Intra-household Distribution of Expenditures in Rural Ethiopia: A Demand Systems Approach

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Abstract

This paper examines the combined effects of changes in prices, income and demographic composition on adult and young, male and female members of households. The recently developed Quadratic Almost Ideal Demand System (QUAIDS) is used since a demand system provides a unified framework for analysing the combined effects in a systematic fashion. The 'outlay equivalent method', which was used with single demand equations in previous studies, is married to the demand system literature. Underlying preference structures for classifying goods into different groups is also examined by conducting alternative tests of separability in preferences. Panel/longitudinal data are used helping to control for household level heterogeneity. The empirical results show that Ethiopian rural households respond to price, income and demographic changes in a more complicated manner than usually assumed; demographic groups absorbing most of the impact differ for different types of changes. Changes in household income affect male members of households (men and boys) more than female members (women and girls). On the other hand, changes in price affect women and boys more than men and girls. In addition, adjustments in household expenditure due to demographic changes imply that boys are favoured relative to girls. But the overall position of boys and girls in the household depends not only on the 'outlay equivalent ratios' but also on the effects of changes in household income and prices as determined by budget and price elasticities. These findings show that households distribute risks among different demographic groups rather than only one group absorbing all shocks. The findings indicate that studies that only looked at the 'outlay equivalent ratios' tell only part of the story.

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1. Introduction

The importance of intra-household distribution of resources in affecting individual welfare is now well recognized in economics and other social sciences. Extensive literature has shown that the welfare of individuals depends not only on total household income but also on the pattern of its allocation. Expenditures made by households may be biased towards particular members. The study of these issues 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. Information on goods consumed only by some members (exclusive goods) is used to examine intra-household distribution of expenditures. Goods consumed by all household members do not provide much information on intra-household distribution unless the amount consumed by each individual is observed (i.e., unless they are assignable goods).

One method that uses information on exclusive goods (particularly goods consumed by adults) and examines how changes in the demographic composition of households affect the allocation of expenditures is the outlay equivalent method developed by Deaton (1988) and Deaton, et al. (1989). Discrimination between boys and girls in the allocation of household expenditures can be examined by estimating the demand functions for goods consumed only by adults. The decrease in expenditure on adult goods with an additional boy or girl measures the consumption parents forego (an income effect); this effect is captured by the outlay equivalent ratios. Systematic changes in the expenditure on adult goods for additional boys or girls are indications of gender discrimination among children.

The neglect of price and income effects is an important limitation of studies that used the outlay equivalent method. The demand for goods is affected by changes in prices and household income in addition to demographic changes. This paper examines the combined effects of changes in prices, income and demographic composition. Adjustments in the consumption of exclusive goods for changes in prices, income and demographic composition reveal aspects of the 'allocation rule' inside households. A demand system provides a unified framework for analysing this combined effect in a systematic fashion. The recently developed Quadratic Almost Ideal Demand System (QUAIDS) (Banks, Blundell and Lewbel, 1997) is used here. QUAIDS is an extension of the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980b).[1]

In addition to marrying the outlay equivalent method to recent developments in demand systems, the underlying preference structure for classifying goods into different groups is also examined. This is in contrast to most studies that arbitrarily group commodities. Alternative tests of separability in preferences are conducted.

This paper also handles some problems that are not adequately addressed in most previous work using the outlay equivalent method. In previous studies the outlay equivalent ratios are derived from single demand equations; here, as indicated above, a complete demand system is estimated. Unlike most other studies using the outlay equivalent method, instrumental variables are used to mitigate the problem of endogeneity in expenditures. Prices of commodities varying both across regions as well as time are incorporated; previous studies depend on cross sectional data without price variations. Finally, the panel nature of the data helps us to control for household level effects (household heterogeneity).

The empirical results show that Ethiopian rural households respond to price, income and demographic changes in a more complicated manner than usually assumed; demographic groups absorbing most of the impact differ for different types of changes. Changes in household income affect male members of households (men and boys) more than female members (women and girls). On the other hand, changes in price affect women and boys more than men and girls. In addition, adjustments in household expenditure due to demographic changes imply that boys are favoured relative to girls. 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 as

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

determined by budget and price elasticities. For instance, even though the outlay equivalent ratios imply discrimination against girls as compared to boys, when household income is falling and prices are rising girls suffer less than boys.

These findings show that households distribute risks among different demographic groups rather than only one group absorbing all shocks. Responses to income, price and demographic changes are more complicated than usually assumed. In addition, the findings indicate that studies that only looked at demographic changes (using outlay equivalent ratios) probably tell only part of the story. If demographic groups discriminated in one fashion (through the adjustment in adult expenditures) are protected from risks of income and price fluctuations the results from these studies will be misleading. This underscores the importance of integrating income and price effects in studies that look at the impacts of demographic changes.

This paper is structured in the following way. A discussion of the relevant demand systems is given in Section 2. Section 3 outlines the outlay equivalent method. A brief description of variables used in the analysis is given in Section 4. Tests for separability in preferences first by using sub-group demand functions and then cluster analysis are given in Section 5. Section 6 presents tests for demographic separability. While estimation of the demand system is described in Section 7, all main empirical results are given in Section 8. Section 9 concludes.

2. Demand Systems

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 analysing the demand for a single commodity, it is beneficial to estimate a demand system if sufficient information is available. In addition to properly taking interactions between commodity demands into account, the estimation of a demand system consistently relates demand 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 (the adding-up property, Slutsky symmetry are cases in point). Recognition of these advantages led to the development of many demand systems. From the many in the literature, only the Almost Ideal Demand System (AIDS) and the Quadratic Almost Ideal Demand System (QUAIDS) are discussed here.[2]

The AIDS is one of the most popular demand systems. It is derived from a utility function specified as a second-order approximation of any arbitrary utility function. In addition to its generality, the fact that it satisfies the axioms of choice and can be aggregated over consumers without imposing parallel Engel curves (like the linear expenditure system) are two of the advantages that made it popular (Deaton and Muellbauer, 1980b). Deaton and Muellbauer (1980b) started from a cost (expenditure) function that allows exact aggregation over consumers (i.e., market demand can be represented as the outcome of the decision of a representative consumer). If u represents utility and p prices, one class of exactly aggregable cost function is,

$$\ln c(u,p) = (1-u)\ln\{a(p)\} + u\ln\{b(p)\} \qquad \ldots (1)$$

a(p) and *b(p)* are functions of prices that can take the following specific flexible functional forms,

$$\ln a(p) = \alpha_o + \sum_k \alpha_k \ln p_k + \frac{1}{2}\sum_k\sum_j \gamma_{kj}^* \ln p_k \ln p_j \qquad \ldots(2)$$

$$\ln b(p) = \ln a(p) + \beta_o \prod\nolimits_k p_k^{\beta_k} \qquad \ldots(3)$$

Substituting for *a(p)* and *b(p)* into the cost function gives

$$\ln c(u,p) = \alpha_o + \sum_k \alpha_k \ln p_k + \frac{1}{2}\sum_k\sum_j \gamma_{kj}^* \ln p_k \ln p_j + u\beta_o \prod p_k^{\beta_k} \qquad \ldots(4)$$

All the Greek letters (α_i, β_i and γ_{ij}^*) are parameters. The derivative of a cost (expenditure) function with respect to prices (by Shephard's Lemma) gives the (Hicksian) demand functions. The logarithmic derivation of the cost (expenditure) function with respect to prices gives the budget share of commodities, w_i.

$$\frac{\partial c(u,p)}{\partial p_i} = q_i \rightarrow \frac{\partial c(u,p)}{\partial p_i}\frac{p_i}{c(u,p)} = q_i \frac{p_i}{c(u,p)} \rightarrow \frac{\partial \ln c(u,p)}{\partial \ln p_i} = \frac{p_i q_i}{c(u,p)} = w_i \ldots(5)$$

The logarithmic derivative of the cost function with respect to price is

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i u \beta_o \prod p_k^{\beta_k} \qquad \ldots(6)$$

[2] 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.

where $\gamma_{ij} = \frac{1}{2}(\gamma_{ij}^{*} + \gamma_{ji}^{*})$.

Under the assumption of utility maximization, the total expenditure, *X*, is equal to cost, *c(u, p)*. Hence, substitute *X* for *c(u, p)* in the cost function and solve for *u* as a function of *X* and *p*; that gives the indirect utility function. If the indirect utility function is used to substitute for *u* in the budget share equations above, the budget share will be expressed as a function of prices, *p*, and total expenditure, *X*. In other words, the (Marshallian) demand equations for the AIDS in budget share form are derived.

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln\{\frac{X}{P}\} \qquad \ldots(7)$$

In the above equation, *P* stands for a price index given by

$$\ln P = \alpha_o + \sum_k \alpha_k \ln p_k + \frac{1}{2}\sum_j \sum_k \gamma_{kj} \ln p_k \ln p_j \qquad \ldots(8)$$

The restrictions below follow from utility theory:

$$\sum_{i=1}^{n} \alpha_i = 1; \sum_{i=1}^{n} \gamma_{ij} = 0; \sum_{i=1}^{n} \beta_i = 0; \sum_j \gamma_{ij} = 0; \gamma_{ij} = \gamma_{ji} \qquad \ldots(9)$$

These restrictions imply adding-up (budget shares add-up to one, i.e., Σw_i=1), homogeneity of degree zero in prices and total expenditure and Slutsky symmetry (the compensated cross-price effects are equal).

An attractive aspect of the AIDS is its simplicity. Replacing the price index, *ln P*, by a simpler approximation gives a demand function linear in prices and total expenditure. Deaton and Muellbauer (1980a) suggested using Stone's price index, the logarithm of which is given by $\Sigma w_k \ln p_k$ where w_k are budget shares (used as weights).

In the empirical estimation of the Engel curves of some commodities, non-linearity appeared to be important. For instance, Banks, et al. (1997) show that the Engel curves for clothing and alcohol in the UK are non-linear in the logarithm of expenditures. Since the AIDS demand curves are linear in the logarithm of expenditures, they are not appropriate for the estimation of these Engel curves, even though they perform well for some items like food. Banks, et al. (1997) developed the Quadratic Almost Ideal Demand System (QUAIDS) based on this empirical reason as well as on theoretical grounds. In the following paragraphs, a brief summary of the theoretical arguments for the QUAIDS is given.

The empirical evidence suggests the following general form of Engel equations:

$$w_i = A_i(p) + B_i(p)\ln x + C_i(p)g(x) \qquad \ldots(10)$$

for goods i = 1, 2, ..., n

where p is a vector of prices, x is real expenditure, $\left(\dfrac{X}{a(p)}\right)$, and $A_i(p)$, $B_i(p)$, $C_i(p)$ and $g(x)$ are differentiable functions. The last term in the above equation allows for the non-linearity in Engel curves.

The rank of a demand system is defined as the rank of the matrix constituted of the coefficients of the Engel equations. For instance, the rank of the demand system in (10) equals the rank of the N by 3 matrix of Engel equation coefficients, the matrix with the rows $[A_i(p):B_i(p):C_i(p)]$. Since this matrix has three columns, the maximum possible rank is three.

A demand system linear in functions of expenditure is known as an exactly aggregable demand system because the same type of equation can be used for aggregate data as well as for micro data. Gorman (1981) has proved that the maximum possible rank of an exactly aggregable demand system is 3. This implies that there is not much to be gained by adding additional terms on the above Engel equation because as long as the system is linear in expenditures the additional columns in the matrix of coefficients will be linearly dependent on the others.

There are two alternatives for all exactly aggregable demand systems in the form of (10). Either the rank of the Engel curve is less than 3 implying that coefficients are linearly dependent on each other, i.e.,

$$C_i(p) = d(p)B_i(p) \qquad \ldots(11)$$

for some function $d(p)$ or the rank is 3. Gorman's proof indicates that it cannot be more than 3. If the rank is 3, the indirect utility function corresponding to this demand system becomes

$$\ln V = \left\{ \left(\frac{\ln X - \ln a(p)}{b(p)} \right)^{-1} + \lambda(p) \right\}^{-1} \qquad \ldots(12)$$

The term, $\frac{\ln X = \ln a(p)}{b(p)}$, is the indirect utility function of a demand system with budget shares linear in log of total expenditure (known as PIGLOG demand system, which includes AIDS). $\lambda(p)$ is a differentiable, homogeneous function of degree zero in prices (see Theorem 1 in Banks, et al. (1997)). By using Roy's identity, the budget share equations for this indirect utility function can be derived.

$$w_i = \frac{\partial \ln a(p)}{\partial \ln p_i} + \frac{\partial \ln b(p)}{\partial \ln p_i} + \frac{\partial \lambda}{\partial \ln p_i}\frac{1}{b(p)}(\ln x)^2 \qquad \ldots(13)$$

These budget share equations are quadratic in the logarithm of real expenditure, *ln x = ln X - ln a(p)*. Banks, et al. (1997) showed that all rank 3 exactly aggregable utility-derived demand systems in the form of (10) have $g(x) = (\ln x)^2$(see corollary 1 in Banks, et al., (1997)).

The AIDS has an indirect utility function given by (12) with the $\lambda(p)$ set to zero, and as seen above (see equation (8)), *ln a(p)* has the translog form,

$$\ln a(p) = \alpha_o + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \qquad \ldots(14)$$

and *b(p)* is the Cobb-Douglas price aggregator

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \qquad \ldots(15)$$

The indirect utility function (12) is defined with

$$\lambda(p) = \sum_{i=1}^{n} \lambda_i \ln p_i \qquad \ldots(16)$$

where $\sum_{i=1}^{n} \lambda_i = 0$. The indirect utility function (12), and the functions (14), (15) and (16) together define QUAIDS. Using equation (13), the budget share equations become

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{X}{a(p)}\right) + \frac{\lambda_i}{b(p)}\left\{\ln\left(\frac{X}{a(p)}\right)\right\}^2 \qquad \ldots(17)$$

The QUAIDS gives a theoretical justification for the empirically observed shapes of 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 (given by (7)), 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.

The next section outlines the outlay equivalent method.

3. The Outlay Equivalent Method

The theoretical foundations of the outlay equivalent method go back to the long-established literature on equivalence scales and the measurement of child costs. A study of the costs of children is an important link in the study of equivalent scales. When children are born, unless they come with some additional endowments like inheritance, the family budget must adjust in order to accommodate them. Given the same level of income, cut backs from some expenditure items or leisure is 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 and Rothbarth (1943) suggested different ways of measuring child costs.

For Engel, 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 must 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 focussing 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.

$$p_i q_i = f(X, A, Z, u) \qquad \ldots(18)$$

The demographic characteristics can be divided into those associated with adults,

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

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 now more people are using the same level of household expenditure 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

$$p_i q_i = f[\phi(X, A_a, A_c), A_a] \qquad \ldots(19)$$

The $\phi(.)$ function can be understood as representing the real income available to the household. Characteristics related to children affect the demand for adult goods only through the $\phi(.)$ function. Equation (19) summarises the condition Deaton, et al., (1989) termed demographic separability. Good i – the adult good - is demographically separable from demographic group c (children).

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}.

$$\pi_{ir} = \frac{\frac{\partial(p_i q_i)}{\partial n_r}}{\frac{\partial(p_i q_i)}{\partial X}} \frac{n}{X} \qquad \ldots(20)$$

If group r is demographically separable from commodity i, the ratios between the two marginal changes will be proportional to each other. Since the effect of a change in

[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.

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,

$$\frac{\partial(p_i q_i)}{\partial n_r} = \theta_r \frac{\partial(p_i q_i)}{\partial X} \qquad \ldots(21)$$

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

The above arguments can be presented in a slightly different way for testing demographic separability; the deviations of the π_{ir}'s from their mean for all goods separable to the demographic group r should be zero (except random variations). If there are v different goods for which separability with demographic group r is tested, the following must hold (see Deaton, et al. (1989) and Deaton (1988))

$$\hat{\Delta}_{ir} = \hat{\pi}_{ir} - \frac{\sum_{j}^{v} \hat{\pi}_{jr}}{v} = 0 \qquad \ldots(22)$$

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 (22) can be expressed as $\Delta_r = A\pi_r$. A general formula for the variance of the outlay equivalent ratios is

$$\left(V_{\pi_r}\right)_{ij} = E\left(\left(\hat{\pi}_{ir} - \pi_{ir}\right)\left(\hat{\pi}_{jr} - \pi_{jr}\right)\right) = J_{ir}'\left(X'X\right)^{-1} J_{jr}\sigma_{ij} \qquad \ldots(23)$$

where $J_{ir} = \frac{\partial \pi_{ir}}{\partial \beta_i}$, 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 ith and jth demand equations. This can be estimated by using the residuals from the respective equations, e_i, in the following formula,

$$\hat{\sigma}_{ij} = \left(n-k\right)^{-1} e_i' e_j \qquad \ldots(24)$$

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:

$$W_r = \hat{\pi}'_r A'\left(A'V_{\pi_r}A\right)^{-1} A\hat{\pi}_r \qquad \ldots(25)$$

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

The next section briefly describes the data and variables used in the analysis.

4. Data and Variables

In 1989, the International Food Policy Research Institute (IFPRI) (based in Washington D.C.) conducted a household survey in seven rural sites in Ethiopia covering around 600 households. The survey sites were: peasant associations around Debre Berhan and Dinki in northern Shewa (central Ethiopia), Korodegaga near the resort town of Sodere (south-east of Addis Ababa), Adele Keke near the town of Alemaya in Hararghe (east Ethiopia), Gara Godo in Wolaita, Domaa in Gamo and Beke Pond in Borana, Sidamo (all three in southern Ethiopia). IFPRI's research examined conditions in areas frequently affected by famine and evaluated food-for-work and other relief-related projects. Corresponding to the objective of the project, almost all the sites were located in famine vulnerable areas. In addition, the regional coverage of the project was restricted due to the civil war in the northern part of the country at the time. No village was selected particularly from the traditionally famine vulnerable areas of Tigrai and Wello in the north.

In 1994, the Department of Economics at Addis Ababa University and the Centre for the Study of African Economies (CSAE) at Oxford launched the Ethiopian Rural Household Survey (ERHS) covering around 1,500 households. Sida (Sweden) funded the survey. Three different rounds approximately spaced in four months interval to capture seasonal variations were conducted.[5]

Instead of starting anew, revisiting the sites surveyed by IFPRI in 1989 gave a chance to generate household panel data. From the seven survey sites that were covered by IFPRI, six were incorporated into the ERHS. Beke Pond in Borana was abandoned since most households were dislocated due to ethnic conflicts after 1989.

The ERHS aimed at gathering wider information on the main farming systems of the country in contrast to the limited objectives of the 1989 survey that focused on the impact of public works. This necessitated increasing the number of sites. First, richer rural areas of the country in different farming systems must be represented. Second, the northern part of the country, particularly regions traditionally affected by famine, should be included. There was no security problem after the end of the civil war in 1991 making fieldwork in the north possible.

Nine additional sites were added to the six IFPRI panel sites. Particular villages were selected from regions that typically represent the main farming systems of the country.[6] Employees of the Ministry of Agriculture with long practical experience were consulted in the selection of regions and particular survey villages.

Three northern peasant associations in the famine vulnerable regions of Tigrai and Wello were selected. While the two sites in Tigrai are Geblen and Haresaw, the village in Wello is Shumsheha located near the historic town of Lalibela. Yetmen in Gojam (in north-western Ethiopia) and Sirbana Godeti (around 60 km southeast of Addis Ababa in Adaa *woreda*[7]) were chosen as samples from rich *teff*[8](and wheat) producing areas. *Teff* is one of the most important cereals consumed in Ethiopia commanding a relatively high price and is a vital source of cash income for many farmers. Imdibir, in Gurage (southern Ethiopia), is a typical village in an *enset*[9]-farming system. A significant proportion of the farmers in the south are dependent on *enset* as staple food. In some regions of southern Ethiopia (particularly in Kembata and Wolaita), household heads work in far off plantations for a significant part of the year (temporary migration). Aze Deboa in Kembata was included to gather information on households participating in long-distance migration. Adado near the town of Dilla in Sidamo (southern Ethiopia) is located in a rich

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[5] IFPRI also participated in the first round of the survey covering half of the sites.

[6] Nomadic areas are not covered by the ERHS.

[7] *Woreda* is one of the lowest administrative sub-divisions of Ethiopia; below the *woreda* are peasant and urban dwellers' associations.

[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.

[9] *Enset* is the root of false banana tree and is used as staple food in some parts of the country, particularly in the south.

coffee growing area. Coffee is by far the most important export of the country. The inclusion of a site heavily dependent on coffee will also give a chance to monitor the effects of export related policy decisions on the welfare of households. Finally, Terufe Kechema near the town of Shashemene was included as a rich peasant association with a mixed cropping system (*enset* with cereals and a variety of other crops).

While the selection of the villages purposively captured the main farming systems in the country, that of households from these villages was done randomly. The number of sampled households in each village is proportional to the population size of the *woreda* in which they are located.

Two more rounds were conducted in 1997 and 1999/2000, both funded by USAID, as follow-up of the surveys in 1994/95. While the 1997 survey (done in collaboration with IFPRI) focused on intra-household issues, the latest emphasized innovations and adoptions. Around 1,500 households were covered by these surveys and attrition rate is very low (between 1994 and 1997 it is around 5%). This paper uses data from four survey rounds conducted in 1994/95 and 1997.

The ERHS collected community-level information in addition to household data. This includes information on local prices, traditional measurement units and community level infrastructure (like education and health facilities). Other survey techniques (for example, participatory wealth ranking) were also employed to gather complementary information on the community level. Graduate students from the Sociology Department of Addis Ababa University prepared sociological profiles of the surveyed villages. These supplementary surveys have generated information on the community level that complement the data gathered from households. The combination of panel household surveys with community level information has created a rich data set that is unique not only for Ethiopia but also for Africa.

The overall sampling strategy can be characterised as stratified random sampling where farming systems are used for stratification. After the selection of the villages representing the main farming systems households in each village were selected randomly.

The total monthly expenditure (outlay) of households is constituted of four different categories as recorded in the survey questionnaires: expenditures on non-food items, household consumables, food and consumption from own production. The recall periods for these categories vary: four months for non-food expenditures, one month for household consumables and a week for food purchases and own consumption. Purchases of food include expenditures on food eaten outside and bulk purchases of cereals and pulses. The recall period for the bulk purchases of cereals and pulses is four months unlike the other food purchases. These figures were changed into monthly values.

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 own produced food due to the semi-subsistence nature of most rural households in Ethiopia. Median local market prices are used to value own consumption. In cases where no information is available on prices, median unit values are used. The goods purchased by the households are classified into nine groups. The classification particularly focuses on goods consumed only by some members of households (either consumed by males or females or are adult goods). The seven commodity groups are:

(1) Alcohol, *chat*[10] and cigarette/tobacco (henceforth referred to as 'alcohol')

(2) Coffee, soft drinks and *karibo*[11]('coffee')

(3) Transport and eating out ('transport')

(4) Men's clothes/shoes/fabric ('men's clothes')

(5) Women's clothes/shoes/fabric ('women's clothes')

(6) Boys' clothes/shoes/fabric ('boys' clothes') and

(7) Girls' clothes/shoes/fabric ('girls' clothes').

In addition to the seven groups, the rest of commodities consumed by households are classified into 'food' and 'non-food'. Alcohol, coffee and transport are hypothesised to be adult goods (used by both female and male adults). Male and female (either adult or child) members of households consume the remaining four groups of commodities.

Unlike most previous studies using the outlay equivalent method, this paper

[10] *Chat* is a mildly intoxicating plant extensively used in some of the survey sites (particularly in Adele Keke, Kersa). It is also an important source of cash income for farmers cultivating it.

[11] *Karibo* is home-brewed non-alcoholic drink.

incorporates prices into the analysis. Price variations are important because of 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, since data from four survey periods are used, temporal variations are also important.

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 the 'prices' of the commodity groups should be estimated - note that the eight commodity groups are constituted of many individual commodities.

One possible alternative for a general price index is to use the national consumer price index or one or another sort of a rural price index computed on the national level (by the Central Statistical Authority). 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 to 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. The general price index is Stone's price index. The logarithm of Stone's price index equals $\sum w_k \ln p_k$, where w_k is the expenditure share of commodity k and p_k its price (Deaton and Muellbauer, 1980a).

For computing the general price index, twenty-four commodities covering around 70% 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 eight 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 eight commodity groups, fifteen sites and four different rounds, the above procedure involves computing 480 local prices.

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

The first issue to be addressed in estimation is separability, both separability in preferences and demographic separability. First, the classification of commodities into the eight groups has to be justified. Second, the designation of some commodities as 'adult' goods has to be tested. The next section discusses the first problem.

5. 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. This form of separability between goods is sometimes referred to as Hicksian separability. Since prices of commodities considered to be 'closely related' generally fluctuate in different directions, the empirical importance of this theorem to group commodities is limited (see Deaton and Muellbauer, 1980a).

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

$$(q_1, q) \succ (q_1^{'}, q) \Leftrightarrow (q_1, q) \succ (q_1^{'}, q^{'}) \qquad \ldots(26)$$

This means if q_1 is preferred to q_1' for some choice of other 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 the commodities are partitioned into n groups and the commodity groups are weakly separable in preferences, utility, u, can be represented as,

$$u = f[v_1(q_1), v_2(q_2), \ldots, v_n(q_n)] \qquad \ldots(27)$$

$v_i(q_i)$ 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 (see Deaton and Muellbauer, 1980a). If q_i^j represents the individual commodity j in group i and if the utility function can be written in the above form, that is the commodities are weakly separable, then the subgroup demands for all j belonging to group i can be written as

$$q_i^j = g_i(x_i, p_i) \qquad \ldots(28)$$

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.[12]

Weak separability is closely related to the idea of two-stage budgeting. The budgeting process in households can be thought of as a two-stage task if groups of commodities are weakly separable from each other. In the first, households decide on the amount to be allocated on the broad groups of commodities; in the second stage they determine expenditures on individual goods in each group. After the group expenditure is determined, allocation within the group is affected only by information from the group; prices and expenditures on other groups of commodities are irrelevant for the allocation in a group. Probably, households in reality simplify their decision-making by using a procedure like two-stage budgeting; the allocation of total budget to particular goods at one stroke is a complicated task.

In addition to implying two-stage budgeting and the existence of sub-group demand functions, weak separability also 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 (see Baccouche and Laisney, 1991)

$$e_{ij}^* = \lambda_{GH}\, e_i\, e_j\, w_j \qquad \forall i \in G, \forall j \in H \qquad \ldots(29)$$

The existence of sub-group demand functions and the above restrictions on elasticities are both used to test whether or not the commodity groups identified above are weakly separable. The next two sub-sections will discuss the results from the tests.

5.1. Sub-group Demand Functions and Weak Separability

Weak separability implies, as stated above, the existence of sub-group demand functions. To test for the weak separability of the eight commodity groups, sub-group

[12] The assumption of weak separability between consumption and labour supply decisions is usually used to justify consumption analysis by ignoring the labour supply decisions of households.

demand functions similar to equation (28) are estimated. The purchased quantities[13] of the individual commodities in a group are regressed on the (log) total group expenditure, the (log) prices of all the commodities in that group, household size and dummies for survey rounds. If these regression equations are significant for most of the commodities in a group, that indicates they are weakly separable from commodities in other groups; the demand for the individual commodities in a group are determined by the expenditure and prices in the group.

Correlation between total group expenditure and the error terms is expected in the sub-group demand functions. Two-stage least squares, with value of household assets and size of cultivated land as instruments, are used. In addition, tobit estimates of the same sub-group demand functions are generated since the expenditures of a number of households on particular commodities are zero. The predicted value of total group expenditure using instruments is used in the tobits instead of the actual values. Robust estimates (Huber-White sandwich estimator) of standard errors are used to minimise possible loss of efficiency due to heteroscedasticity. The results are presented in Table 1.

Table 1: Tests for Weak Separability: Sub-Group Demand Functions

Items	Statistics		Items	Statistics	
	IV (F-statistics)	Tobit (Chi-square)		IV (F-statistics)	Tobit (Chi-sqaure)
	'Food'		*Areke*	10.12	393.41
Teff	50.95	975.13	Cigarettes	13.70	767.58
Barley	37.39	508.54	Chat	3.78	182.63
Wheat	24.09	357.35		**'Coffee'**	
Maize	53.56	1280.82	Coffee	24.93	285.4
Sorghum	34.06	628.63	Soft drinks	6.42	85.59
Enset	19.81	1160.29	*Karibo*	2.61	100.05
	'Non-food'			**'Others'**	
Omo	40.10	140.76	Transport	26.21	721.66
Dry cells	39.93	611.70	Men's cl.	57.01	429.92
Soap	30.33	244.04	Women's cl.	107.29	306.91
Matches	2.69	253.87	Boys' cl.	81.23	668.45
	'Alcohol'		Girls' cl.	83.27	629.43
Tella	5.42	482.72			
Teji	11.65	259.00			

Note: The F- and Chi-square statistics are for the significance of the demand equations. All statistics are significant at 1% level.

[13] Quantities are computed by dividing expenditures by the price indices for the group.

All the F- and Chi-square statistics for the regressions are significant at 1% level implying the existence of sub-group demand functions and weak separability among the nine groups. Hence, the classification of commodities into the nine groups is supported.

The next sub-section uses cluster analysis to test again for weak separability.

5.2. An Alternative Test for Weak Separability: Cluster Analysis

The alternative test for separability is based on Baccouche and Laisney (1991). Weak separability imposes restrictions on elasticities as presented in equation (29) above; the compensated (cross) price elasticities of the commodities in two weakly separable commodity groups will be a multiple of the income elasticities of the two goods, the budget share and a certain scalar, which is expected to be the same for all commodity couples in the two weakly separable groups. Following this idea, Baccouche and Laisney (1991) propose a method for testing separability using the approximate structure of matrix *K* with elements

$$k_{ij} = \frac{e_{ij}^*}{e_i e_j w_j} \qquad \ldots(30)$$

Matrix *K* is symmetric and no constraint is imposed on the diagonal elements 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. The k_{ij}'s are not expected to be exactly equal to each other due to random errors. They will be in a cluster (approximately equal to each other) if the commodity groups are weakly separable. Cluster analysis is directly applied on the k_{ij}'s computed from estimated demand equations slightly departing from the method suggested by Baccouche and Laisney (1991).

Demand equations for 21 goods belonging to the nine commodity groups are estimated to derive the elasticities required to compute the k_{ij}'s. The nine groups and the corresponding commodities are:

(1) Food: *teff*, wheat, sorghum, barley, maize and *enset*

(2) Non-food: powdered soap (*omo*), matches and dry cell

(3) Alcohol: *tella*, *teji*, *areke,*[14] cigarettes and *chat*

(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.[15]

The double logarithmic form is used to simplify the computation of elasticities; budget and price elasticities are the coefficients on total expenditure and prices respectively. The compensated price elasticity, e_{ij}^*, is computed from the uncompensated price elasticities by using the formula $e_{ij}^* = e_{ij} + w_j e_i$, where e_{ij}, w_j and e_i are the uncompensated price elasticity, the budget share and income elasticity respectively.

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 to mitigate the possible effects of heteroscedasticity.

After estimating the demand equations, the necessary elasticities and the k_{ij}'s are derived. For all the 21 commodities a total of 441 (21*21) k_{ij}'s are computed. Only the lower triangular part of the K matrix is used. This drops 210($\frac{21*(21-1)}{2}$) of the k_{ij}'s. The elasticity restriction does not constrain the values in the main diagonal of K in any

[14] *Tella, teji* and *areke* are home-brewed alcoholic drinks, the alcoholic content of the latter two being higher than the first.

[15] The demand equations estimated in this sub-section are different from the sub-group demand equations in the previous sub-section. In the previous sub-section, the dependent variables are quantities while here they are expenditures. In addition, while in the previous case commodity group expenditures were used, here total expenditure of households is employed.

way implying that the 21 diagonal k_{ii}'s are not required. In addition, there is no restriction imposed on commodities that are found in the same group; 29 k_{ij}'s are for couple of goods found in the same commodity group. 181 relevant k_{ij}'s remain after deducting all these.

To examine how the k_{ij}'s for goods in two commodity groups are approximately equal to each other, hierarchical cluster analysis is used.[16] This procedure first computes a distance measure of similarity/dissimilarity between the k_{ij}'s. From the many possible measures of distance, squared Euclidean distance is used. The squared Euclidean distance, *SEUCLID*, between variables *x* and *y* is

$$SEUCLID\ (x, y) = \sum(x_i - y_i)^2 \qquad \ldots(31)$$

After measuring the distance, hierarchical cluster analysis combines the nearest clusters. Again it re-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 provided.

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 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 three up to 36 clusters are considered. From all these values, Table 2 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.

[16] The hierarchical cluster analysis programme of the software SPSS is used.

Table 2: Tests for Weak Separability: Cluster Analysis

Commodity Combination	10 clusters	20 clusters	30 clusters	36 clusters
Food-nonfood	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 cl.	6 (100.0%)	6 (100.0%)	6 (100.0%)	5 (83.3%)
Food-women's cl.	6 (100.0%)	6 (100.0%)	6 (100.0%)	6 (100.0%)
Food-boys' cl.	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%)
Nonfood-alcohol	14 (93.3%)	9 (60.0%)	7 (46.7%)	4 (26.7%)
Nonfood-coffee	6(100%)	4(66.7%)	3(50.0%)	3(50.0%)
Nonfood-transport	3(100%)	3(100%)	3(100%)	3(100%)
Nonfood-men's cl.	3(100%)	3(100%)	3(100%)	3(100%)
Nonfood-women's c.	3(100%)	3(100%)	3(100%)	3(100%)
Nonfood-boys' cl.	3(100%)	3(100%)	3(100%)	3(100%)
Nonfood-girls' cl.	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 cl.	5(100%)	5(100%)	3(60.0%)	3(60.0%)
Alcohol-women’s cl.	5(100%)	5(100%)	4(80.0%)	3(60.0%)
Alcohol-boys’ cl.	5(100%)	4(80.0%)	3(60.0%)	3(60.0%)
Alcohol-girls’ cl.	5(100%)	3(60.0%)	3(60.0%)	3(60.0%)
Coffee-transport	2(100%)	5(100%)	2(100%)	2(100%)
Coffee-men’s cl.	2(100%)	5(100%)	2(100%)	2(100%)
Coffee-women’s cl.	2(100%)	5(100%)	2(100%)	2(100%)
Coffee-boys’ cl.	2(100%)	5(100%)	2(100%)	2(100%)
Coffee-girl’s cl.	2(100%)	5(100%)	2(100%)	2(100%)
Transport-men’s cl.	1(100%)	1(100%)	1(100%)	1(100%)
Transport-women’s	1(100%)	1(100%)	1(100%)	1(100%)
Transport-boys’ cl.	1(100%)	1(100%)	1(100%)	1(100%)
Transport-girls’ cl.	1(100%)	1(100%)	1(100%)	1(100%)
Men’s-women’s cl.	1(100%)	1(100%)	1(100%)	1(100%)
Men’s-boys’ cl.	1(100%)	1(100%)	1(100%)	1(100%)
Men’s-girls’ cl.	1(100%)	1(100%)	1(100%)	1(100%)
Women’s-boys’ cl.	1(100%)	1(100%)	1(100%)	1(100%)
Women’s-girls’ cl.	1(100%)	1(100%)	1(100%)	1(100%)
Boys’-girls’ cl.	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.

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 terms, all the percentages in Table 2 would become 100%. 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% of the cases); the percentage is 50% ignoring commodity group couples with only one commodity. This increases to 32 cases with 10 clusters (89%); the percentage drops to 85% when ignoring groups with one commodity. In the latter case, only four commodity couples (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% of the k_{ij}'s are found in one cluster, the alcohol-coffee being 93%. A similar picture also emerges when considering 20 or 30 clusters; in the former 75% and in the latter 69% 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% 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 impressionistically. Coupled with the results from the previous tests for separability using sub-group demand functions our classification seems to be done across weakly separable commodities.[17]

The next section presents tests for demographic separability.

6. Demographic Separability

The seven commodity groups, apart from food and non-food, are hypothesised to be consumed only by some members of households; commodity groups alcohol, coffee and transport by adults (men and women) and the remaining four groups are clothes (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 (is separable from children), its demand function can be written as

[17] One alternative test for separability is the procedure identified in Varian (1982, 1983). This is based on the application of the Generalised Axiom of Revealed Preference and as a non-parametric procedure it is not affected by specification of functional forms.

$$p_i q_i = f[\phi(X, n_a, n_c), n_a] \qquad \text{…(32)}$$

n_a and n_c are demographic characteristics of adults and children respectively. In this paper, the number of people in four demographic groups (males and females in the age ranges 0-16 and above 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)

$$u = u[v(q_a, n_a), q - q_a, n_c] \qquad \text{…(33)}$$

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 subgroup demand functions for the good. For adult good i

$$q_i = f_i(x_a, p_a, n_a) \qquad \text{…(34)}$$

where x_a is total expenditure on adult goods and p_a is the price vector of adult goods. In other terms, 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,

$$p_i q_i = b_o + \sum b_{ij} p_j + b_{1i} \ln X_a + \sum c_{ij} n_r + d_i + v_i \qquad \text{…(35)}$$

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, z 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 significantly different from zero. If they are not statistically different from zero the commodity is an adult good. If all children are grouped into one, the t-statistics for the coefficients gives the information on whether or not they are statistically significant. If they are in more than one group (in our case they are in two groups), the F-statistics for joint significance of the coefficients must be used.

Equation (35) 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[18], (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 above 16), a dummy for primary education of the household head, a variable reflecting proximity of the survey site to an urban area[19] and dummies for female-headed households are included.

One problem in the estimation of (35) is the endogeneity of total expenditure on adult (or children) goods. Instrumental variable estimation (IV), total expenditure as an instrument, is used. 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. And 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 3.

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.[20] The results from the Tobits indicate that all the adult goods pass the test of separability. The IV results probably are biased as a result of the heavy censoring of alcohol consumption (many zero consumption levels).

Table 3: Tests for Demographic Separability: F-Statistics for IV, Tobit and IV Fixed Effects Estimates

Commodity	IV estimates		Tobit estimates		IV fixed effects	
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 cl.	NR	2.41	NR	2.45	NR	3.31
Women's c	NR	1.85	NR	0.31	NR	0.41
Boys' cl.	0.13	NR	23.84**	NR	0.14	NR
Girls' cl	1.38	NR	28.40**	NR	4.99*	NR

Note: F-statistics are given for the hypothesis that the relevant coefficients are jointly zero.
NR= Not relevant; **Significant at 1%; * Significant at 5%

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

[19] 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.

[20] 'Transport' is also statistically significant at 10% level.

Clothes for boys and girls are hypothesised to be demographically separable from adults. But while the coefficients for the IV estimates are statistically insignificant those from the tobits are highly significant (even at 1% level). This may cast doubt on the separability of boys' and girls' clothes from adults. This result may be driven either by errors in variables or direct interdependence in the utility function. In the former, some clothes used by adults may have been recorded as boys' or girls' clothes. In the latter case, additional adults in the household may have a direct effect on the demand for children's clothes apart from their effect through total expenditures.

As mentioned in Section 3 and above, 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 (through expenditures). For instance, families with more children may 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, the direct effect of children on the demand for adult goods, are constant over time (are fixed effects). The panel data used here give us an opportunity to estimate household-level fixed effects that control for time-invariant tastes and other fixed factors. If the results from the IV and tobit estimates are very different from fixed effects estimates, the direct effects of children on adult goods are compromising the conclusions. In the IV and tobit models preferences of households (fixed effects) are not controlled for.

The last two columns of Table 3 give the F-statistics for the instrumental variable household-level fixed effects estimates. All the five F-statistics for adult goods are not statistically significant at conventional levels.[21] The F-statistics from the fixed effects indicate that the results from the previous estimates, particularly from the tobits, are not biased by the unobservable tastes of households for adult goods and children. Hence, adult goods considered here are demographically separable from 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-statistics for boys' clothes is no more significant and that for girls' clothes is significant only at 5% (1% in

[21] But the one for men's clothes becomes significant at 10%.

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 clothes almost disappears.[22]

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

7. Estimation of the Demand System

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. The theoretical reasons for using QUAIDS and a more detailed description of the demand system are given in Section 2. In this section results from endogeneity tests and outline of the estimation strategy are presented.

Budget shares of the commodity groups (food, non-food, coffee, transport, alcohol, men's, women's, boys' and girls' clothes) are regressed on the number of people in four demographic groups, n_r (number of males and females aged 0-16 and 16 plus),[23] log of prices, $ln\ p_{ij}$, log of total real expenditures, $ln\left(\frac{X}{a(p)}\right)$ and its 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:

$$w_i = \alpha_i + \sum \delta_{ir} n_r + \sum \gamma_{ij} \ln p_j + \beta_i \ln \frac{X}{a(p)} + \frac{\lambda_i}{b(p)} \left(\ln \frac{X}{a(p)} \right)^2 + \sum \sigma_{ik} z_k + \varepsilon_i \quad (36)$$

The Greek letters represent parameters to be estimated, *b(p)* is the Cobb-Douglas

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[22] These results imply that 'demographic separability' of children from adult goods on the one hand and of adults from children goods on the other are not symmetrical. This probably is due to the fact that children do not have the decision-making power in households.

[23] 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).

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, ..., 9).

Durbin-Wu-Hausman tests are conducted to examine the endogeneity of total expenditures (see Table 4). Except in the cases of coffee and alcohol, the t-statistics are significant at 1% level. This implies that total expenditures are correlated with the error terms of the demand equations (are endogenous). To mitigate this problem, three-stage-least-squares with real value of household assets and the size of cultivated land as instruments is employed.

Table 4: Durbin-Wu-Hausman Tests for Exogeneity of Total Expenditures

Commodity group	t-statistics	Commodity group	t-statistics
Food	11.471**	Men's clothes	-6.841**
Non-food	-9.845**	Women's clothes	-2.775**
Coffee	0.990	Boys' clothes	-6.509**
Transport	-8.990**	Girls' clothes	-4.698**
Alcohol	0.337		

Note: Household asset values and size of cultivated land by households are used as instruments for total expenditures; ** Significant at 1%; * Significant at 5%.

For consistency with utility theory the following restrictions are imposed.

$$\sum_j \gamma_{ij} = 0; \sum_i \alpha_i = 1; \sum_i \gamma_{ij} = \sum_i \beta_i = \sum_i \lambda_i = 0; \gamma_{ij} = \gamma_{ji} \qquad \ldots(37)$$

The first restriction is due to homogeneity in prices. The second set of restrictions follows 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). The parameters of the dropped demand equation can be recovered by using the adding-up restriction. This means, since one equation is dropped the adding-up restriction in practice will be automatically satisfied.

Both unrestricted and restricted demand systems are estimated but only the results from the latter are reported here. Imposing the above restrictions in estimating the demand system results in running the three-stages-least square with 36 constraints: eight homogeneity and twenty-eight cross-price restrictions. Random and fixed effects regressions are run; Hausman specification tests support the fixed effects estimates. The

Chi-square values for these tests are given in Table 5. All the Chi-square statistics are significant at 1%.[24]

Table 5: 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

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

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

8. The Effects of Income, Price and Demographic Changes

Changes in income, prices and demographic composition affect households' budgets resulting in re-allocations of expenditures. Budget and price elasticities and the outlay equivalent ratios capture the magnitude of re-allocations in household expenditures due to price and demographic changes. The next three sub-sections summarise the implications of the estimated elasticities and outlay equivalent ratios.

8.1. Budget Elasticities

The budget elasticity, ξ_i, from the QUAIDS equals,

$$\xi_i = 1 + \frac{\beta_i}{w_i} + \frac{2\lambda_i}{b(p)}\frac{1}{w_i}\ln\left(\frac{X}{a(p)}\right) \qquad \ldots(38)$$

Table 6 presents the budget elasticities from the simple three stage least squares (3SLS), random and fixed effects estimates (all estimated with the constraints imposed). All the budget elasticities are positive as expected and are significantly different from zero

[24] In a previous version of this paper, a method for estimation with censored values was used (Maddala, 1983: 221-222). The regression was in the form $y_i = \Phi_i \beta' X_i + \phi_i$, where Φ_i is the cumulative and ϕ_i is the density function; both are obtained from a first stage of probit. This estimation strategy is not used here. The computation of the slope parameters of the demand equation will be complicated since both Φ_i and ϕ_i are functions of the independent variables for identification purposes. I am grateful to Stephen Younger for pointing out the latter problem. In addition, the censoring at zero is not a major problem with panel data since mean values of the dependent variables have less number of zero values (observations with zeros for all the four rounds are less frequent).

at 1% level.

Table 6: Budget Elasticities

Commodity group	Budget elasticity 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 cloth	1.272(0.121)	1.363(0.121)	1.332(0.128)
Women's cloth	0.694(0.102)	0.868(0.102)	1.077(0.108)
Boys' cloth	1.175(0.136)	1.078(0.136)	1.215(0.145)
Girls' cloth	1.019(0.144)	0.766(0.144)	0.732(0.153)

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

The main results are:

- In all the estimates, men and boys clothes are income elastic (elasticity more than one) 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 panel estimates).
- Tests for equality of the 3SLS and the fixed effects elasticities are rejected at 1% level of significance for all the commodities. Controlling for fixed characteristics of households significantly affects the values of the parameters. Budget elasticities change from being elastic to inelastic (food, transport and girls' clothes) or the other way round (alcohol and women's clothes) when controlling for fixed effects. These results indicate the importance of using panel data and controlling for fixed effects.
- The mean budget elasticities of goods for male (men's and boys' clothes) and female (women's and girls' clothes) members of households are not statistically different from each other. But when taking the budget elasticity of individual groups, the results are different. 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' clothes; in both cases for all estimations, t-tests for equality are

rejected at 1% level. These results reiterate that clothes for males are more budget elastic than clothes for females inside households.

- The relatively high budget elasticity for food reflects the vulnerability of rural households to income shocks; changes in income significantly affect the consumption of food.

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 income 'shocks' more than their female counterparts. In times when household income is increasing (economic growth) this will bring proportionally more benefit to male members; but during contractions in income they will be hurt more. But the elasticities do not provide information on the current level of consumption; they inform us on the variation in demand when income changes. 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 those consumed by females. To have a rough idea, the household per capita expenditures on men's, boys', women's 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 are 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 on clothes.

The next sub-section examines price elasticities.

8.2. Price Elasticities

Changes in prices affect the expenditure patterns of households; these effects are captured by price elasticities. The uncompensated own-price elasticities are given in Table 7. Own-price elasticity is computed by using the formula,

$$\xi_{ii} = -1 + \frac{\gamma_{ii}}{w_i} - \beta_i - \frac{\beta_i \lambda_i}{b(p) w_i}\left[\ln\left(\frac{X}{a(p)}\right)\right]^2 - \frac{2\lambda_i}{b9p)}\ln\left(\frac{X}{a(p)}\right) \qquad \ldots(39)$$

Except for coffee and girls' clothes, all the other elasticities are significant at 1% 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 twenty-four elasticities only three are positive from which one is not significantly different from zero.

Table 7: 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 cloth	-0.857(0.115)*	-0.855(0.063)*	-0.563(0.060)*
Women's cloth	-1.178(0.084)*	-1.248(0.058)*	-1.224(0.100)*
Boys' cloth	-0.934(0.200)*	-1.009(0.055)*	-0.997(0.008) *
Girls' cloth	-0.039(0.337)	-0.824(0.042)*	-0.661(0.077)*

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

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

- Own price elasticities computed by the three estimations are statistically significantly different from each other. This points to the importance of controlling for fixed effects – similar to the budget elasticities above.
- While food is elastic (elasticity more than or equal to one) in all three estimations, transport, men's and girls' clothes are inelastic. The high elasticity of food is partly explained by its large budget share. But it also indicates the vulnerability of households' food consumption to price fluctuations.[25] The high elasticities indicate the exposure of households' food consumption to risks from both price and income fluctuations.
- 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. But if commodities are taken individually the results are different. In all the three estimations, the elasticities for women's clothes are higher than that of men's; in addition, the demand for boys' clothes is more elastic than for girls' clothes.[26] In all cases, these differences are significant at 1% level.

The own-price elasticities give a different picture from the ones from budget

[25] Even those households mainly dependent on their own production will be affected by food prices; the opportunity cost of own-consumption increases with food prices.

[26] 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.

elasticities. Own-price elasticities indicate that households adjust to price changes by cutting from the expenditures on women's and boys' clothes more than on men's and girls' clothes. In other terms, price 'shocks' seem to 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 shocks in a more complicated manner than usually presumed. While income shocks seem to be more absorbed by expenditures on male than female members of households, price shocks are more absorbed by expenditures on women and boys' goods. Girls seem to be more protected from both shocks, while boys are more affected by both.

In addition to incomes and own-prices, the demand for a commodity is affected by the prices of other goods. This effect is captured by cross-price elasticities, ξ_{ij}, computed by the following formula:

$$\xi_{ij} = \frac{\gamma_{ij}}{w_i} - \beta_i \frac{w_j}{w_i} - \frac{\beta_j}{w_i}\frac{\lambda_i}{b(p)}\left[\ln\left(\frac{X}{a(p)}\right)\right]^2 - \frac{2\lambda_i}{b(p)}\frac{w_j}{w_i}\ln\left(\frac{X}{a(p)}\right) \qquad \ldots(40)$$

Table 8 presents the cross-price elasticities from the fixed effects. In most cases, boys' and girls' clothes are either substitutes or complements to the same goods. Both are complements to food and men's clothes but substitutes for coffee, transport and alcohol. In all cases, the elasticities for girls' clothes are higher than for boys'. Even though expenditures on girls' clothes are less sensitive to changes in own-price, they are more sensitive to changes in the prices of other goods. This increases the sensitivity of expenditure on girls' clothes for changes in other prices. The same is true in the case of men and women clothes vis-à-vis their cross-price elasticity to food; men's clothes are more elastic than female clothes.

Table 8: Cross-price Elasticities

	Food	Coffee	Transport	Alcohol	Men's cl	Women's cl	Boys' cl
Coffee	-.445						
Transport	-.024	-.002					
Alcohol	-.140	.902	.114				
Men's cl.	.035	-.303	.107	-.259			
Women's	.005	.164	-.153	.111	-.103		
Boys' cl.	-.103	.620	.096	.501	-.101	.066	
Girls' cl.	-.194	1.157	.163	.978	-.300	-.032	1.022

Note: The elasticities are from household fixed effects estimation. All elasticities are significant at 1%.

As previously indicated, in addition to changes in income and price, variations in demographic composition affect intra-household distribution of expenditures. This is examined in the next section using outlay equivalent ratios.

8.3. 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

$$\pi_{ir} = \frac{n\delta_{ir}}{w_i + \beta_i + 2\dfrac{\lambda_i}{b(p)}\ln\left(\dfrac{X}{a(p)}\right)} \qquad \ldots(41)$$

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 (Greene, 1990; Deaton, et al. 1989).

Table 9: 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	.031(.172)	-.018(.165)	-.098(.212)	-.031(.211)	.185(.246)	.111(.266)
Transport	.002(.138)	.051(.133)	-.114(.210)	.054(.210)	-.391(.346)	-.354(.373)
Alcohol	.473(.265)[10]	-.579(.246)[1]	.575(.450)	-.483(.330)	.548(.454)	-.335(.406)
Men's cl.	-.539(.125)[1]	-.489(.120)[1]	-.604(.185)[1]	-.483(.179)[5]	-.874(.279)[1]	-.422(.299)[20]
Women's cl	-.039(.208)	-.084(.200)	-.171(.239)	-.389(.208)	-.111(.005)[1]	-.813(.354)[5]

Note: 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.

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 favour of boys. The outlay equivalent ratios for adult goods computed from the simple, random and fixed effects 3SLS estimations are given in Table 9. As expected most of the ratios are negative but are also 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 are to be equal, except for random errors. In Section 6, tests were conducted using demand equations and the overall results support demographic separability. In addition, an alternative test of demographic separability using deviations from the mean values of outlay equivalent ratios was outlined in Section 3. Following that and using the outlay equivalent ratios from the 3SLS fixed effects in Table 9 the Wald statistics for different combinations of adult goods is computed (see Table 10). Even if the whole set of adult goods are not separable, smaller 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), 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 10 indicate that at 1% level most of the combinations pass the test of demographic separability (except for the groups with five commodities for male children and, may be surprisingly, with two commodities for female children).[27] This result generally supports the previous tests. Hence, the apparent lack of consistent pattern in the outlay equivalent ratios is not due to failure in demographic separability.

Table 10: Wald Tests for Demographic Separability

	Females 0-16 years				Males 0-16 years			
Coffee	√				√			
Transport	√	√	√		√	√	√	
Alcohol	√	√			√	√		
Men's cloth	√	√	√	√	√	√	√	√
Women's cloth	√	√	√	√	√	√	√	√
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 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 1% level.

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 estimation errors. This in turn implies that the ratios can be used to assess the effect of additional female and

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

male children on household expenditures as long as the estimation errors are taken into account. The estimation errors are measured by the standard errors. Considering the above five, four, three and two groups of adult goods (as given in Table 10) the average outlay equivalent ratios for female and male children 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. If these average figures measure the income effects of additional girls and boys, the results indicate that the latter are favoured. But here estimation errors are not considered - the mean figures are taken as exact values. To overcome this limitation, the 95% confidence intervals for the outlay equivalent ratios are computed to examine if similar results re-emerge (see Table 11).

The lower and upper values of the 95% confidence interval 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 as compared to that of girls. Unless there are systematic errors that have increased the values for girls and decreased that for boys (which is unlikely) this implies the ratios for boys are drawn from a distribution whose central mass is to the left of those for girls. This supports the previous conclusion that boys are favoured in the allocation of household expenditures.

Table 11: 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 cloth	-1.4208	-0.3272	-1.0080	0.1640
Women’s cloth	-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**

The results in sub-sections 8.1, 8.2 and 8.3 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 some scenarios that illustrate the combined effects of income, price and demographic changes.

8.4. Combined Effects of Income, Price and Demographic Changes

Results presented in the previous sub-sections indicate the separate effects of changes in income, prices and demographic composition of households. But these changes may simultaneously happen. For example, a boy or girl may be born to the household at a time when prices and incomes are changing. The unified framework provided by the demand system approach helps to understand the combined effects of these changes. In this sub-section, a scenario with a combination of changes in income, price and demographic composition is presented to illustrate how intra-household expenditures adjust and correspondingly how household members differentially absorb the risks from 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 12 gives the total expenditures on adult and children clothes per household. All pair-wise t-tests for differences between the expenditures indicate that differences between the mean values are significant. On the average, households expend more on women's clothes, followed by men's, boys' and girls.

Table 12: Mean Monthly Expenditure on Clothes (in Birr)

Goods	Mean expenditure	Standard Error	95% confidence interval	
Men's cloth	7.64	0.2443	7.16	8.11
Women's cloth	8.18	0.2238	7.74	8.62
Boys' cloth	6.14	0.2007	5.75	6.53
Girls' cloth	5.44	0.1883	5.07	5.81

Changes in demand following changes in income are captured by the budget elasticities. When prices change, the percentage change in demand is captured by the price elasticities. 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 on demographic groups in households will be the sum of all the above effects transmitted through the three channels.

The outlay equivalent ratios computed indicate that generally households adjust expenditures in favour 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 give the impression that girls are discriminated against. All studies using the outlay equivalent method stop here without considering the effects of changes in income and prices. The effects of the latter should not necessarily affect household expenditures in the same fashion as the demographic changes. Hence, an important aspect that should be incorporated is to examine how changes in income and prices affect household expenditures.

Even though both the outlay equivalent ratios as well as the mean expenditure on clothes indicate the unfavourable position of girls, the budget and price elasticities show that girls' are probably the most 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 using a specific example is useful. Suppose there is a 1% fall in income and a 1% increase in general price (all prices increase by 1%).[28] The fall in income and the rise in own prices will decrease demand. The effect of other prices on the demand of a particular commodity will depend on whether the other commodities are complements or substitutes (with negative or positive cross-price elasticities). The budget, own-price and cross-prices elasticities of each commodity should be summed-up to identify the overall effect on the demand for goods.[29] Table 13 presents the fall in demand for clothes for a 1% decrease in income and 1% rise in all prices.

Table 13: Changes in Demand for Clothes for 1% Fall in Income and 1% Rise in All Prices

Commodity	% change in demand	Standard error	95% confidence interval for % change	
Men's cloth	-2.819	0.608	-4.011	-1.627
Women's cloth	-2.243	0.908	-4.023	-0.463
Boys' cloth	-0.111	0.209	-0.521	0.299
Girls' cloth	1.401	0.769	-0.106	2.908

[28] Because of homogeneity in prices, this is equivalent to a 2% decrease in income.
[29] The negative of the budget elasticity should be taken since in the specific example income is falling.

The results in Table 13 indicate the overall negative income and price shock will affect adults more than children and girls are the most protected from it. Conversely, if the change were in a positive direction (an increase in income and a decrease in prices), girls would have missed most of the benefits as compared to other demographic groups. The observations from the mean percentage changes in demand are reinforced by the 95% confidence intervals.

The findings show that households distribute risks among different demographic groups rather than only one group absorbing all shocks. Responses to income, price and demographic changes are more complicated that usually assumed. In addition, the findings indicate that studies that only looked at demographic changes (using outlay equivalent ratios) tell only part of the story. If demographic groups that are discriminated in one fashion are protected from other risks the results from studies using only outlay equivalent ratios will be misleading. This underscores the importance of integrating income and price effects in studies that look at effects of demographic changes.

Hence, the overall position of boys and girls in the household depends not only on the outlay equivalent ratios but also on the effects of changes in household income and prices as determined by the elasticities. For instance, even though the outlay equivalent ratios indicate discrimination against girls as compared to boys, when household income is falling and prices are rising girls suffer less than boys.

The next section concludes.

9. 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 male members of households (men and boys) more than female members (women and girls). On the other hand, changes in price affect women and boys more than men and girls. In addition, adjustments in household expenditure to demographic changes imply that boys are favoured relative to girls. 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 as determined by budget and price elasticities. These findings show that households distribute risks among different demographic groups rather than only one group absorbing all types of shocks. The findings also indicate that studies that only looked at demographic changes (using outlay equivalent ratios) tell only part of the story. If demographic groups that are discriminated in one fashion (through the adjustment in adult expenditures) are protected from other risks the results from these studies will be misleading. This underscores the importance of integrating income and price effects in studies that look at the impacts of demographic changes.

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 paper.

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