_i = 0, \tag{2.10}$$

and

$$\lambda(p_g, p_{g^*}) = \begin{cases} 0 & \text{for log-linear system of the PIGLOG}^{5} \text{ class (rank 2).} \\ \rho b(p_g, p_{g^*}) & \text{for Quadratic Logarithmic (QL) system (rank 2).} \end{cases} \tag{2.11}$$

Here $(d_{15+}^{a} - 2)$ denotes the number of adults (normalised),[6] as a childless 2-adults household is considered as reference here. D_k denotes a dummy variable which equals one when a household belongs to the particular occupation/social group (k) and d_j^c, $j = 1, 2, \ldots, M$ denotes the number of children in the age group j. The parameter α_a relates to adult characteristics and takes the value 1 for the reference household, ν's relate to children characteristics that give the marginal effect of children on the consumption pattern and α_c is a linear function of adult and children characteristics.

The corresponding budget share equations are given by:

$$w_i = \begin{cases} \Lambda_i + \beta_i \ln\left(\dfrac{y}{a(p)}\right) & \text{for PIGLOG} \\ \Lambda_i + \beta_i \ln\left(\dfrac{y}{a(p)}\right) + \rho\beta_i \ln\left(\dfrac{y}{a(p)}\right)^2 & \text{for QL (rank 2)} \end{cases} \tag{2.12}$$

where

$$\Lambda_i = \begin{cases} \xi_i & \text{for } \textit{adult good} \\ \delta_i + \xi_i & \text{for other commodities}^{7} \end{cases}$$

---

[5] Price Independent Generalised Log-Linear System of Muellbauer (1975, 1976).

[6] A childless 2-adult household is considered as the reference household, for which the scale value is 1. The number of adult members in a household less two is used to measure the marginal effect of additional adults in that household.

[7] It may be mentioned that since δ_i and ξ_i are also involved in the expression of $a(p)$, which enters non-linearly in the system, these two are separately identifiable.

and

$$\ln a(p) = \sum_{k=1}^{K} \nu_{0k}(d_{15+}^{a} - 2)D_k + \sum_{j=1}^{M}\sum_{k=1}^{K} \nu_{jk} d_j^c D_k + \sum_{i \in g^*} \delta_i \ln p_i + \sum_{i \in g \cup g^*} \xi_i \ln p_i. \tag{2.13}$$

Note that, in the absence of price variations the R.H.S. of (2.13) equals:

$$1 + \sum_{k=1}^{K} \nu_{0k}(d_{15+}^{a} - 2)D_k + \sum_{j=1}^{M}\sum_{k=1}^{K} \nu_{jk} d_j^c D_k,$$

which can be interpreted as the logarithm of household general *equivalence scale*. The *exact relative cost of children* is given by[8]:

$$a_1(p_{g^*}, d^{ar}, d^c) = e^{(\alpha_c/2)} \prod_{i \in g^*} (p_i)^{\delta_i}. \tag{2.14}$$

3. Data

The data used here are collected by the National Sample Survey (NSS) organisation of India in the 38th round of their survey operation. The period covered is January–December, 1983. We use the detailed consumption expenditure, demographic and socio-economic data for the rural sector of Maharashtra. The choice of the state of Maharashtra is determined solely by our access to NSS data. It may, however, be noted that Maharashtra is a fairly developed state in terms of a moderate level of health achievement ratio (next to Kerala, Punjab, Karnataka), achievement ratio in school enrolment (next to Kerala, Tamil Nadu, Himachal Pradesh, etc.) (Dutta, Panda, & Wadhwa, 1994). Examination of the issue of child cost in such a state is an interesting exercise by itself. Single-person households are excluded as their consumption pattern may not be comparable with that of the rest in the sample.

We consider the following five commodity groups: (1) cereals; (2) other food; (3) adult goods (see Chakrabarty, 1995); (4) fuel and light; and (5) clothing (excluding adult clothing items).[9] Six regions in the state of Maharashtra are considered. They are: Coastal, Inland Western, Inland Northern, Inland Central, Inland Eastern and Eastern.[10]

The four demographic categories considered here are the age-groups 0–5 years, 6–10 years, 11–14 years and the adult-age group of 15 years and above. Five occu-

[8] Note that this formulation does not allow for economies of scale.

[9] The list of items included in each group are documented in Appendix A.

[10] See Appendix B for a detailed description of the regions.

pational groups (classified according to the occupational group of the household head) are taken. They are: (a) self-employed in non-agricultural activity (NASE) (397); (b) agricultural labourer (AL) (1875); (c) other labourer (OL) (330); (d) self-employed in agriculture (ASE) (1868); and (e) other households (OH) (353).[11] Since in India the scheduled caste and scheduled tribe households are, in general, economically backward, their pattern of consumption and attitudes towards children are likely to be different. Within the occupation groups, to separate out the caste habit effect, we subdivide each occupation group into these two social classes viz., Scheduled caste and Scheduled tribe combined (SC-ST) and OTHER. The OTHER class consists of: (i) other Hindu; (ii) other Muslim; and (iii) other households which include neo-Buddhists, Jains, Christians, etc., excluding SC and ST from each religious community.

In order to estimate the demand system price variability is introduced into the system by considering *unit values* over the regions.[12] The *unit value* for each individual commodity is obtained by dividing the expenditure by the quantity. In this paper we adopt the procedure described in Yen and Roe (1989) for computing the price indices for the commodity groups from the *unit values*. The procedure is described briefly below. All individual *unit values* are deflated by their corresponding sample means to account for different measuring units. Then the price index for each commodity group is taken to be the weighted sum of all deflated component *unit values* in the group, weights being the expenditure shares. The assumptions we make are: (1) the intra-regional price variation is negligible compared to the inter-regional price variation for the six regions; and (2) the regional average of these indices represent the price for the commodity group in that region. We may note here that these price indices serve only as a proxy. However, given the non-availability of price data we consider this to be the closest substitute for the actual price data.

4. Results

Table 1 presents the parameter estimates of the QL (rank-two) model. The parameters δ_i's, ξ_i's, β_i's and ρ turn out to be significant and the β_i's have the expected signs. However, not all coefficients of the dummy variables are significant. It may be observed that most of the coefficients increase with the increase in the age of the children for all occupation and social classes, a pattern that seems quite plausible. Here, as the children characteristics are independent of the item subscript, the dummies fail to capture the effect of children on the consumption pattern of individual items.

Table 2 presents the estimates of expenditure elasticity (calculated at sample averages) for the two social classes SC-ST and OTHER within the two major

[11] The figures in parentheses denote the respective sample sizes.

[12] Only those goods which are consumed by a significant number of households and for which both quantity and value are available are chosen.

Table 1
Estimates of parameters of QL (rank-two) demand system

Parameter	Value	Parameter	Value	Parameter	Value
δ_{cereal}	.254 (28.40)	ξ_{cereal}	.255 (28.50)	β_{cereal}	−.048 (121.92)
$\delta_{otherfood}$	.003 (10.05)	$\xi_{otherfood}$	.116 (23.60)	$\beta_{otherfood}$	.075 (174.68)
$\delta_{adulthood}$	.169 (23.84)	$\xi_{adulthood}$	−.003 (14.71)	ρ	−.010 (2.44)
$\delta_{clothing}$	−.293 (279.71)	$\xi_{clothing}$	.314 (150.85)	$\beta_{clothing}$	−.012 (11.02)

Occupational/social categories	Age group (years)							
	15+[a]		0–5		6–10		11–14	
	Parameter	Value	Parameter	Value	Parameter	Value	Parameter	value
Household characteristics parameters								
NASE	ν_{01}	.040 (0.44)	ν_{11}	.045 (1.60)	ν_{21}	.132 (0.60)	ν_{31}	.110 (0.85)
AL	ν_{02}	.119 (0.40)	ν_{12}	.117 (1.20)	ν_{22}	.137 (1.20)	ν_{32}	.151 (1.00)
OL	ν_{03}	.151 (0.95)	ν_{13}	.116 (1.60)	ν_{23}	.171 (1.05)	ν_{33}	.162 (1.50)
ASE	ν_{04}	.038 (1.75)	ν_{14}	.058 (1.20)	ν_{24}	.056 (0.95)	ν_{34}	.144 (1.00)
OH	ν_{05}	.102 (1.00)	ν_{15}	.041 (2.25)	ν_{25}	.051 (1.00)	ν_{35}	.119 (1.25)
SC-ST	ν_{06}	.209 (1.30)	ν_{16}	.137 (0.13)	ν_{26}	.257 (0.95)	ν_{36}	.351 (1.00)
OTHER	ν_{07}	.149 (1.20)	ν_{17}	.128 (0.85)	ν_{27}	.195 (1.02)	ν_{37}	.249 (0.90)

Log-likelihood value for QL (rank-two) system: 30076.40. Figures in parentheses are the absolute t-values.

[a] Normalised adults.

Table 2
Expenditure elasticity for the QL (rank-two) demand system by occupational groups and social classes within these occupational groups

Commodity	Expenditure elasticity[a]			
	Occupation group AL		Occupation group ASE	
	SC-ST	OTHER	SC-ST	OTHER
Cereals	0.861	0.850	0.853	0.839
Other food	1.232	1.211	1.211	1.173
Adult good	0.979	0.979	0.978	0.978
Clothing	0.203	0.150	0.287	0.282
Fuel and light	0.896	0.885	0.879	0.873

[a] Expenditure elasticity for QL (rank-two) demand system $= 1 + \beta_i / w_i (1 + 2\rho \ln(y/a(p)))$.

occupation classes, viz., AL and ASE.[13] Cereals, fuel and light, clothing and adult good turn out to be necessary goods and other food is a luxury good. The occupational and social classes do not seem to have too much of an effect on the value of the expenditure elasticity.

Table 3 presents the *relative cost of a child* for different age-groups within the household classifications using Engel's method in a single-equation framework.[14] In the first part of the table scales have been calculated using the conventional procedure, i.e., by considering the commodity *food* for the Engel scale. The second part presents Engel scales by taking the commodity *adult good* (which has been found to be a necessary item) as suggested by Blackorby and Donaldson (1994). It is observed that *food* Engel scales are larger than the Engel scales using *adult good.* Deaton (1997) estimated the cost of a child for three children categories for rural Maharashtra as a whole. The estimates (presented in Table 3) are marginally different from ours. Our results for the group ASE compares fairly well with Deaton's results. The *cost of a child* in the occupation group AL turns out to be higher than the corresponding state level value.

It may also be observed that the scales using *adult good* generally turn out to be less than 1. An explanation for this is in order. Suppose for a household with no children, x_f and x_a are the expenditures on 'food' and 'adult good,' respectively and let x_{f_1} and x_{a_1} be the corresponding expenditures after the arrival of a child. Suppose the corresponding compensations to maintain the Engel ratio are given

[13] For the occupation classes NASE, OL and OH the subgrouping into SC-ST and OTHER leads to very small sample sizes in each household composition. We, therefore, confine our attention only to AL and ASE.

[14] Only the results for one child have been reported here. However, while estimating, all possible demographic compositions have been taken into account. It may also be pointed out here that the average number of children per household for all types of households for all age-groups turn out to be 1. The scales are based on the Working-Leser (WL) form. We have also calculated the scales using the extended Working-Leser (EWL) form which is a quadratic extension of the WL form. However, since the results turn out to be similar, we present the results for the WL form only.

Table 3

Relative cost of a child for three children categories by occupational groups and social classes from the single-equation approach

Household composition (d^a, d^c_{0-5}, d^c_{6-10}, d^c_{11-14})[a]	Occupation group AL		Occupation group ASE		Deaton's (1997) estimates[b]
	SC-ST (644)[c]	OTHER (1231)	SC-ST (251)	OTHER (1217)	
Engel scale using food					
(2,1,0,0)[d]	1.37	1.14	1.04	1.14	1.24
(2,0,1,0)	2.36	2.79	1.35	1.27	1.28
(2,0,0,1)	2.44	2.16	1.69	1.35	1.30
Engel scale using adult good					
(2,1,0,0)	0.86	0.92	0.77	0.80	–
(2,0,1,0)	0.71	0.83	0.42	0.41	–
(2,0,0,1)	1.16	0.94	0.34	0.33	–

[a] d^a: Number of adults, d^c_{0-5}: number of children in the age-group 0–5 years, d^c_{6-10}: number of children in the age-group 6–10 years and d^c_{11-14}: number of children in the age-group 11–14 years.

[b] The age-groups are slightly different, viz., 0–4 years, 5–9 years, and 10–14 years.

[c] Sample size.

[d] The reference household consists of only two adults, i.e., with demographic composition (2,0,0,0) for which *relative cost/general equivalence scale* is 1.

Table 4
Relative cost of a child/adult by occupational groups and social classes from the systems approach

Household composition $(d^a, d^c_{0-5}, d^c_{6-10}, d^c_{11-14})$	*Relative cost of a child/adult*				Average adult good expenditure share			
	Occupation group AL		Occupation group ASE		Occupation group AL		Occupation group ASE	
	SC-ST	OTHER	SC-ST	OTHER	SC-ST	OTHER	SC-ST	OTHER
(2,1,0,0)	2.236	2.216	2.108	2.089	0.16 (35)	0.17 (59)	0.15 (6)	0.16 (21)
(2,0,1,0)	2.572	2.417	2.372	2.229	0.14 (17)	0.15 (21)	0.17 (4)	0.16 (14)
(2,0,0,1)	2.865	2.589	2.817	2.570	0.16 (12)	0.15 (28)	0.12 (6)	0.14 (27)
(3,0,0,0)	4.755	3.874	4.559	3.802	0.15 (24)	0.17 (49)	0.15 (16)	0.16 (61)

by c_f and c_a. Let y be the income of the household. Now since both the goods are necessary goods in our case, we have, for 'food,' $x_f/y < x_{f_1}/(y + c)$ for $c < c_f$ and $x_f/y = x_{f_1}/(y + c_f)$, implying $c_f = ((x_{f_1}/x_f) - 1)y > 0$. For 'adult good' on the other hand, we have $x_a/y < x_{a_1}/(y + c)$ for $c < c_a$ by the 'necessity property' of the commodity, $x_{a_1} < x_a$ by the 'adult good' property and $x_a/y = x_{a_1}/(y + c_a)$. Thus, $c_a = ((x_{a_1}/x_a) - 1)y < 0$. Therefore, use of 'any' necessary item for measuring child cost does not yield plausible results.[15] It is also observed from Table 3 that the cost is sensitive to the occupational and social classes the households belong to and the cost increases with the increase in the age of a child.

Table 4 presents the cost of a child and also of an additional adult from our system for the above occupational/social classes. It is observed that *child cost* estimates are much larger than the single equation estimates of *food* Engel scale, which are known to be overestimates. However, compared to an additional adult a child costs at most 70% of the adult (this is obtained by dividing the first three rows by the last row (Deaton, 1997)). The rather large estimates of the scales from the systems approach using *adult good* could be due to the fact that the formulation does not allow interaction between children characteristics and item specific effects. Thus, it seems that while measuring the *cost of children* using the iso-prop method the overall effect of an additional child on the budget share of the *item concerned* should be examined carefully rather than considering just the fact that the item is a *necessary* item. While the single equation approach clearly produces implausible results in such a situation, in the system framework this can possibly be taken care of by incorporating interaction between children characteristics and item specific effects.

5. Conclusion

This paper measures the *exact relative cost* of a child using the single equation approach and the systems approach. A rank-two Quadratic Logarithmic demand system is proposed and estimated. Although the estimates of the cost of a child turn out to be rather large, the increase in the cost with the age of a child shows quite a plausible pattern. Also, compared to an additional adult the cost of a child is at most 70% of the adult.

The main finding that emerges from this study is that it is just not enough to consider any 'necessary' commodity in using iso-prop method for measuring *child cost*. One has to carefully look at the nature of the commodity as well as the effect of children on the consumption of that particular commodity, as is the case for *adult good* here. This could make a lot of difference in the measurement of *child cost* as has been observed here.

---

[15] The value for the children of 11–14 years age-group within AL is quite plausible given the fact that they are at the borderline and exert a positive effect on the consumption of these goods.

Some limitations of this study are: (i) the *exactness* property, which could be a testable one, is built into the model[16] and (ii) due to limitation of our price data the model has been proposed so as to have limited interaction between prices and demographic characteristics.

Acknowledgments

Thanks are due to the authorities of NSSO for permitting the use of updated tapes containing the NSS 38th round consumption expenditure data and employment data supplied to ISI, Calcutta, for the purpose of the present analysis. We would like to thank Professor Dipankor Coondoo for his comments and helpful suggestions.

Appendix A. List of items

- Cereals: This group includes cereal, gram and cereal substitutes.
- Other food: This group includes pulses and pulse products, milk, edible oil, meat, eggs, fish, vegetables, fruits, sugar, salt, spices and beverages excluding tea-coffee.
- Adult good: This group includes tea-coffee, pan leaf and pan finished, supari, katha, lime, other ingredients for pan, biri, cigarettes, tobacco, zarda, ganja, bhang, charas, foreign liquor, opium, beer, other drugs and adult clothing items like dhoti, sari, cloth for shirt, pyjama, salwar, coat, trousers, etc. and lungi.
- Fuel and Light: This group includes coke, firewoods, electricity, dung-cake, kerosine, matches, coal, coalgas, gas, other oil used for lighting, candles, gobar gas, etc.
- Clothing: This group includes chaddar, dopatta, wraper, gamcha, bed-cover, mats, knitting wool, etc.

Appendix B. Break-up of various regions of Maharashtra

In NSS data states are first divided into agro-climatic regions which are groups of contiguous districts, similar with respect to population density and crop pattern. NSSO divides Maharashtra into six regions. The regions are:

1. Coastal: The Coastal region consists of Greater Bombay and also the districts of Thane, Kolaba, Ratnagiri and Sindhudurg of Maharashtra.[17]

---

16 However, as pointed out in Blundell and Lewbel (1991) and Dickens et al. (1993), the test is conclusive only in the case of rejection. Murthi (1994) tested the restriction implied by exactness in the context of different parametric forms of Engel curves on Sri Lankan data and in most of the cases exactness was not rejected. Pashardes (1995), on the other hand, found rejection of the hypothesis on UK data for the models he proposed.

17 Here we use the 1983 definitions of the districts. After 1983, some of the districts of Maharashtra were divided into smaller districts because of administrative reasons.

2. Inland Western: The Inland Western region of Maharashtra consists of the districts of Ahmednagar, Pune, Satara, Sangli, Solapur and Kolhapur.
3. Inland Northern: The Inland Northern part is formed with only three districts, viz., Nasik, Dhule and Jalgaon.
4. Inland Central: The region of Maharashtra roughly coincides with the Marathawada region. It consists of the districts of Aurangabad, Parabhani, Beed, Nanded, Usmanabad and Jalna.
5. Inland Eastern: This region of Maharashtra is formed with the districts of Nagpur, Wardha, Yavatmal, Amaravati, Buldana and Akola.
6. Eastern: This region is formed with only two districts, viz., Chandrapur and Bhandara.

   The Inland Eastern and the Eastern regions of Maharashtra form a part of what is more popularly known as the Vidarbha region of India.

Although Maharashtra is considered to be one of the most developed states in India in terms of several conventional indicators of development, the aggregate indices hide enormous regional differences that exist within the state. While the neighbourhood of Bombay and the Western part of Maharashtra are highly developed the rest of the state is grossly underdeveloped relative to these parts (Dev, 1992). Within the underdeveloped part the regions differ widely among themselves with respect to employment, irrigation infrastructure etc. (Bhattacharya, 1995).

References

Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic Engel curves, indirect tax reform and welfare measurement. *Review of Economics and Statistics*, *XXIX*(4), 527–539.

Bhattacharya, K. (1995). *Employment fluctuation in rural India: A statistical analysis with special reference to Maharashtra*. PhD dissertation, Indian Statistical Institute, Calcutta.

Blackorby, C., & Donaldson, D. (1994). Measuring the cost of children: A theoretical framework. In R. Blundell, I. Preston, & I. Walker (Eds.), *The measurement of household welfare*. Cambridge: Cambridge University Press.

Blundell, R. W., & Lewbel, A. (1991). The information content of equivalence scales. *Journal of Econometrics*, *50*, 49–68.

Browning, M. (1992). Children and household economic behaviour. *Journal of Economic Literature*, *30*, 1434–1475.

Browning, M. (1988). *The exact preference associated with the Engel and Rothbarth methods*. Department of Economics, McMaster University.

Chakrabarty, M. (1995). Identification of adult goods and demographic separability — The case of rural Maharashtra. *Sarvekshana*, *xix*(2), 31–41.

Deaton, A. S. (1997). *The analysis of household surveys — A micro econometric approach to development policy*. The John Hopkins University Press.

Deaton, A. S., Castillo, J. R., & Thomas, D. (1989). The influence of household consumption on household expenditure patterns: Theory and Spanish evidence. *Journal of Political Economy*, *97*, 179–200.

Deaton, A. S., & Muellbauer, J. (1986). On measuring child cost: With application to poor countries. *Journal of Political Economy*, *94*, 720–744.

Dev, S. M. (1992). *Poverty alleviation programs: A case study of Maharashtra with emphasis on employment guarantee scheme* (Discussion Paper 77). Indira Gandhi Institute of Development Research.

Dickens, R., Fry, V., & Pashardes, P. (1993). Non-linearities and equivalence scales. *Economic Journal, 103*, 359–368.

Dutta, B., Panda, M., & Wadhwa, W. (1994). *Human development in India: An inter-state analysis*. Mimeo.

Engel, E. (1895). Die Lebenskosten Belgischer Arbeiter-Familien Fruher and Jetzt. *International Statistical Institute Bulletin, 9*, 1–74.

Fisher, F. M. (1987). Household equivalence scales and interpersonal comparisons. *Review of Economic Studies, 54*, 519–524.

Gill, L., & Lewbel, A. (1992). Testing the rank and definiteness of estimated matrices with application to factor, state-space and ARMA models. *Journal of the American Statistical Association, 87*, 766–776.

Lancaster, G., & Ray, R. (1998). Comparison of alternative methods of estimating household equivalence scales: The Australian evidence on pooled time series of unit record data. *Economic Record, 74*, 1–14.

Lewbel, A. (1989). Household equivalence scales and welfare comparisons. *Journal of Public Economics, 39*, 377–391.

Lewbel, A. (1991). The rank of demand systems: Theory and nonparametric estimation. *Econometrica, 59*, 711–730.

Majumder, A., & Chakrabarty, M. (1998). A nonparametric exploratory analysis of the form of Engel curves and rank of the demand system — The case of rural Maharashtra. *Sankhyā, 60*(Series B), 349–376.

Muellbauer, J. (1974). Household composition, Engel curves and welfare comparisons between households: A duality approach. *European Economic Review, 5*, 103–122.

Muellbauer, J. (1975). Aggregates income distribution and consumer demand. *Review of Economic Studies, 62*, 525–543.

Muellbauer, J. (1976). Community preferences and the representative consumer. *Econometrica, 44*, 979–999.

Murthi, M. (1994). Engel equivalence scales in Sri Lanka: Exactness, specification, measurement error. In R. Blundell, I. Preston, & I. Walker (Eds.), *The measurement of household welfare*. Cambridge: Cambridge University Press.

Pashardes, P. (1995). Equivalence scales in a rank-3 demand system. *Journal of Public Economics, 58*, 143–158.

Phipps, A. S. (1998). What is the income "cost of a child"? Exact equivalence scales for Canadian two-parent families. *Review of Economics and Statistics, 80*, 157–164.

Pollak, R. A., & Wales, T. J. (1979). Welfare comparisons and equivalence scales. *American Economic Review, 69*, 216–221.

Ray, R. (1983). Measuring the costs of children: An alternative approach. *Journal of Public Economics, 22*, 89–102.

Rothbarth, E. (1943). Note on a method of determining equivalent income for families of different compositions. In Madge, C. (Ed.), *Appendix 4 in war-time pattern of saving and spending* (Occasional Paper No. 4). Cambridge University Press.

Yen, T. S., & Roe, L. T. (1989). Estimation of a two-level demand system with limited dependent variables. *American Journal of Agricultural Economics, 71*, 85–98.