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COMPARISON OF ALTERNATIVE TAX AND TRANSFER TREATMENT OF CHILDREN USING ADULT EQUIVALENCE SCALES

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This paper estimates adult equivalence scales in the context of a nonlinear demand system using cross-section individual household data. It then evaluates the treatment of children under the tax allowance and child benefit systems on the basis of the estimated equivalence scales. The results suggest that a child benefit system allowing for economies of scale in the family is consistent with the cost of children implied by the notion of adult equivalence scale.

1. INTRODUCTION

For any tax and benefit system to be considered equitable it must allow for dissimilar treatment of unequals or similar treatment of equals. Households are unequal not only in terms of their income level, but also in terms of their size and composition. For example, families with children that have the same income as childless families are likely to have lower standards of living because of the financial burden of raising children. Therefore, an equitable tax and benefit system should equivalize the well-being of families with alternative size and composition in the assessment of net income taxes.

Most countries attempt to equivalize the well-being of families with different size and composition through child welfare programs. Such programs usually provide assistance to families with children either in the form of a *tax allowance*, a reduction in the tax liability of the household, or a *child benefit*, a payment to the person who looks after the child. The child welfare programs in developed countries are often based on a child benefit and payments may vary with the number and age of children. In the U.K., for example, the child welfare system was originally based on tax allowance, but since 1977 has changed to one based on child benefit. This change was implemented mainly because the tax allowance system is regressive since households benefit in proportion to their marginal income tax rate. Under the tax allowance system, families with low income will not receive any financial assistance for their children because they pay no taxes. The cost of children can be measured with the concept of (*adult*) *equivalence scale*, generally defined as the cost of reaching a given level of utility under different family composition (Muellbauer, 1974). As Browning (1992) explains, however, the cost of children can be taken to mean a number of things depending on the issue being analysed. First is the "need" question which is concerned with how

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much a family with children need compared to a family without children. Second is the "expenditure" question which is concerned with how much parents actually spend on their children. Finally is the "iso-welfare" question which is concerned with how much a family with children requires to be as well-off as a family without children. In this paper we are concerned with the "iso-welfare" question. Although equivalence scales are intended to allow the living standards of families of different size to be brought into equivalence, assuming that everyone within the family is equally well-off, they are not generally used for designing a redistributive tax and benefit system. For example Banks and Johnson (1993) argue that the U.K. benefit system is not based on any particular set of estimated equivalence scales.

Clearly, a child welfare system based on tax allowance will not treat families with the same size and composition similarly since low income families who pay no taxes will not benefit at all whereas rich families who are paying high tax rates will benefit the most. To my knowledge no systematic study has been undertaken to provide evidence on (i) the extent to which this system is inequitable and (ii) whether an alternative system based on child benefit will treat families more equitably. In this study we provide empirical evidence on these issues by comparing the tax allowance and child benefit systems. We examine the distribution and adequacy of the financial assistance to families with different composition and income class under the two systems on the basis of child costs computed from estimated equivalence scales. The lessons drawn from the analysis are of particular interest to less developed countries where financial assistance to families with children is still generally based on the tax allowance system. The analysis also indicates that by adopting a child benefit system reflecting the relative consumption needs of families of different composition, a child welfare program can become more equitable without raising the cost of the program.

The structure of the paper is as follows. Section 2 presents estimates of child costs using individual household data from Cyprus. The choice of Cyprus here is relevant for the analysis of the issues raised in the paper because (i) it has a child welfare system which is based on tax allowance and (ii) the family expenditure survey (based on the U.K. prototype) offers the information required for the empirical analysis. In Section 3 we assess the treatment of families with children under the two alternative child welfare systems by examining the distribution and adequacy of the financial assistance by family type and income class and we compare the actual financial assistance with the estimated child costs implied from the households consumption behavior. In Section 4 we conclude the paper.

2. Modeling and Estimating Child Costs

The two principal approaches to estimating equivalence scales are based on observed patterns of consumption (Browning, 1992). The first approach involves welfare proxy techniques and stems from the work of Engel. It is based on the assumption that there is some measurable variable that relates to the welfare level of the household; so by examining this identifying variable we can infer information regarding the well-being of the household. The two main welfare proxy techniques are the Engel and Rothbarth methods: the former considers the share of food in expenditure as a negative measure while the latter considers

the expenditure on adult goods as a positive measure of the welfare of the household. However, the strong assumptions upon which these methods are based (Deaton, Ruiz-Castillo, and Thomas, 1989; Deaton and Muellbauer, 1986) have led to an alternative approach to estimating equivalence scales, through the cost (indirect utility) function. According to this approach parameters reflecting the cost of children are specified in the household cost function and appear in the Marshallian demand equations; as such they can be empirically estimated together with the other parameters of the demand system.

The cost function approach to estimating equivalence scales, however, can also be problematic: without price variation (as in cross-section data) and in the context of a model where the budget shares are linear in utility (as in the popular Almost Ideal demand system of Deaton and Muellbauer, 1980) the equivalence scales cannot be identified without imposing demographic separability restrictions (Deaton *et al.*, 1989). These restrictions imply that demographic characteristics have "income" but no "substitution" effects on demand and can yield biased estimates of equivalence scales. In theory price variation can provide identifying information for the estimation of equivalence scales in demand system with linear in utility budget share equations (Muellbauer, 1974), although this has been argued to be unsuccessful in empirical applications (Pashardes, 1991). Recently Dickens, Fry, and Pashardes (1993) and Pashardes (1994) have shown that in a demand system where the budget shares are nonlinear in utility, it is possible to identify equivalence scales from cross-section data without imposing demographic separability restrictions. This advantage is particularly important in the case of developing countries where household expenditure surveys do not take place every year and the data collected are not intertemporally comparable. It should be added here that linear in utility demand systems are found to be inappropriate for the analysis of individual household data (Blundell, Pashardes, and Weber, 1993).

When equivalence scales are estimated within the context of demand systems non-linear in utility, the only requirement not for statistical identification but for meaningful interpretation, is for the estimated scales to be independent of the base utility level. This property has been termed as *Equivalence Scale Exactness* by Blackorby and Donaldson (1993) and *Independence of Base* (IB) by Lewbel (1989) and Blundell and Lewbel (1991). If IB holds the estimated scales will be independent of the level of income at which household cost is compared, then their application is greatly simplified.

Adopting the framework proposed by Dickens, Fry, and Pashardes (1993) and Pashardes (1994), we assume that consumer preferences are defined by the Quadratic Logarithmic cost function

$$\ln C(u_h, p) = a(p, z_h) + b(p, z_h)/[(u_h)^{-1} - g(p, z_h)], \tag{2.1}$$

where u_h is a utility index of household h, p is a vector of prices and z_{kh}, where $k = 1, \ldots, K$ is a vector of household characteristics.[1] The functions

[1]It includes demographic characteristics like the number of children between ages 0–11 and 12–17, the number of adults besides the head, the product of the number of children under 11 and 12–17 as well as other conditioning household characteristics like the sex, employment and economic status of the head (found to be significant in determining child costs by Browning and Meghir, 1991), age, regional location, durable ownership, ownership of the house etc.

$a(p, z_h)$, $b(p, z_h)$ and $g(p, z_h)$ are some household specific price indices (Lewbel, 1990).

Using the subscript 0 to denote the hypothetical reference household, defined by $z_{kh}=0$ all k, the adult equivalence scale can be written as $m_h = C(p, z_h, u_0)/C(p, z_0, u_0)$ and measures the compensation required by household h to attain the same level of utility as the reference household. When household h has the same characteristics as household 0, defined to be a childless two adult family, except for a child of a particular age, then m_h represents the adult equivalence scale for this child. The analysis below assumes that m_h is independent of the base utility u_0 (IB) as defined by Lewbel (1989). The conditions for IB in the context of (2.1) are $b(p, z_h)=b(p, z_0)$ and $g(p, z_h)=g(p, z_0)$.[2] Then

$$\ln m_h = \ln a(p, z_h) - \ln a(p, z_0). \tag{2.2}$$

The Engel curves which we estimate correspond to the Almost Ideal Quadratic Logarithmic (AIQL) demand system of Fry and Pashardes (1992) as explained in the Appendix A and have the following form

$$w_{ih} = \alpha_i + \Sigma_k \alpha_{ik} z_{kh} + \beta_i(\ln y_h - \alpha_0 - \Sigma_n \alpha_{0n} z_{nh}) + \lambda_i(\ln y_h - \alpha_0 - \Sigma_n \alpha_{0n} z_{nh})^2, \tag{2.3}$$

where y_h is the expenditure of household h. The parameters obey the restrictions $\Sigma_i \alpha_i = 1$, $\Sigma_i \alpha_{ik} = 0$ all k, $\Sigma_i \beta_i = 0$ and $\Sigma_i \lambda_i = 0$ for adding up. Also, z_{nh}, where $n = 1, \ldots, N$, is a vector containing only demographic characteristics of the household (i.e. $k = 1, \ldots, N, \ldots, K$). In the empirical analysis below this vector includes three demographic characteristics: the number of children aged 0–11, the number of children aged 12–17 and the number of adults (besides the head of the household). The square of the number of children and the square of the number of adults are also included in z_{nh} to capture economies of scale in the family.

The parameter α_{in} represents the *demographic substitution effects* (Deaton, Ruiz-Castillo, and Thomas, 1989), indicating the effect of characteristic n on the budget share of the ith good at a given *equivalized* expenditure level. In other words these parameters show shifts in "preferences" (movement *along* indifference curves) and do not have welfare implications, e.g. households with children buy ice-cream or toys simply because children like them. In contrast, the parameter a_{0n} correspond to the log equivalence scale of a household with the characteristic n relative to a household without this characteristic. Thus, a_{0n} indicates shifts in "needs" (movements *between* indifference curves) caused by the demographic characteristic n, e.g. a child or an adult.

The system of equations given by (2.3) are estimated using individual household data drawn from the *Cyprus Household Income and Expenditure Survey 1991*. The data include all households whose head is under retirement age (under 65), a total of 2,179 observations. The summary statistics for the cross-section data used in this study are presented in the Appendix B. The

[2]The IB hypothesis is tested and the results are reported in Table 1 and discussed later in this section.

TABLE 1

SELECTED PARAMETER ESTIMATES

Log Equivalence Scale, α_{0n}:		Parameter	Absolute t-ratio
Child 00-11		0.151	3.37
Child 11-17		0.221	4.10
Second adult		0.503	8.60
Adults square		−0.022	−2.74
Children square		−0.019	−1.99
Substitution Effects, α_{in}:		**Parameter**	**Absolute t-ratio**
Child 00-11	Food	0.024	8.57
	Take away	−0.014	6.26
	Alcohol and Tobacco	−0.002	2.12
	Household supplies	−0.001	0.38
	Clothing	0.008	3.86
	Fuel and fares	−0.005	4.20
	Housing expenses	−0.016	3.17
	Personal goods	0.003	2.59
Child 11-17	Food	0.023	5.04
	Take away	0.002	0.60
	Alcohol and Tobacco	−0.002	1.08
	Household supplies	−0.009	3.00
	Clothing	0.014	4.15
	Fuel and fares	−0.001	0.43
	Housing expenses	−0.032	4.07
	Personal goods	0.004	2.52
Adults	Food	0.025	4.37
	Take away	−0.001	0.40
	Alcohol and Tobacco	0.003	1.89
	Household supplies	0.019	5.87
	Clothing	0.013	3.36
	Fuel and fares	−0.002	0.94
	Housing expenses	−0.066	7.72
	Personal goods	0.005	2.72
System Statistics:			
Number of parameters		181	
Number of observations		2,179	
Demographic separability		$\chi^2(24,337)$	
Independence of base		$\chi^2(16,112)$	
Model specification		$\chi^2(8,1)$	

empirical analysis is based on nine categories of nondurable consumer expenditure: food, take away, tobacco and alcohol, household supplies, clothing and footwear, fuel and fares, housing expenses, personal goods and services and recreational expenditure.[3] The estimated method adopted is nonlinear SUR.

Table 1 reports selected parameter estimates which correspond to the demographic variables of interest mentioned above: the log equivalence scales at base period prices and subsistence expenditure level, α_{0n} and the demographic

[3]Durable goods are excluded to avoid the need for a dynamic specification. The implication is that the estimated demands are conditional on decisions concerning durable ownership and this is modeled by including in the estimated budget share equations dummies for car ownership.

substitution effects, α_{in}. The complete list of parameter estimates can be obtained from the author on request.

The parameters α_{0n} are significant and suggest that, relative to the reference household taken to be an otherwise similar two adult family without a child, a two adult family with a child aged 0–11 has a scale of 1.14.[4] This means that, at base period prices and subsistence expenditure level defined as the minimum level of expenditure for the reference household, a two adult family with a child aged 0–11 must spend 1.14 times more than an otherwise similar two adult family without children to be as well-off, i.e. the marginal cost of the first child aged 0–11 is 14 percent of the cost of the couple. Relative to an otherwise similar two adult family without a child a two adult family with a child aged 12–17 has an equivalence scale of 1.22, i.e. the marginal cost of the first child aged 12–17 is 22 percent of the cost of the couple. This implies that older children cost substantially more than younger children. Relative to an otherwise similar single adult family, a two adult family has an equivalence scale of 1.65 suggesting that the marginal cost of the second adult is 65 percent of the cost of the single adult family.

TABLE 2

ECONOMIES OF SCALE IN A 2-ADULT FAMILY

	Equivalence Scale	
Family Size	Level	Change
2 adults	1.00	—
2 adults + 1 child 00–11	1.14	0.14
2 adults + 2 children 00–11	1.25	0.11
2 adults + 3 children 00–11	1.32	0.07
2 adults + 4 children 00–11	1.35	0.03
2 adults + 1 child 12–17	1.22	0.22
2 adults + 2 children 12–17	1.44	0.22
2 adults + 3 children 12–17	1.63	0.19
2 adults + 4 children 12–17	1.77	0.15

The parameters reflecting economies of scale within the family, adult square and children square, are also significant. Table 2 shows how equivalence scales vary with family size, thus enabling one to assess the extent to which the marginal cost of children declines with the number of children. There appears to be substantial economies of scale in families with younger children, especially after the third child whose cost is about half the cost of the first child. Among families with older children the economies of scale are less pronounced.

The demographic substitution parameters α_{in} suggest that at equivalent expenditure and by comparison to otherwise similar families without children families with a child aged 0–11 prefer food, clothing and footwear and personal goods and services over tobacco and alcohol, fuel and fares, housing expenses and take away. At equivalent expenditure and by comparison to otherwise

[4]The equivalence scale for a child aged 0–11 is calculated as the exp (0.151–0.019), for a child aged 12–17 the exp (0.22 0.019) and for a second adult the exp (0.503 0.022).

similar families without children, families with a child aged 12–17 also prefer food, clothing and footwear, personal goods and services, over household supplies, fuel and fares and housing expenses. Finally, at equivalent expenditure and by comparison to otherwise similar single adult families, two adult families prefer food, household supplies, clothing and personal goods over housing expenses.

The IB-hypothesis is tested by allowing the β's and λ's to vary between households with and without children. The χ^2 statistic reported at the bottom of Table 1 suggests rejection of the IB hypothesis.[5] This is consistent with the results of studies that have tested IB using U.K. household expenditure data like Lewbel (1989) and Blundell and Lewbel (1991). The failure of the IB test implies that the observed consumer behavior can be used for unambiguous comparisons of *changes in* but not *levels of* welfare (Blundell and Lewbel, 1991). The equivalence scales estimated here can therefore be seen as measures of the relative cost of demographic characteristics at some chosen level of expenditure only which we will later define to be the "subsistence" level of expenditure. The demographic substitution effects are tested by imposing the demographic separability restrictions $\alpha_{in}=0$, $n=1, \ldots, N$. This implies that at equivalized expenditure levels, demographic characteristics (that is the number of children aged 0–11 and 12–17, the number of adults besides the head, the square of the number of adults and the square of the number of children) do not affect the household's preferences over goods. The results suggest rejection of his hypothesis too.

The model specification test involves the testing of the hypothesis that the squared predicted budget shares are jointly insignificant as explanatory variables in the system. This hypothesis cannot be rejected suggesting that, in general, terms with higher order than that implied by the AIQL model (e.g. cubic log expenditure terms) are not required as explanatory variables in the budget share equations. This result is consistent with results reported in other studies (e.g. Lewbel 1991 and Pashardes, 1994).

3. Assessment of the Tax Allowance and Child Benefit Systems

In this section, we use the empirical estimates of equivalence scales obtained in the previous section to investigate whether families of different type (i.e. different number and ages of children) are treated equitably under the tax allowance and child benefit systems. Our judgment is based on the extent to which families with similar demographic characteristics receive similar treatment and on whether sufficient compensation is given to households with different demographic characteristics so as to reach the welfare level of the reference household which is defined below.

We derive our conclusions by comparing the *distribution* as well as the *level* of financial assistance to families with different size and composition under (i)

[5]The tests are carried out by imposing the covariance of the unrestricted residuals on the restricted estimates and computing the difference in the log likelihood function between the unrestricted and restricted estimates (Gallant, 1987).

the present system which is based on tax allowance and (ii) an alternative system which is based on child benefit. Since the previous reported estimates of equivalence scales are non-IB, we shall restrict our analysis to assessing child compensation at the subsistence level of expenditure. Before we proceed with the discussion of the results, however, let us briefly mention the main aspects of the current tax allowance system in Cyprus and make a few clarifications pertaining to our calculations.

The main tax allowances to families with children under the age of 18 are: (i) for each child under the age of 16 a tax credit of $200 U.S.; (ii) for each child in secondary education a tax credit of $300 U.S.; (iii) for each child under the age of 6 in kindergarten education an additional tax credit of $100 U.S.; and (iv) for each child in a family with more than three children an additional tax credit of $80 U.S.[6]

In order to estimate the level of financial support to families with children under the present system and the child costs implied by the consumer demand analysis the following assumptions were made:

(a) Only two adult families whose head is an employee are used. Families whose head is self-employed are excluded because their tax payments are usually not reliable due to well-known reasons (e.g. tax evasion). This restricts our sample to 754 households.

(b) Under the tax allowance system, a tax credit is also given to low income families and to the spouse.[7] In this paper we assume that the tax allowance for children is given priority over other types of tax allowances. This implies that the level of financial assistance to low income families with children is the highest possible. The financial assistance to high income families with children is not affected.

(c) The child costs based on the estimated equivalence scales are calculated at the minimum level of expenditure of a family without children, which is taken to be $2,000 U.S. per annum. This amount corresponds to the average expenditure of a childless household in the poorest 1 percent of the sample. It also corresponds to the minimum pension in Cyprus. Therefore the estimated child costs are the lowest possible and reflect the subsistence consumption needs of children.

Table 3 presents estimates of the total and marginal benefit received annually by families (classified by the number of younger and older children and by income class) under alternative child welfare systems. Table 3(a) suggests that the tax allowance system does not provide for equal treatment of families with the same family composition. In the case of families with younger children the unequal treatment under this system is particularly pronounced since the level of financial assistance rises with the level of income of the family: high income families with young children benefit the most while families with gross income below $8,000 U.S. do not benefit at all because they do not have tax liability. It must be pointed out that the tax credits are of greater value to higher income families because of

[6]The figures here are calculated using the conversion ratio: 1 Cyprus pound = 2 U.S. dollars.

[7]For families whose annual income is smaller than $9,000 U.S. and greater than $9,000 U.S. but smaller than $12,000 U.S. a tax allowance of $280 U.S. and $200 U.S. is applicable respectively. For the spouse the tax allowance is $400 U.S.

TABLE 3

CHILD SUPPORT UNDER THE TAX ALLOWANCE AND CHILD BENEFIT SYSTEMS
(Figures are annual in U.S. dollars)

(a) Total Benefit/Tax Allowance

	Tax Allowance System				Child Benefit System	
	Up to 8,000	8,001-16,000	16,001-24,000	Over 24,000	Equivalence Scales	Cost Neutral Reform
1 child 00-11	0	186	228	234	280	236
2 children 00-11	0	372	464	480	500	421
3 children 00-11	—	480	634	696	640	539
4 children 00-11	—	655	1,180	1,320	700	590
1 child 12-17	0	224	300	300	440	371
2 children 12-17	0	360	600	600	880	742
3 children 12-17	—	—	900	900	1,260	1,061

(b) Marginal Benefit/Tax Allowance

	Tax Allowance System				Child Benefit System	
	Up to 8,000	8,001 16,000	16,001 24,000	Over 24,000	Equivalence Scales	Cost Neutral Reform
1st child 00-11	0	186	228	234	280	236
2nd child 00-11	0	186	236	246	220	185
3rd child 00-11	—	108	170	216	140	118
4th child 00-11	—	175	546	624	60	51
1st child 12-17	0	224	300	300	440	371
2nd child 12-17	0	136	300	300	420	371
3rd child 12-17	—	—	300	300	380	319

the progressivity of the tax system. This result will not hold in the case of refundable credits evaluated at a single tax rate such as those used elsewhere (e.g. Canada).

Regarding the adequacy of the compensation level given to families with children the results in Table 3 support that, under the present tax allowance system, families with only one child are not adequately compensated for the cost of their child evaluated at subsistence expenditure level. On the other hand the level of financial assistance to families with two children appears to be adequate and to families with more than three children more than adequate. In the case of high income families with four children the financial assistance is more than double the child costs estimated. This is due to the policy of the government to increase the size of the family by providing an additional $80 U.S. for each child of a family with more than three children. In this sense the present system completely ignores the economies of scale that were found in the empirical analysis to be significant and large in the case of younger children. It is also very generous to high income families.

In the case of older children, Table 3 suggests that under the present tax allowance system families receive the same level of assistance for each child regardless of their income, except that families with older children whose gross income is below $8,000 U.S. do not benefit from the system. On the basis of the estimated

costs of older children the present system can be judged to be generally inadequate. In this case, however, the fact that this system ignores economies of scale in family size is less critical because the empirical results suggest that the economies of scale for older children are generally very small.

Next we consider an alternative system based on a child benefit system that reflects the relative consumption needs of children in different age groups; we examine whether such a system can be more equitable and more adequate than a tax allowance system without necessarily raising the cost to the government. A fundamental feature of a child benefit system is that the benefit is paid to all families including those which need it the most, the low income families (which are excluded under the tax allowance system). This is particularly important in the cases where the welfare system does not include special provisions for financial payments to low income families with children. The last column in Table 3 represents annual payments to families under a hypothetical situation where the current tax allowance system is replaced by a child benefit system without changing the cost of the child welfare program to the government[8]. The results suggest that such a cost neutral reform would enable families to be compensated up to around 85% of the subsistence costs of children implied by the estimated equivalence scales.

4. Conclusion

A child welfare system based on tax allowances is inherently regressive since it excludes families with low incomes because they have no tax liability. Despite this feature there are still countries that base their welfare systems on this system. This paper uses individual household data to assess the extent to which a tax allowance system allows for equal treatment for all families and provides the minimum necessary compensation required by households with children to reach the welfare level of households without children. It then compares the results with those corresponding to a child benefit system.

Our comparison of the two alternative ways of delivering benefits to families with children was based on adult equivalence scales estimated from a system of nonlinear Engel curves applied to Cyprus data. These scales suggest that child costs increase with age and that there are significant economies of scale in the family, particularly in the case of younger children. Therefore, the practice followed by some countries of providing successively higher benefits for additional children, e.g. Sweden, France and Germany, is not supported. The empirical results support the view that a child benefit system is closer to the structure of costs implied by consumer demand analysis when the level of compensation increases with the age and declines with the number of children in the family. The same will hold true for a system of refundable credits evaluated at a single tax rate that is larger for older children and smaller for additional children. Our

[8]Child benefits are found by first calculating the benefits received by families with children under the present tax allowance system and by subsequently re-distributing the total amount of these benefits on the basis of the information regarding the relative consumption needs of children in different age groups, given by the estimated equivalence scales. In this way families with the same number and ages of children benefit the same regardless of their level of income.

empirical findings also suggest that the increase in government spending required to switch from a tax allowance to a child benefit system that fully compensates families for the subsistence cost of their children can be very small.

Appendix A

The Marshallian budget shares corresponding to the Quadratic Logarithmic cost function (2.1) are

$$w_{ih} = a_i(p, z_h) + \beta_i(p, z_h)[\ln y_h - a(p, z_h)] + \lambda_i(p, z_h)[\ln y_h - a(p, z_h)]^2, \tag{A.1}$$

where

$$\beta_i(p, z_h) = b_i(p, z_h)/b(p, z_h),$$
$$\lambda_i(p, z_h) = g_i(p, z_h)/b(p, z_h),$$
$$a_i(p, z_h) = \partial a(p, z_h)/\partial \ln p_i,$$
$$b_i(p, z_h) = \partial b(p, z_h)/\partial \ln p_i,$$
$$g_i(p, z_h) = \partial g(p, z_h)/\partial \ln p_i,$$

and y_h is the expenditure level (budget) of household h.

Assuming $a(p, z_h)$, $b(p, z_h)$ and $g(p, z_h)$ to have the explicit form corresponding to the Almost Ideal Quadratic Logarithmic demand system (Fry and Pashardes 1992),

$$a(p, z_h) = \alpha_0(z_h) + \Sigma_i \alpha_i(z_h) \ln p_i + 0.5\Sigma_i\Sigma_j \gamma_{ij} \ln p_i \ln p_j, \tag{A.2a}$$

$$b(p, z_h) = \beta_0(z_h)\Pi_i p_i^{\beta_i}, \tag{A.2b}$$

$$g(p, z_h) = \lambda(p, z_h) = \lambda_0 + \Sigma_i \lambda_i(z_h) \ln p_i, \tag{A.2c}$$

we obtain the empirical Marshallian budget shares

$$w_{ih} = \alpha_i(z_h) + \Sigma_j \gamma_{ij} \ln p_i + \beta_i(z_h)(\ln y_h - \ln P_h) + \lambda_i(z_h)(\ln y_h - \ln P_h)^2, \tag{A.3}$$

where

$$\ln P_h = \alpha_0(z_h) + \Sigma_i \alpha_i(z_h) \ln p_i + 0.5\Sigma_i\Sigma_j \gamma_{ij} \ln p_i \ln p_j.$$

Under the assumption of constant prices household specific parameters $\alpha_i(z_h)$ and $\alpha_0(z_h)$ are linear functions of household characteristics and imposing the IB restrictions $\beta_i(z_h) = \beta_i$ and $\lambda_i(z_h) = \lambda_i$, we arrive at the Engel curves estimated in Section 2.

Data Appendix

The data used in this paper refer to cross-section data for the year 1991. The data includes all households whose head is under retirement age (under the age of 65). The demand system is based on nine categories of nondurable consumer expenditure defined as follows:

Food: expenditure on food purchased in stores.

Take away: expenditure on meals and drinks purchased in restaurants and take away.

Tobacco and Alcohol: expenditure on alcoholic beverages and tobacco.

Household supplies: expenditure on household supplies and household services.

Clothing and Footwear: expenditure on men's, women's and children's clothing and footwear.

Fuel and Fares: expenditure on bus and taxi fares, gasoline.

Housing Expenses, light and fuel: expenditure on house rent, water and sewage charges, maintenance and repairs, municipal and community taxes, electricity, gas for cooking and heating.

Personal Goods and Services: expenditure on personal care items, and services.

Recreation Expenditure: expenditure on recreation and entertainment equipment, recreation goods and services.

The table below presents full sample (unweighted) means and their standard deviations for the budget shares and all the variables used on the right-hand side of the budget share equations.

VARIABLES USED IN THE DEMAND SYSTEM

Variable	Mean	Standard Error
Share of food	0.301	0.119
Share of take away	0.068	0.074
Share of alcohol and tobacco	0.024	0.033
Share of household supplies	0.083	0.064
Share of clothing	0.108	0.070
Share of fuel and fares	0.078	0.045
Share of housing expenditure	0.252	0.112
Share of personal goods	0.035	0.034
Share of recreation goods	0.047	0.037
Log expenditure (LX)	8.621	0.489
Age of head–45 (AGE)	4.371	12.074
No. of females	1.805	0.934
No. of adults beside head	1.426	0.947
No. of earners (EARNER)	1.672	0.847
No. of children age 0 11 (CHG1)	0.883	1.049
No. of children age 12 17 (CHG2)	0.377	0.688
No. of children (KIDS)	1.260	1.196
KIDS square	3.020	4.181
CHG1 square	1.882	3.031
CHG2 square	0.616	1.454
CHG1* CHG2	0.260	0.815
EARNER* LX	14.569	7.715
AGE* LX	36.587	101.519
Dummy for presence of child	0.624	0.484
Dummy for urban household	0.363	0.481
Dummy for rural household	0.636	0.481
Dummy for refrigerator	0.993	0.082
Dummy for washing machine	0.114	0.318
Dummy for air conditioning	0.126	0.332
Dummy for secondary education	0.301	0.458
Dummy for rented housing	0.123	0.329
Dummy for refugee housing	0.104	0.305
Dummy for owner-occupied housing	0.703	0.457
Dummy for second house	0.054	0.226

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