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INTRA-HOUSEHOLD ALLOCATIONS IN RURAL ETHIOPIA: A DEMAND SYSTEMS APPROACH

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This article examines the effects of price, income and demographic changes on intra-household allocations by integrating the outlay equivalent method into the Quadratic Almost Ideal Demand System (QUAIDS). Tests for separability in preferences and "demographic separability" are conducted. Longitudinal data to control for household heterogeneity are used. Results indicate that Ethiopian rural households respond to price, income and demographic changes in a more complicated manner than usually presumed; price, income and demographic changes do not have similar effects on all household members. Income changes affect men and boys more than women and girls, but variations in prices affect women and boys more than men and girls. Even though outlay equivalent ratios on average indicate discrimination against girls, girls are more protected from fluctuations in income and prices compared to boys. The results highlight limitations of previous studies that ignore direct income and price effects.

1. INTRODUCTION

The importance of intra-household distribution in affecting individual welfare is now well recognized. Extensive literature shows that individual welfare depends not only on total household income but also on its allocation within the household. The study of intra-household allocations is made difficult by lack of data on the consumption of individual members. For instance, it would be difficult to know how much of the household food expenditure is made on behalf of particular members, except in cases where nutritional surveys have directly measured individual intakes. Hence, information on goods consumed only by some members (exclusive goods) is extensively used to examine intra-household distribution of expenditures.

The outlay equivalent method (Deaton, 1988; Deaton *et al.*, 1989) uses consumption of exclusive goods—particularly consumed only by adults—to examine the effects of demographic changes on expenditure allocations. In this approach, first the demand function for goods consumed only by adults is estimated. Then, from the demand function, the decrease in the consumption of adult goods with an additional boy or girl is estimated. Systematic differences in the consumption changes indicate gender discrimination.

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A major limitation of the outlay equivalent method is the neglect of price and direct income effects. This paper improves on that by examining the combined effects of price, income and demographic changes on household expenditures. A demand system provides a unified and systematic framework for doing that; in particular, the recently developed Quadratic Almost Ideal Demand System (QUAIDS) (Banks *et al.*, 1997) is used.[1]

The underlying preference structure for classifying goods into different groups is examined here; unlike most other studies, tests for separability in preferences are conducted. Also unlike most other studies using the outlay equivalent method, this study uses instrumental variable estimation to mitigate problems of endogeneity. Panel/longitudinal data help to control for household heterogeneity and capture both regional and spatial price variations.

Data from the Ethiopian Rural Household Survey (ERHS) are used. The ERHS is a collaborative project between the Department of Economics (Addis Ababa University), the Centre for the Study of African Economies (CSAE, Oxford University) and the International Food Policy Research Institute (IFPRI). The survey covered 15 villages representing the main farming systems of Ethiopia. Four rounds of surveys in 1994, 1995 and 1997 generated household level panel data on around 1,500 households. The sample is not nationally representative. Due to the careful selection of villages located in the main farming systems of the country, however, figures from the sample compared well with those from nationally representative ones.[2] The overall sampling strategy can be characterized as stratified random sampling; first villages representing main farming systems were purposively chosen and then households in each village were randomly selected.

The empirical results show that Ethiopian rural households respond to price, income and demographic changes in a more complicated manner than usually presumed; demographic groups absorbing the impacts differ for different types of changes. Changes in household income affect men and boys more than women and girls. On the other hand, changes in price affect women and boys more than men and girls. Even though the outlay equivalent ratios imply discrimination against girls, girls are more protected from fluctuations in income and prices as compared to boys, even though the later benefit more when incomes rise.

The findings imply that studies that only looked at demographic changes—using outlay equivalent ratios—tell us only part of the story. If demographic groups discriminated in one respect are protected from risks of income and price fluctuations, the results from these studies will be misleading. This underscores the importance of integrating direct income and price effects in future studies.

The article is structured in the following way. A discussion of the conceptual framework is given in Section 2. Tests for preference and demographic separability are presented in Sections 3 and 4 respectively. The estimation of the demand system and the main empirical results are discussed in Sections 5 and 6. Section 7 provides the conclusions.

[1]The analysis of demand systems in Africa is not a frequent exercise as it is for developed countries. In the case of Ethiopia, one exception is Shimeles (1993).

[2]See Dercon (2000) for comparisons of statistics from ERHS and nationally representative surveys.

2. Conceptual Framework

The theoretical foundation of the outlay equivalent method goes back to the long-established literature on equivalence scales and measurement of child costs. When children are born, unless they come with some additional endowments like inheritance, the family budget must adjust to accommodate them. Given the same level of income, cutbacks from some expenditure items or leisure are necessary. Hence, the amount of expenditure needed to take the family back to its original level of welfare indicates the cost of the child. Engel (1857) and Rothbarth (1943) suggested different ways of measuring child costs.

For Engel (1857), the budget share of food from total expenditure measures the standard of living; the larger the share, the lower the welfare of the household ("Engel's law"). Hence, the amount of compensation the household should get to be at the initial welfare level is equal to the expenditure needed to attain the first (lower) food budget share. In contrast, Rothbarth (1943) argues that if the compensation is to reflect the costs of children, it should be based on maintaining the same level of expenditure on goods consumed only by adults ("adult goods").[3]

Deaton (1988) and Deaton *et al.* (1989) followed the approach of Rothbarth, focusing on adult goods to examine intra-household distributions. To illustrate Rothbarth's approach, let us start from an Engel curve relating the expenditure on a particular commodity, $p_i q_i$, to total household expenditure, X, demographic characteristics, A, other variables, Z, and unobservable taste variations, u.

$$p_i q_i = f(X, A, Z, u). \tag{1}$$

The demographic characteristics can be divided into those associated with adults, A_a, and those with children, A_c. Consider the demand for adult goods. Adults influence the demand for those goods in a general manner while children are likely to have only an income effect. An additional adult will consume the commodity—there will be a substitution towards the commodity—but since more people are now using the same level of income the household is poorer and must consume less of the commodity (an income effect). In the case of an additional child, only the second effect operates unless there is a direct effect of the child on the demand of adults for adult goods.[4] By using the demographic characteristics of children and adults, the demand function for adult goods, ignoring Z and u, can be written as

$$p_i q_i = f[\phi(X, A_a, A_c), A_a]. \tag{2}$$

The $\phi(.)$ function represents the real income available to the household. Characteristics related to children affect the demand for adult goods only through the $\phi(.)$ function. Equation (2) summarizes the condition Deaton *et al.* (1989) called demographic separability. Good i—the adult good—is separable from demographic group c (children).

[3]For a detailed discussion of the methods by Engel and Rothbarth, see Deaton and Muellbauer (1986).

[4]For example, parents may decrease or stop smoking when a child is born not only because of the income effect but also because it can hurt the health of the child.

Suppose n_r represents the number of people in demographic group r. The change in demand for good i due to a change in the number of people in the r demographic group is $\frac{\partial(p_i q_i)}{\partial n_r}$. The marginal propensity to spend on good i equals $\frac{\partial(p_i q_i)}{\partial X}$. The ratio of the former to the latter indicates the change in demand for the commodity due to the change in the r demographic group expressed in terms of the marginal propensity to spend. Dividing this by household expenditure per capita, $\frac{X}{n}$, gives the outlay equivalent ratio for good i and for demographic group r, π_{ir}.

(3)
$$\pi_{ir} = \frac{\frac{\partial(p_i q_i)}{\partial n_r}}{\frac{\partial(p_i q_i)}{\partial X}} \frac{n}{X}.$$

If group r is demographically separable from commodity i, the ratios between the two marginal changes will be proportional to each other. The effect of a change in the demographic group is only an income effect that will be proportional to the marginal propensity to spend which also measures an income effect. This ratio must be the same for all the goods separable from the demographic group r. Formally,

(4)
$$\frac{\partial(p_i q_i)}{\partial n_r} = \theta_r \frac{\partial(p_i q_i)}{\partial X}.$$

The factor of proportionality, θ_r, is independent of the goods—there is no subscript i. θ_r measures the magnitude of the income effect. For instance, in the case of adult goods, a higher absolute value of θ_r for boys than for girls indicates that budget adjustments are made more in favor of boys than girls.

Studies that have used the outlay equivalent method used single demand equations. The estimation of separate demand equations ignores interactions between commodities and may give a distorted picture of household demand. Even in cases where one is interested in analyzing the demand for a single commodity, it is beneficial to estimate a demand system if sufficient information is available. The estimation of a demand system also consistently relates the analysis to utility theory. In single equation demand analysis, some of the restrictions imposed by economic theory cannot be tested if they appear as cross-equation restrictions (adding-up property, Slutsky symmetry, etc).

Previous studies looked at only the outlay equivalent ratios, ignoring price and direct income effects.[5] Looking at how household expenditures change when prices and income change is important; some of the effects captured by the outlay equivalent ratios may be counteracted by price and direct income changes.

[5]Most previous studies used cross-section data without price variation and this is one of the reasons why price effects are not incorporated.

The interdependence between commodity demand and the need to capture price and direct income effects leads us to the estimation of demand systems.[6] Here the Quadratic Almost Ideal Demand System (QUAIDS) is used.

The budget share (w_i) equations for QUAIDS is given by

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{X}{a(p)}\right) + \frac{\lambda_i}{b(p)}\left\{\ln\left(\frac{X}{a(p)}\right)\right\}^2. \tag{5}$$

Here p_j, $a(p)$ and X are prices, a price index and nominal expenditures respectively, and all the Greek letters represent parameters to be estimated. The QUAIDS gives a theoretical justification for empirically observed non-linear Engel curves. It has the flexibility of non-linear Engel curves while retaining integrability (Jones and Mazzi, 1996). In addition, it has the same degree of price flexibility as AIDS (the Almost Ideal Demand System); it is as close to linearity as theoretical considerations allow, nests the AIDS within it and introduces only few additional parameters (Banks *et al.*, 1997). The QUAIDS is a rank-three demand system with a high degree of similarity to AIDS; the extensive empirical application of the latter is an additional reason for increasing the popularity of the former (for details, see Banks *et al.*, 1997).

An issue in the estimation of demand systems is how to handle endogenous fertility choices. One possible alternative is to structurally include preferences on children into the demand system. This is made difficult in a number of ways. First, because of genetic ties and emotional attachments, preferences over children are likely very different to those on goods. Second, children can be considered as durable consumption goods; durable goods are not covered here. Third, children are investment as well as consumption goods. Fourth, price of children is not readily available. The alternative followed here is to use fixed effects estimates to control for endogeneity bias as fertility choices are part of the stable preferences of households.

Before estimating the demand system, the classification of goods into groups has to be justified using the concept of separability. The next section presents tests for preference separability.

3. Separability in Preferences

Hicks' (1946) composite commodity theorem can be used as a basis for grouping commodities. The composite commodity theorem states that if prices of a group of commodities move in proportion to each other, they can be treated as a single good. The empirical importance of this theorem—sometimes referred to as Hicksian separability—to group commodities is limited since prices of commodities considered to be "closely related" to each other generally fluctuate in different directions (Deaton and Muellbauer, 1980a).

In most empirical studies, the idea behind grouping of commodities is weak separability (sometimes called functional separability (Varian, 1992)). If weak separability holds, preferences over commodities grouped together will be

[6]Deaton and Muellbauer (1980a), Pollak and Wales (1992) and Sadoulet and de Janvry (1995) are three among the large number of references on demand systems.

independent of the quantities of goods in other groups. Suppose q_1 represents the vector of commodities in one group and all the remaining commodities are classified as q. Weak separability implies

(6) $$(q_1, q) \succ (q_1', q) \Leftrightarrow (q_1, q') \succ (q_1', q').$$

This means that if q_1 is preferred to q_1' for some choice of goods, it will be preferred to the choice of all other goods (Varian, 1992). In this case, sub-utility functions for each group of commodities exist. If all goods are partitioned into n groups and the groups are weakly separable in preferences, utility, u, can be represented as,

(7) $$u = f[v_1(q_1), v_2(q_2), \ldots, v_n(q_n)].$$

$v_i(q_i)$ is the sub-utility function for group i (q_i is the vector of commodities in group i) and f is an increasing function in the arguments (Deaton and Muellbauer, 1980a, 1980b). If q_i^j represents the individual commodity j in group i and if the utility function can be written in the above form—are weakly separable—then the subgroup demands for all j belonging to group i can be written as

(8) $$q_i^j = g_i(x_i, p_i)$$

where x_i is the total expenditure on commodities in group i and p_i is a vector of the prices of commodities in the same group. This implies that the demand for a good in a group is not affected by expenditures and prices of goods in other groups.

The existence of sub-group demand functions (weak separability) imposes restrictions on price and budget elasticities of commodities that are found in separable groups. Let e_{ij}^* stand for the compensated price elasticity between goods i and j, e_i and w_i for the budget elasticity and budget share of good i respectively. For two weakly separable commodity groups G and H (where $G \neq H$), there exists a scalar λ_{GH} such that (Baccouche and Laisney, 1991)

(9) $$e_{ij}^* = \lambda_{GH} e_i e_j w_j \quad \forall i \in G, \forall j \in H.$$

The scalar λ_{GH} is the same for all commodity couples in the two weakly separable groups. These restrictions on elasticities are used to test for weak separability. Baccouche and Laisney (1991) propose a method for testing for separability using the approximate structure of a matrix K with elements (which corresponds to λ_{GH} in equation (9) above):

(10) $$k_{ij} = \frac{e_{ij}^*}{e_i e_j w_j}.$$

No constraint is imposed on the main diagonal elements of matrix K since weak separability does not restrict the value of k_{ii} in any way. With n commodity groups, the information from the separability restriction is contained in the

$\frac{n(n-1)}{2}$ non-diagonal elements. In other words, the restriction implies that the k_{ij}'s for commodities in two weakly separable groups are equal except for random errors.

Demand equations for 21 goods belonging to nine commodity groups are estimated to derive the elasticities required to compute the k_{ij}'s. The nine commodity groups with the corresponding individual goods are:[7]

(1) Food: *teff*, wheat, sorghum, barley, maize and *enset*[8]
(2) Non-food: soap/powdered soap, matches and dry cells
(3) Alcohol: *tella*, *teji*, *areke*, cigarettes and *chat*[9]
(4) Coffee: coffee and soft drinks
(5) Transport cost
(6) Men's clothes
(7) Women's clothes
(8) Boys' clothes
(9) Girls' clothes

Household size, total household expenditure, prices of all commodities and dummies for survey rounds are the independent variables included in all the 21 demand equations. The double logarithmic form is used to simplify the computation of elasticities. Using the value of household assets and size of cultivated land as instruments, the Durbin–Wu–Hausman test for endogeneity of total expenditures is conducted. From the 21 equations, total expenditures are exogenous only in seven of the cases: sorghum, barley, *teji*, *areke*, cigarettes, *chat* and soft drinks. Predicted values are used in the 14 demand equations where total expenditure is endogenous. Due to censoring, the demand equations are estimated by Tobit. In addition, robust (Huber–White) estimators are used.

In total there are 441 (21*21) k_{ij}'s. Only the lower triangular part of the K matrix is used. This drops $210\left(\frac{21*(21-1)}{2}\right)$ of the k_{ij}'s. The elasticity restrictions do not constrain the main diagonal elements in any way, implying that the 21 k_{ii}'s are not required. In addition, there is no restriction imposed on commodities in the same group; 29 k_{ij}'s are, for pairs of goods, found in the same commodity group. After deducting all these, 181 relevant k_{ij}'s remain.

Let K^* be the vector of the 181 k_{ij}'s ranked in an ascending order and K^*_α its α-th coordinate. The mapping of $\alpha \rightarrow K^*_\alpha$ is presented in Figure 1.

[7]The diet of rural inhabitants in Ethiopia is predominantly based on grains/cereals. For example, the consumption of fruits in rural areas is virtually zero. Since sufficient information on consumption of livestock products and vegetables is not available, these are not included. No consumer durables are considered; "transportation cost" covers money paid for buses and other means of travel rather than for purchase of private cars or similar forms of transport. Housing costs are not included. There are no housing markets in rural areas of Ethiopia. People have their own houses (mostly huts); selling and buying houses as well as renting are extremely rare.

[8]*Teff* (*Eragrostis abyssinica*) is a type of cereal used as a staple food in many parts of the country—especially in the urban areas—and is indigenous to Ethiopia. *Enset* is the root of the false banana tree and is used as staple food in some parts of the country, particularly in the south.

[9]*Tella*, *teji* and *areke* are home-brewed alcoholic drinks, the alcoholic content of the latter two being higher than the first. *Chat* is a mildly intoxicating plant extensively used in some of the survey sites. It is also an important source of cash income for farmers cultivating it.

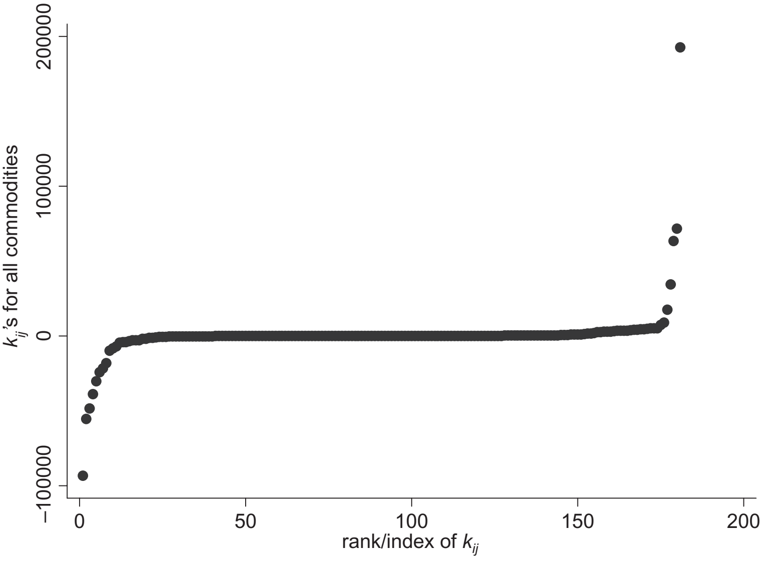

Figure 1. All Relevant k_{ij}'s in Ascending Order

The main idea of the test is to examine if there are clusters/steps corresponding to separable goods in this mapping. To do that, large vertical gaps and corresponding plateaus ("critical values," $\lambda(\delta)$) in the plot are identified; since we do not expect all k_{ij}'s of separable commodity groups to be exactly equal to each other, "tolerances" ($\varepsilon(\delta)$) indicating by how much K_α^* is allowed to vary around critical values are computed (see Figure 2 with only mid-value k_{ij}'s that shows possible clusters/steps; due to the scale it is difficult to see this in Figure 1). Details of the test procedure are given below.

For $\alpha > 1$, let $\delta_\alpha = K_\alpha^* - K_{\alpha-1}^*$ and call δ_β^* the vector of distinct values of δ_α ranked in descending order (β indexing the order); hence, δ_β^* contains the gaps between consecutive k_{ij}'s ordered from the highest to the lowest. The idea is to split the vector of K^* at points where δ_α is greater than a chosen threshold δ_β^*. After the split, the "critical values" (λ_j) identifying the clusters/plateaus and "tolerances" (ε_j) are computed in the following way.

(11)
$$\lambda_j = \frac{\left(\overline{b_j} + \underline{b_j}\right)}{2}.$$
$$\varepsilon_j = \frac{\left(\overline{b_j} - \underline{b_j}\right)}{2}$$

Here, $\overline{b_j}$ and $\underline{b_j}$ stand for the maximum and minimum k_{ij}'s in the specific cluster/plateau.

In our case, the differences between the 181 computed k_{ij}'s give 180 distinct values. Using the mean difference, the k_{ij}'s are divided into 17 groups. The formulae

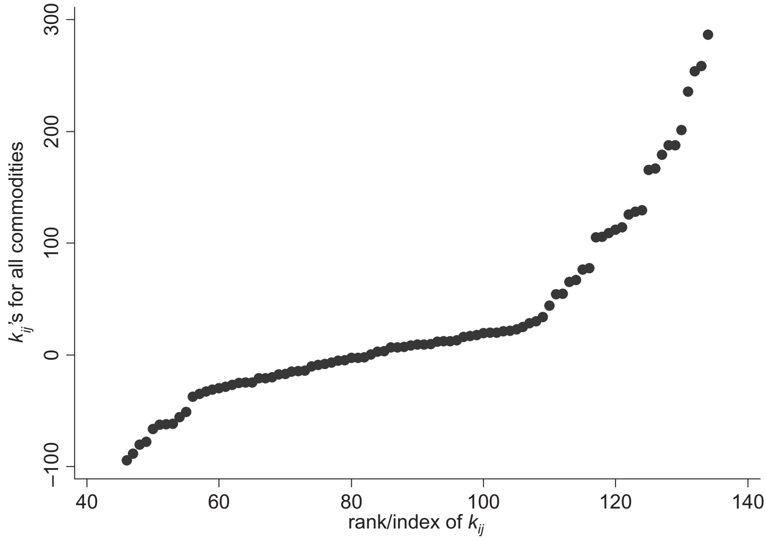

Figure 2. A Sub-Set of k_{ij}'s in Ascending Order

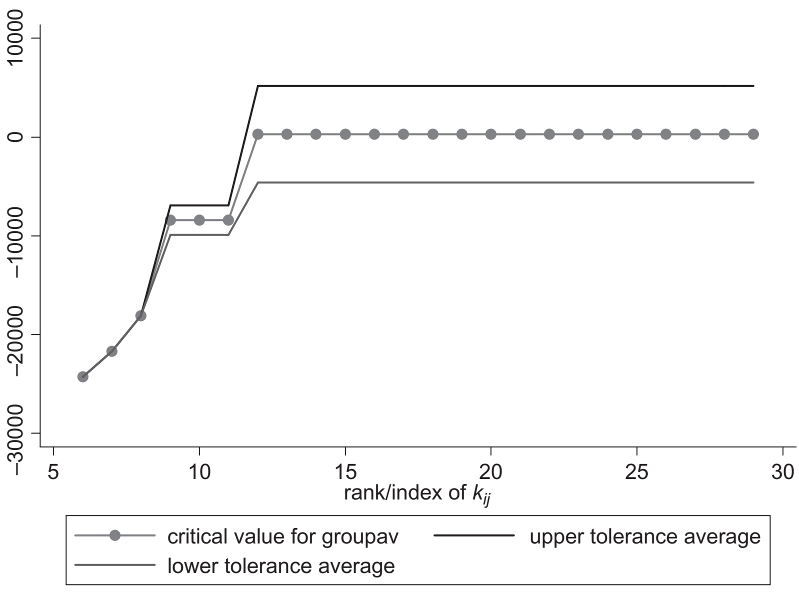

Figure 3. Critical Values and Tolerances $\left(\delta_\beta^* = \text{mean difference}\right)$

in (11) are used to compute the critical values (λ_j) and the corresponding tolerances (ε_j) for each group. Figure 3 presents the critical values and tolerances for some values of k_{ij}'s when mean difference is used (i.e. $\delta_\beta^* = \text{mean of differences}$); the steps/plateaus with the critical values are discernible.

TABLE 1

Distribution of k_{ij}'s (mean difference as tolerance, δ^*_β)

		δ^*_β = Mean Difference	
Commodity Combination	Max	1	2
Food–non-food	18	2	17 (87.5%)
Food–alcohol	30	7	23 (76.7%)
Food–coffee	12	4	9 (75.0%)
Food–transport	6	1	6 (100.0%)
Food–men's clothes	6	1	6 (100.0%)
Food–women's clothes	6	1	6 (100.0%)
Food–boys' clothes	6	1	6 (100.0%)
Food–girls' clothes	6	1	6 (100.0%)
Non-food–alcohol	15	3	13 (86.7%)
Non-food–coffee	6	1	6 (100.0%)
Non-food–transport	3	1	6 (100.0%)
Non-food–men's clothes	3	1	6 (100.0%)
Non-food–women's clothes	3	1	6 (100.0%)
Non-food–boys' clothes	3	1	6 (100.0%)
Non-food–girls' clothes	3	1	6 (100.0%)
Alcohol–coffee	10	6	5 (50.0%)
Alcohol–transport	5	1	5 (100.0%)
Alcohol–men's clothes	5	1	5 (100.0%)
Alcohol–women's clothes	5	1	5 (100.0%)
Alcohol–boys' clothes	5	1	5 (100.0%)
Alcohol–girls' clothes	5	1	5 (100.0%)
Coffee–transport	2	1	2 (100.0%)
Coffee–men's clothes	2	1	2 (100.0%)
Coffee–women's clothes	2	1	2 (100.0%)
Coffee–boys' clothes	2	1	2 (100.0%)
Coffee–girl's clothes	2	1	2 (100.0%)

Notes: The column with "max" gives the maximum possible number of clusters, i.e. if each k_{ij} falls into distinct clusters. Column "1" indicates the number of clusters into which the relevant k_{ij}'s fall; if all ratios fall into only one group, there is strong support for weak separability. Column "2" gives the numbers (percentages) of k_{ij}'s that fall into the largest group; if the percentages are 100%, there is strong support for separability.

The next step is to examine where the k_{ij}'s for pairs of goods in the different commodity groups fall; for commodities found in two weakly separable groups, the k_{ij}'s are expected to be in the same cluster. Table 1 summarizes the results for those groups with more than one commodity.

In 21 of the 26 cases, all the relevant k_{ij}'s fall in one cluster/plateau, supporting the assumption of weak separability between our commodity groups.[10]

The next section presents tests for demographic separability.

4. Demographic Separability

Excluding food and non-food, the remaining seven commodity groups are consumed only by some members of households. Alcohol, coffee and transport are consumed by adults (both men and women); the remaining four groups are clothes

[10]An alternative procedure using hierarchical cluster analysis is given in the appendix.

(including fabrics, shoes, etc) used by men, women, boys and girls. This section presents tests for separability of the goods from respective demographic groups of households. The tests employed follow Deaton (1988) and Deaton *et al.* (1989).

If good i is an adult good—in other words, is separable from children—its demand function can be written as

$$p_i q_i = f[\phi(X, n_a, n_c), n_a]. \tag{12}$$

While p, q and X are price, quantity and total expenditure, n_a and n_c stand for demographic characteristics of adults and children respectively. The number of household members in four demographic groups—males and females in the age ranges 0–16 and >16—is used. Children's characteristics affect the demand for adult goods only through $\phi(.)$. Two cases of preferences that generate this type of demand are cost separability and weak separability of the utility function. In the latter case, the utility function appears as (see Deaton *et al.*, 1989 for details):

$$u = u[v(q_a, n_a), q - q_a, n_c] \tag{13}$$

where q_a stands for the amount of adult goods, n_i for demographic characteristics of i (a = adults and c = children) and $q - q_a$ stands for all commodities except adult goods. This weak separability in the utility function implies the existence of sub-group demand functions for the good. For adult good i:

$$q_i = f_i(x_a, p_a, n_a) \tag{14}$$

where x_a is total expenditure on adult goods and p_a is the price vector of adult goods. In other words, the demographic characteristics related to children are not significant in directly affecting the demand for adult goods. This is the basis for the test of demographic separability. The following demand equations are estimated for testing demographic separability:

$$p_i q_i = b_o + \sum b_{ij} p_j + b_{1i} \ln X_a + \sum c_{ij} n_r + \sum e_{ij} d_i + v_i \tag{15}$$

where X_a is the total expenditure on adult goods, p_j is the prices of the commodities in that group, n_r is the number of people in the r-th demographic group, d_i represents other variables and v_i is a randomly distributed error term. If the commodity in question is an adult good, a test of demographic separability from children entails whether or not the c_{ij} coefficients on the number of children are statistically significant. If they are not, the commodity is an adult good.

Equation (15) is estimated for the hypothesized adult and children goods by pooling the data for all the four rounds with dummy variables for the rounds. In addition to (log) prices,[11] (log) total expenditures on adult (children) goods and the number of people in the four age/sex categories (males and females in age groups 0–16 and >16), a dummy for primary education of the household head, a variable

[11]In Deaton *et al.* (1989) prices are not included in the regression because they use cross sectional data without price variation.

TABLE 2
Tests for Demographic Separability: F-Statistics for IV, Tobit and IV Fixed Effects Estimates

	IV Estimates		Tobit Estimates		IV Fixed Effects	
Commodity Group	Adults	Children	Adults	Children	Adults	Children
Coffee	NR	0.07	NR	0.13	NR	1.62
Transport	NR	3.69	NR	2.61	NR	1.97
Alcohol	NR	4.15*	NR	1.79	NR	0.49
Men's clothes	NR	2.41	NR	2.45	NR	3.31
Women's clothes	NR	1.85	NR	0.31	NR	0.41
Boys' clothes	0.13	NR	23.84**	NR	0.14	NR
Girls' clothes	1.38	NR	28.40**	NR	4.99*	NR

Notes: F-statistics are given for the hypothesis that the relevant coefficients are jointly zero. NR, not relevant. **Significant at 1%; *Significant at 5%.

reflecting proximity of the survey site to an urban area[12] and dummies for female-headed households are included.

One problem in the estimation of (15) is the endogeneity of total expenditure on adult (or children) goods. To address this, instrumental variable estimation (IV) is applied using total expenditure as an instrument. In addition, for mitigating the problem of censoring, a second round of Tobit estimates, with predicted values of adult or children expenditures, are used. For adult goods, the significance of the coefficients on the number of children with ages less than or equal to 16 years is tested. For goods consumed by children, the significance of coefficients on the number of household members over the age of 16 is tested. The results from the IV and Tobit estimates are given in Table 2.

From the five adult commodities one F-statistic is significant in the IV estimation; "alcohol" fails to pass the test of demographic separability from children.[13] The results from the Tobits indicate that all the adult goods pass the test. The IV results probably are biased as a result of the censoring (zero consumption levels) of alcohol consumption.

Clothes for boys and girls are hypothesized to be demographically separable from adults. But while the coefficients for the IV estimates are statistically insignificant, those from the Tobits are highly significant. This casts doubt on the separability of boys' and girls' clothes from adults. This is probably due to the fact that changes in the number of adults have an effect not only on real incomes but also on household decision making. Hence, "demographic separability" of children from adult goods and of adults from children's goods are likely not symmetrical.

As indicated, the test of demographic separability is complicated by the possibility that children may directly affect the demand for adult goods instead of indirectly through the income effect. For instance, families with more children may

[12]This variable is computed by dividing the population of the nearest town by its distance from the survey site. While the population indicates the size of the nearest big market, distance is a rough measure of its accessibility for inhabitants of the village. The influence of urban areas on the demand for commodities is expected to be significant both by affecting tastes of households as well as the availability of goods.

[13]"Transport" is also statistically significant at the 10 percent level.

decrease consumption of cigarettes not only because of the income effect but also due to the concern for the health of children. It is reasonable to assume that these taste parameters are constant over time (are fixed effects) as preference stability is assumed in most economic analysis. The panel data give us an opportunity to estimate household-level fixed effects. The last two columns of Table 2 give the F-statistics for the instrumental variable household-level fixed effects estimates. All five F-statistics for adult goods are not statistically significant at conventional levels.[14] This reinforces the results from previous estimates—particularly from the Tobits—supporting that the adult goods considered here are demographically separable from those of children.

In contrast, the F-values for children's goods are very different in the household-level fixed effects estimation than in the Tobits. Specifically, the F-statistic for boys' clothes is no longer significant and that for girls' clothes is significant only at 5 percent (1 percent in the case of Tobits). This implies that direct substitution between number of adults in the household and expenditure on observable children's goods is important; when controlling for preferences of households, the effect of number of adults on the demand for children's clothes almost disappears.

The estimation of the demand system is discussed in the next section.

5. Estimation of the Demand System

As indicated in the introduction, panel data from four rounds of the Ethiopian Rural Household Survey (ERHS) between 1994 and 1997 are used. The total monthly household expenditure consists of four different categories: expenditure on non-food items, household consumables, and food, and consumption from own production. Purchases of food include expenditures on food eaten outside and bulk purchases of cereals and pulses. From non-food expenditures the following items were excluded, either because they are lumpy or are of a very irregular nature or are not part of consumption expenditure: expenditures on building materials, ceremonial expenses, contributions to a person, taxes and levies, compensation or penalty, involuntary contributions and medical and education expenditures to members of other households.

An important component of food consumption is consumption of own produced food due to the semi-subsistence nature of rural households in Ethiopia. Own consumption is included into food consumption valued at median local prices—or unit values if price information is not available. The diet of rural inhabitants in Ethiopia is predominantly based on grains/cereals. For example, the consumption of fruits in rural areas is virtually zero. Since sufficient information on consumption of livestock products and vegetables is not available, these are not covered. With the dominance of cereals, not much will be missed. In the demand system, no consumer durables are included; "transportation" covers money paid for buses and other means of travel rather than for purchase of private cars or similar forms of transport. Housing costs are not included. There are no housing markets in rural areas of Ethiopia. People have their own houses (mostly huts);

[14]But the one for men's clothes becomes significant at 10 percent.

selling and buying houses as well as renting are extremely rare. The consumption of households is classified into the nine commodity groups listed in Section 3.

Unlike most previous studies using the outlay equivalent method, this paper incorporates prices into the analysis. Price variations are important for two reasons. First, the survey sites are located in different regions of the country, some very far from others. Price variations between them are significant. Second, temporal variations are also important since data from four periods are used.

For the estimation of the demand equations two types of price indices are required. First, a general price index is needed to deflate current expenditures. Second, price indexes of the commodity groups should be estimated—note that groups are constituted of individual commodities.

One possible alternative for a general price index is to use the national consumer price index or a rural price index computed at the national level. Since the first includes prices of commodities in urban areas, it is not appropriate for our purpose. In the second case, an index corresponding to the survey period is not available. In addition, how far the prices collected represent national variation tally with the prices in the survey sites is not clear. For these reasons, the alternative of computing a general price index from the data on local prices is opted for. Stone's price index is used here. The logarithm of Stone's price index equals $\Sigma w_k \ln p_k$, where w_k is the expenditure share of commodity k, and p_k its price (Deaton and Muellbauer, 1980a, 1980b).

For computing the general price index, 24 commodities covering around 70 percent of the expenditure of all households were selected. The logarithm of the local prices for each commodity is weighted by the percentage of expenditure on that good made in the particular site to total expenditure of all households. This general price index for the first round is used to deflate the expenditures in the other rounds.

In computing the prices of the nine commodity groups, a similar procedure is used. The prices of the commodities vary from site to site. The percentages of expenditure on particular commodities constituting a group to the total expenditure on that group are used as weights in computing the local price of the commodity groups. Since there are nine commodity groups, fifteen sites and four different rounds, the above procedure involves computing 540 local prices.

After dropping some households that lack crucial information, 1,403 households remained with full information for all the four survey periods, giving a total of 5,612 observations.

The Quadratic Almost Ideal System (QUAIDS) augmented with demographic composition of households and some other variables is estimated to derive the elasticities and the outlay equivalent ratios.

Budget shares of the nine commodity groups are regressed on the number of people in four demographic groups, n_r (number of males and females aged 0–16 and >16),[15] log of prices, $\ln p_{ij}$, log of total real expenditures, $\ln\left(\frac{X}{a(p)}\right)$ and its

[15]To simplify estimations, the demographic variables, n_r, and the additional variables, z_k, are incorporated into the demand system additively. More sophisticated ways of including demographic variables lead to non-linear estimation. For demographic translation and scaling, see Pollak and Wales (1992).

square, a variable reflecting the proximity of survey sites to urban areas and dummies for female-headed households, household heads with primary education and survey rounds. Dummies for female-headed households and primary education of the household head are included as taste shifters. The proximity of villages to urban areas is expected to influence both the tastes of households and the availability of some goods (particularly manufactured goods). The dummy variables for the survey rounds are included to control for possible seasonal effects. Formally, the demand equations have the following form:

$$(16)\quad w_i = \alpha_i + \sum \delta_{ir} n_r + \sum \gamma_{ij} \ln p_j + \beta_i \ln \frac{X}{a(p)} + \frac{\lambda_i}{b(p)} \left(\ln \frac{X}{a(p)} \right)^2 + \sum \sigma_{ik} z_k + \varepsilon_i .$$

The Greek letters represent parameters to be estimated, $b(p)$ is the Cobb–Douglas price aggregator, $\prod p_i^{\beta_i}$. It can be computed by using the estimates of the β_i-parameters after which λ_i's can be recovered. While z_k represents the remaining variables, ε_i stands for the error term in the i-th equation ($i = 1, \ldots, 9$).

Durbin–Wu–Hausman tests are conducted to examine the endogeneity of total expenditures. Except in the cases of coffee and alcohol, the t-statistics are significant at the 1 percent level, implying that total expenditures are correlated with the error terms of the demand equations. To mitigate this problem, three-stage-least-squares (3SLS) with real value of household assets and the size of cultivated land as instruments are used.

For consistency with utility theory, the following restrictions are imposed.

$$(17)\qquad \sum_j \gamma_{ij} = 0; \quad \sum_i \alpha_i = 1; \quad \sum_i \gamma_{ij} = \sum_i \beta_i = \sum_i \lambda_i = 0; \quad \gamma_{ij} = \gamma_{ji}.$$

The first restriction is due to homogeneity in prices. The second set of restrictions follow from the adding up property. The final equality reflects symmetry in price effects. Due to the adding-up property the demand equations become linearly dependent and one of them must be dropped (in our case, the non-food demand equation). Both unrestricted and restricted demand systems are estimated, but only the results from the latter are reported. Imposing the above restrictions in estimating the demand system results in running 3SLS with 36 constraints: eight homogeneity and 28 cross-price restrictions. Simple 3SLS, 3SLS with random and fixed effects regressions are run; Hausman specification tests support the fixed effects estimates.[16] The chi-square values for these tests are given in Table 3. All the chi-square statistics are significant at 1 percent.

The main results from the estimated demand equations are summarized in the next section.

[16]Even though the fixed effects estimates help to control for endogeneity they may provide biased estimated due to measurement error (Deaton, 1997). This article presents the simple and random effects estimated side-by-side with the fixed estimates to have a comparative view.

TABLE 3

Hausman Specification Tests for Random and Fixed Effects Models

Equations	Chi-Square Statistics	Equations	Chi-Square Statistics
Food	490.76	Men's clothes	97.79
Coffee	806.87	Women's clothes	117.75
Transport	131.86	Boys' clothes	123.31
Alcohol	146.15	Girls' clothes	74.15

Notes: The null hypothesis is that the difference between the random and fixed effects coefficients are not significantly different from each other. All chi-square statistics are significant at 1%.

TABLE 4

Budget Elasticities

	Budget Elasticity		
Commodity Group	3SLS	3SLS Random Effects	3SLS Fixed Effects
Food	1.037 (0.018)	1.016 (0.018)	0.977 (0.019)
Coffee	0.576 (0.069)	0.651 (0.069)	0.778 (0.073)
Transport	1.162 (0.103)	1.053 (0.103)	0.926 (0.109)
Alcohol	0.802 (0.113)	0.853 (0.113)	1.238 (0.120)
Men's clothes	1.272 (0.121)	1.363 (0.121)	1.332 (0.128)
Women's clothes	0.694 (0.102)	0.868 (0.102)	1.077 (0.108)
Boys' clothes	1.175 (0.136)	1.078 (0.136)	1.215 (0.145)
Girls' clothes	1.019 (0.144)	0.766 (0.144)	0.732 (0.153)

Notes: Standard errors are computed by the delta-method and are given in parentheses. All budget elasticities are significant at 1%.

6. Main Results

Changes in income, prices and demographic composition affect household decisions, resulting in reallocations of expenditures; budget and price elasticities and the outlay equivalent ratios respectively capture these effects.

6.1. *Budget Elasticities*

The budget elasticity, ξ_i, from the QUAIDS equals,

$$\xi_i = 1 + \frac{\beta_i}{w_i} + \frac{2\lambda_i}{b(p)}\frac{1}{w_i}\ln\left(\frac{X}{a(p)}\right). \tag{18}$$

Table 4 presents the budget elasticities from the simple, random and fixed effects 3SLS computed at mean values. All the budget elasticities are positive as expected and are significant at the 1 percent level.

The main results are:

- In all the estimates, men's and boys' clothes are income elastic while coffee is inelastic. The latter result indicates that coffee is a necessity for most rural households, very much reflecting the strong coffee-drinking tradition of the country.

- In all cases, men's clothes rank first, mostly followed by boys' clothes. On the other hand, girls' clothes are very inelastic (particularly for the random and fixed effects estimates).
- Tests for equality of the 3SLS and the fixed effects elasticities are rejected at the 1 percent level of significance for all the commodities. Controlling for fixed characteristics (including preferences) of households significantly affects the values of the parameters.
- In all the three estimations, the budget elasticity of men's clothes is higher than that of women's clothes, and that of boys' is higher than girls' at the 1 percent level of significance, reiterating that clothes for males are more budget elastic than clothes for females inside households.
- The budget elasticity for food is around 1 (unitary elastic), indicating that food expenditure proportionally adjusts to income changes.

The higher budget elasticities of men's and boys' clothes as compared to women's and girls' clothes imply that male members of households absorb the effect of income changes more than their female counterparts. In times when household income is increasing, this will bring proportionally more benefit to males; but during contractions they will be hurt proportionally more. The elasticities inform us on the variation in demand when income changes, but do not provide information on the current level of consumption. For instance, even though the budget elasticities of goods consumed by male members are high, the total amount consumed by males could be significantly higher than that consumed by females. To have a rough idea, the household per capita expenditures on men's, women's, boys' and girls' clothes are computed; the corresponding figures are Birr 5.56, 6.49, 3.91 and 3.40 per capita per month respectively. The figures indicate that while per capita expenditure on women's clothes is higher than on men's clothes, that on boys' is slightly higher than girls'. This roughly shows that the higher budget elasticities of clothes for males are not accompanied by higher per capita expenditures.

The next sub-section examines price elasticities.

6.2. *Price Elasticities*

Own-price elasticity for QUAIDS is computed by using the formula,

$$\xi_{ii} = -1 + \frac{\gamma_{ii}}{w_i} - \beta_i - \frac{\beta_i \lambda_i}{b(p) w_i}\left[\ln\left(\frac{X}{a(p)}\right)\right]^2 - \frac{2\lambda_i}{b(p)}\ln\left(\frac{X}{a(p)}\right). \tag{19}$$

The uncompensated own-price elasticities, computed at mean values, are given in Table 5. Except for coffee and girls' clothes, all the other elasticities are significant at the 1 percent level. While all the elasticities from the random effects model are negative, only coffee for fixed effects and coffee and alcohol for simple 3SLS are positive, i.e. from the 24 elasticities, only three are positive, one of which is not significantly different from zero.

The main results from the estimated own-price elasticities are:

- Own price elasticities computed by the three estimations are statistically significantly different from each other, pointing to the importance of controlling for fixed effects.

TABLE 5
Own-Price Elasticities

Commodity Groups	Own-Price Elasticity		
	3SLS	3SLS Random Effects	3SLS Fixed Effects
Food	–1.00 (0.071)*	–1.032 (0.016)*	–1.064 (0.036)*
Coffee	0.322 (0.192)	–0.355 (0.076)*	1.162 (0.077)*
Transport	–0.777 (0.198)*	–0.835 (0.076)*	–0.519 (0.081)*
Alcohol	2.159 (0.288)*	–0.578 (0.134)*	–0.564 (0.123)*
Men's clothes	–0.857 (0.115)*	–0.855 (0.063)*	–0.563 (0.060)*
Women's clothes	–1.178 (0.084)*	–1.248 (0.058)*	–1.224 (0.100)*
Boys' clothes	–0.934 (0.200)*	–1.009 (0.055)*	–0.997 (0.008)*
Girls' clothes	–0.039 (0.337)	–0.824 (0.042)*	–0.661 (0.077)*

Notes: Elasticities are from restricted estimations. Standard errors are given in parentheses and are computed by the delta-method. *Significant at 1%.

- While food is elastic in all three estimations, transport, and men's and girls' clothes are inelastic. The high elasticity of food is partly explained by its large budget share. The importance of income and price effects in the nutritional status of rural households is highlighted by the high budget and price elasticities.
- The mean own-price elasticities of goods consumed by males (men's and boys' clothes) and females (women's and girls' clothes) are not significantly different from each other. However, in all three estimations, the elasticities for women's clothes are higher than for men's clothes; in addition, the demand for boys' clothes is more elastic than for girls' clothes.[17] In all cases, these differences are significant at the 1 percent level.

The own-price elasticities give a different picture from the ones from budget elasticities. Own-price elasticities indicate that households adjust to price variations by changing expenditures on women's and boys' clothes more than on men's and girls' clothes. In other terms, price changes affect the consumption of women and boys more than that of men and girls.

The patterns in the budget and own-price elasticities indicate that households respond to income and price changes in a more complicated manner than usually presumed. While income shocks are more absorbed by expenditures on males than females, price changes are more absorbed by women and boys. Girls are more protected from both shocks compared to boys.

The effect of demographic changes is examined in the next section using the outlay equivalent ratios.

6.3. *Outlay Equivalent Ratios*

The outlay equivalent ratio expresses the change in expenditure due to a change in demographic characteristics as a ratio to the marginal propensity to expend normalized by the per capita expenditure of households. For QUAIDS, the outlay equivalent ratio for demographic group r and commodity i, π_{ir}, is:

[17]The price elasticities for girls' clothes are not significantly different from zero in the simple 3SLS estimation. This does not affect our conclusion that boys' clothes are more elastic than girls' clothes.

$$\pi_{ir} = \frac{n\delta_{ir}}{w_i + \beta_i + 2\frac{\lambda_i}{b(p)}\ln\left(\frac{X}{a(p)}\right)}. \tag{20}$$

The ratios are computed by using the parameter estimates of the demand system and mean sample values. Since the outlay equivalent ratios are non-linear functions of the parameters, their standard errors are estimated by the delta method (Deaton *et al.*, 1989; Greene, 1990).

Comparing the magnitudes of the outlay equivalent ratios is used to examine by how much households adjust their expenditures to additional people in the relevant demographic group. For instance, if the outlay equivalent ratios for adult goods are higher in absolute values for boys than for girls, this implies that the household budget is allocated in favor of boys. The outlay equivalent ratios for adult goods computed from the simple, random and fixed effects 3SLS estimations are given in Table 6. Most of the ratios are negative but are not statistically significant. Apparently no general pattern emerges when looking at the individual outlay equivalent ratios.

In addition to the insignificance of many outlay equivalent ratios, the differences in their magnitudes make one suspicious of whether demographic separability holds; if demographic separability holds, the ratios tend to be equal, except for random errors.

In Section 4, tests were conducted and the overall results support demographic separability. Deaton *et al.* (1989) and Deaton (1988) also suggested another test procedure for demographic separability using outlay equivalent ratios.[18]

As indicated, if demographic separability holds, the adult equivalent ratios will be equal, except for random errors; in other words, the deviations of the π_{ir}'s from their mean for all goods separable to the demographic group r will be zero. If there are v different goods for which separability with demographic group r is tested, the following must hold (see Deaton, 1988; Deaton *et al.*, 1989):

$$\hat{\Delta}_{ir} = \hat{\pi}_{ir} - \frac{\sum_{j}^{v}\hat{\pi}_{jr}}{v} = 0. \tag{21}$$

If the $\hat{\pi}_{ir}$'s are equal, the $\hat{\Delta}_{ir}$'s should be zero apart from estimation error. Let $\hat{\Delta}_{ir}$ be the v-vector of the discrepancies for demographic group r and $\hat{\pi}_{ir}$ the corresponding outlay equivalent ratios. If A is a matrix $\left(I - \frac{i'i}{v}\right)$ for identify matrix I and a vector of units i the discrepancy in (21) can be expressed as $\Delta_r = A\pi_r$. A general formula for the variance of the outlay equivalent ratios is

$$\left(V_{\pi_r}\right)_{ij} = E\left((\hat{\pi}_{ir} - \pi_{ir})(\hat{\pi}_{jr} - \pi_{jr})\right) = J'_{ir}(X'X)^{-1}J_{jr}\sigma_{ij} \tag{22}$$

[18]We are conducting this alternative test here instead of in Section 4 because we require the outlay equivalent ratios estimated from the demand system.

TABLE 6

Outlay Equivalent Ratios

Commodity Group	3SLS Female 0–16	3SLS Male 0–16	3SLS Random Effects Female 0–16	3SLS Random Effects Male 0–16	3SLS Fixed Effects Female 0–16	3SLS Fixed Effects Male 0–16
Coffee	0.031 (0.172)	–0.018 (0.165)	–0.098 (0.212)	–0.031 (0.211)	0.185 (0.246)	0.111 (0.266)
Transport	0.002 (0.138)	0.051 (0.133)	–0.114 (0.210)	0.054 (0.210)	–0.391 (0.346)	–0.354 (0.373)
Alcohol	0.473 (0.265)[10]	–0.579 (0.246)[1]	0.575 (0.450)	–0.483 (0.330)	0.548 (0.454)	–0.335 (0.406)
Men's clothes	–0.539 (0.125)[1]	–0.489 (0.120)[1]	–0.604 (0.185)[1]	–0.483 (0.179)[5]	–0.874 (0.279)[1]	–0.422 (0.299)[20]
Women's clothes	–0.039 (0.208)	–0.084 (0.200)	–0.171 (0.239)	–0.389 (0.208)	–0.111 (0.005)[1]	–0.813 (0.354)[5]

Notes: All the ratios are from restricted estimation. [1,5,10,20] = Significant at 1%, 5%, 10% and 20% respectively. Standard errors are computed by the delta method.

TABLE 7

Wald Tests for Demographic Separability

	Females 0–16 Years				Males 0–16 Years			
Coffee	√				√			
Transport	√	√	√		√	√	√	
Alcohol	√	√			√	√		
Men's clothes	√	√	√	√	√	√	√	√
Women's clothes	√	√	√	√	√	√	√	√
Wald statistics	12.5231	11.1624	8.6968	8.1728	17.4656	4.5748	3.2820	1.8324

Note: Outlay equivalent ratios from the 3SLS fixed effects estimation are used. √ indicates commodities included in the separability test. χ (4) = 13.28, χ (3) = 11.34, χ (2) = 9.21, χ (1) = 6.63 all at the 1% level.

where $J_{ir} = \dfrac{\partial \pi_{ir}}{\partial \beta_i}$, the partial derivative of the outlay equivalent ratios with respect to the parameter estimates of the demand equations and σ_{ij} is the estimated covariance between the residuals in the i-th and j-th demand equations. This can be estimated by using the residuals from the respective equations, e_i, in the following formula:

$$\hat{\sigma}_{ij} = (n-k)^{-1} e_i' e_j . \tag{23}$$

Under the null hypothesis, the variance of the discrepancies, $V\left(\hat{\Delta}_r\right)$, is $A' V_{\pi_r} A$; if the true Δ_r is zero, the following Wald statistic is asymptotically distributed as χ^2 with $v - 1$ degrees of freedom:

$$W_r = \hat{\pi}_r' A' \left(A' V_{\pi_r} A\right)^{-1} A \hat{\pi}_r . \tag{24}$$

Comparison of the computed with tabulated statistics indicates whether the null hypothesis—demographic separability—holds.

Using the outlay equivalent ratios from the 3SLS fixed effects in Table 6, the Wald statistics for different combinations of adult goods are computed (see Table 7). The tests for different combinations are conducted because even if the whole set of adult goods is not separable, smaller sub-sets of the groups may be; this is the reason for considering different combinations of goods. Four different combinations are considered: all five adult goods; four goods (without coffee, because both ratios are positive in the fixed effects); three goods (without coffee and alcohol, because one ratio for alcohol is positive); and a group with only men's and women's clothes (transport is dropped because ratios are not significant). The results in Table 7 indicate that at the 1 percent level most of the combinations pass the test of demographic separability (except for the groups with five commodities for male children and with two commodities for female children).[19] This result

[19]This is rather surprising because the two commodities, men's and women's clothes, are part of the other groups that pass the test.

TABLE 8
95% CONFIDENCE INTERVALS FOR OUTLAY EQUIVALENT RATIOS

	Females 0–16 Years		Males 0–16 Years	
	Lower Value	Upper Value	Lower Value	Upper Value
Coffee	–0.2972	0.6672	–0.4104	0.6324
Transport	–1.0692	0.2872	–1.0851	0.3771
Alcohol	–0.3418	1.4378	–1.1308	0.4608
Men's clothes	–1.4208	–0.3272	–1.0080	0.1640
Women's clothes	–0.1208	–0.1012	–1.5068	–0.1192
Mean for five	–0.6500	0.3928	–1.0282	0.3030
Mean for four (without coffee)	–0.7382	0.3242	–1.1827	0.2207

generally supports the previous tests. Hence, the apparent lack of consistent pattern in the outlay equivalent ratios is not likely due to failure in demographic separability.

The results from the Wald tests imply that generally the outlay equivalent ratios of adult goods for a demographic group are equal to each other except for errors. This in turn implies that the ratios can be used to assess the effect of additional female and male children on household expenditures as long as the estimation errors (standard errors) are taken into account. Considering the above five, four, three and two groups of adult goods, the average outlay equivalent ratios for girls and boys, respectively, are: –0.129 and –0.363, –0.207 and –0.481, –0.459 and –0.530 and –0.493 and –0.618. The mean ratios for boys are consistently higher than that for girls. In addition, the standard deviations of the ratios for girls are consistently higher than that of boys. The mean figures indicate that the latter are favored. The 95 percent confidence intervals for the outlay equivalent ratios are computed to examine if similar results re-emerge when taking the standard errors (see Table 8).

The lower and upper values of the 95 percent confidence intervals for most of the individual commodity groups as well as the average figures indicate that the distribution of the outlay equivalent ratios for boys are generally shifted to the left compared to girls. Unless there are systematic errors that have increased the values for girls and decreased those for boys—which is unlikely—this implies the ratios for boys are drawn from a distribution whose central mass is to the left of girls. This supports the previous conclusion that boys are favored in the allocation of household expenditures.

The results in sub-sections 6.1–6.3 outline the separate effects of income, price and demographic changes on household expenditures. In reality the three changes may happen at the same time. The next sub-section discusses the combined effects of income, price and demographic changes.

6.4. *Combined Effects of Income, Price and Demographic Changes*

Income, prices and demographic changes may simultaneously happen. For example, a boy may be born at a time when prices and incomes are changing. The unified framework provided by the demand system helps to understand the

TABLE 9

Mean Monthly Expenditure on Clothes (in Birr)

Goods	Mean Expenditure	Standard Error	95% Confidence Interval	
Men's clothes	7.64	0.2443	7.16	8.11
Women's clothes	8.18	0.2238	7.74	8.62
Boys' clothes	6.14	0.2007	5.75	6.53
Girls' clothes	5.44	0.1883	5.07	5.81

combined effects. In this sub-section, a scenario with a combination of changes is presented to illustrate how intra-household expenditures adjust for these changes.

The effects of income, price and demographic changes will depend on initial amounts of expenditures. Since elasticity measures the *percentage* change in expenditure, the absolute changes in expenditures are positively associated to the initial amounts. Table 9 gives the total expenditures on adult and children's clothes per household. All pair-wise t-tests for differences between the expenditures indicate that differences between the mean values are significant. On average, households expend more on women's clothes, followed by men's, boys' and girls'.

Changes in demand following changes in income and prices are captured by the budget and price elasticities respectively. These have two components. First, the demand for a commodity changes if its own price changes (captured by own-price elasticity). Second, the demand for a commodity changes if the prices of other commodities change (captured by cross-price elasticities). Hence, in conditions where both prices and income are changing, the effects are captured by the sum of all the above effects.

The outlay equivalent ratios indicate that generally households adjust expenditures in favor of boys as compared to girls; the amount of adult expenditure sacrificed for a boy is larger than for a girl. In addition, in absolute terms, girls are allocated a smaller amount than boys in terms of clothing. Both these findings imply that girls are discriminated against. All studies using the outlay equivalent method stop here without considering the effects of income and price changes. The latter effects may not necessarily affect household expenditures in the same way as the demographic changes. Hence, an important aspect that should be incorporated is income and price effects.

Even though both the outlay equivalent ratios as well as the mean expenditure on clothes indicate the unfavorable position of girls, the budget and price elasticities show that girls are better protected from income and price fluctuations—budget and price elasticity of girls' clothes are low. Particularly in periods of falling income and rising prices, this could be an advantage.

To illustrate the above idea, let us use a specific example. Suppose income fell by 1 percent and food price rose by 1 percent—in times of food shortage, this is generally expected to happen. The fall in income will decrease demand. The increase in food price will affect demand either positively or negatively—through cross-price elasticities—depending on whether the goods are substitutes or complements. The decreases in demand for men's, women's, boys' and girls' clothes for the above changes are –1.30 percent, –1.07 percent, –1.32 percent and –0.93 percent respectively; the effect on girls is the least.

The findings indicate that studies which only looked at demographic changes (using outlay equivalent ratios) tell only part of the—and maybe misleading—story. If demographic groups that are discriminated in one aspect are protected from other risks, the results from the studies using only outlay equivalent ratios will be misleading. This underscores the importance of integrating direct income and price effects in studies that look at effects of demographic changes.

7. Conclusion

The empirical results show that Ethiopian rural households respond to price, income and demographic changes in a more complicated manner than is usually presumed. Demographic groups absorbing most of the impacts differ for different types of changes. Changes in household income affect males (men and boys) more than females (women and girls). On the other hand, changes in price affect women and boys more than men and girls. In addition, adjustments in household expenditures to demographic changes imply that boys are favored relative to girls. However, the overall position of boys and girls in the household will depend not only on the outlay equivalent ratios but also on the effects of changes in household income and prices. These findings imply that households distribute risks among different demographic groups rather than only one group absorbing all. The findings also indicate that studies that only looked at demographic changes (using outlay equivalent ratios) tell only part of the story.

The more complicated response of Ethiopian rural households to income, price and demographic changes can be a result of risk pooling inside households. It may also be a result of the decision-making process and a reflection of the spheres of control by different demographic groups of the household. But an examination of these causes is quite beyond the scope of this article.

Appendix: Hierarchical Cluster Analysis of Weak Separability

To examine if the k_{ij}'s for goods in two commodity groups are approximately equal to each other, hierarchical cluster analysis can be used (using SPSS). First a distance measure—squared Euclidean distance—between the k_{ij}'s is computed. The squared Euclidean distance, *SEUCLID*, between variables x and y is

$$SEUCLID(x, y) = \sum (x_i - y_i)^2.$$

Second, the nearest clusters are combined. The procedure again computes the distance between the newly created clusters and joins the nearest ones. This process continues until all the items are grouped into one. Hence, at the end of the iteration, a hierarchy of clusters starting from each item constituting a group (in our case 181 clusters) to one cluster where all items are lumped together is generated.

If the nine commodity groups are weakly separable from each other and if the corresponding k_{ij}'s for each couple of commodity groups are in a cluster, there will be 36 groups/clusters (9C2). This is the maximum number of clusters expected if the commodity groups are separable. But the separability restriction does not necessarily imply that the clusters for each couple of commodity groups must be

TABLE A1

Tests for Weak Separability: Hierarchical Cluster Analysis

Commodity Combination	10 Clusters	20 Clusters	30 Clusters	36 Clusters
Food–non-food	18 (100.0%)	15 (83.3%)	13 (72.2%)	9 (50.0%)
Food–alcohol	23 (76.7%)	10 (33.3%)	5 (16.7%)	5 (16.7%)
Food–coffee	9 (75.0%)	7 (58.3%)	7 (58.3%)	6 (50.0%)
Food–transport	6 (100.0%)	6 (100.0%)	6 (100.0%)	6 (100.0%)
Food–men's clothes	6 (100.0%)	6 (100.0%)	6 (100.0%)	5 (83.3%)
Food–women's clothes	6 (100.0%)	6 (100.0%)	6 (100.0%)	6 (100.0%)
Food–boys' clothes	6 (100.0%)	6 (100.0%)	6 (100.0%)	6 (100.0%)
Food–girls' clothes	6 (100.0%)	6 (100.0%)	6 (100.0%)	5 (83.3%)
Non-food–alcohol	14 (93.3%)	9 (60.0%)	7 (46.7%)	4 (26.7%)
Non-food–coffee	6 (100%)	4 (66.7%)	3 (50.0%)	3 (50.0%)
Non-food–transport	3 (100%)	3 (100%)	3 (100%)	3 (100%)
Non-food–men's clothes	3 (100%)	3 (100%)	3 (100%)	3 (100%)
Non-food–women's clothes	3 (100%)	3 (100%)	3 (100%)	3 (100%)
Non-food–boys' clothes	3 (100%)	3 (100%)	3 (100%)	3 (100%)
Non-food–girls' clothes	3 (100%)	3 (100%)	3 (100%)	3 (100%)
Alcohol–coffee	5 (50.0%)	4 (40.0%)	4 (40.0%)	3 (30.0%)
Alcohol–transport	5 (100%)	4 (80.0%)	4 (80.0%)	4 (80.0%)
Alcohol–men's clothes	5 (100%)	5 (100%)	3 (60.0%)	3 (60.0%)
Alcohol–women's clothes	5 (100%)	5 (100%)	4 (80.0%)	3 (60.0%)
Alcohol–boys' clothes	5 (100%)	4 (80.0%)	3 (60.0%)	3 (60.0%)
Alcohol–girls' clothes	5 (100%)	3 (60.0%)	3 (60.0%)	3 (60.0%)
Coffee–transport	2 (100%)	5 (100%)	2 (100%)	2 (100%)
Coffee–men's clothes	2 (100%)	5 (100%)	2 (100%)	2 (100%)
Coffee–women's clothes	2 (100%)	5 (100%)	2 (100%)	2 (100%)
Coffee–boys' clothes	2 (100%)	5 (100%)	2 (100%)	2 (100%)
Coffee–girl's clothes	2 (100%)	5 (100%)	2 (100%)	2 (100%)
Transport–men's clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Transport–women's clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Transport–boys' clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Transport–girls' clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Men's–women's clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Men's–boys' clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Men's–girls' clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Women's–boys' clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Women's–girls' clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Boys'–girls' clothes	1 (100%)	1 (100%)	1 (100%)	1 (100%)

Note: The figures in the table indicate the number (percentage) of k_{ij}'s for a commodity group combination found in one cluster when all k_{ij}'s are classified into 10, 20, 30 or 36 clusters.

unique; hence, the k_{ij}'s can cluster in less than 36 groups. To see how much the pattern depends on the number of groups considered, the classification of the k_{ij}'s into 3–36 clusters are considered. From all these values, Table A1 presents the number (percentage) of k_{ij}'s for a commodity group combination found in one cluster when all k_{ij}'s are classified into 10, 20, 30 or 36 clusters.

All the k_{ij}'s for the 36 commodity group couples would be found in one group for each couple if all the nine commodity groups are weakly separable from each other (which may or may not be the same for different commodity group couples). In other words, all the percentages in Table A1 would become 100 percent. Due to random disturbances such an exact result is not expected. In 23 cases all the k_{ij}'s for commodity group couples are found in the same cluster, even in the case with the maximum 36 clusters for nine commodity groups (64 percent of the cases); the percentage is 50 percent ignoring commodity group couples with only one commodity. This increases to 32 cases with 10 clusters (89 percent); the percentage drops to 85 percent when ignoring groups with one commodity. In the latter case, only four commodity pairs (food–alcohol, food–coffee, non-food–alcohol and alcohol–coffee) have their k_{ij}'s in more than one cluster; but in all four cases more than 50 percent of the k_{ij}'s are found in one cluster, the alcohol–coffee being 93 percent. A similar picture also emerges when considering 20 or 30 clusters; in the former, 75 percent, and in the latter, 69 percent from the 36 commodity group couples have all their k_{ij}'s in one group. At most only three commodity couples have less than 50 percent of their k_{ij}'s in one cluster.

The results above indicate that the separability restrictions imposed are "approximately" satisfied for our commodity groupings. Since the restriction does not guide us on how many clusters to consider—on the threshold values for classifying the k_{ij}'s—the question can only be answered approximately. Coupled with the results from the previous test, the classification seems to be done across weakly separable commodities.

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