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Children's Resources and Poverty in Single-mother and Male-headed Households: A Collective Consumption Evidence from Ethiopia

Getachew Yirga Belete

Martina Menon

Federico Perali

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Children's Resources and Poverty in Single-mother and Male-headed Households: A Collective Consumption Evidence from Ethiopia*

Getachew Yirga Belete† Martina Menon‡ Federico Perali§

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Abstract

We estimate a collective complete demand system model to recover children's resource shares and analyze their poverty. Identification of the sharing rule between children and adults relies on private assignable goods and distribution factors. Based on Ethiopian LSMS-ISA data for two sub-samples of families with children (married male-headed and single female-headed), we observe inequalities in intrahousehold resource allocation and welfare. We find that children command less household resources and are poorer than adults which worsen with the number of children. Resource allocation is affected by parental differences in education and age, child education, proportions of female children and women, and number of non-biological children. Single-mothers not only are more altruistic to their children, but also avoid higher child poverty than married male heads although this seems to disappear when the number of children increases. Unlike the general belief that poor children live only with poor adults and households, our estimates show that non-poor families and adults also host poor children. Further, traditional poverty measures, which ignore intrahousehold resource allocation, are found to understate child (and adult) poverty. Lastly, regional and rural-urban disparities are found to exist. Findings have implications for fertility, gender, targeting and spatial redistribution issues.

Keywords: *Collective AIDS model, resource shares, sharing rule, intrahousehold resource allocation, child poverty, Ethiopia*

JEL codes: *D13, I32, J12, J16, O12*

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†Department of Economics, Bahir Dar University, Ethiopia; Email: getachewy@bdu.edu.et
‡Department of Economics, University of Verona, Italy; Email: martina.menon@univr.it.
§Department of Economics, University of Verona, Italy; Email: federico.perali@univr.it.

1 Introduction

Considering the household as a black box, the unitary model assumes that choices of all household members, including children, are proxied by a single preference of the household head. This, besides violating the microeconomics teachings of individual consumer theory, hides a member's welfare loss or gain due to any inequality in intrahousehold resource allocation. However, there is substantial evidence that rejects this model and underlines the role of intrahousehold resource allocation since the early 90's (e.g., Thomas, 1990; Schultz, 1990; Bourguignon et al., 1993; Browning et al., 1994). Very importantly, ignoring this intrahousehold resource allocation leads to a considerable understatement of the level of poverty in developing countries (Haddad and Kanbur, 1990; Dunbar et al., 2013; Bargain et al., 2014).

Unlike the neoclassical model, the collective household model argues that household choices are grounded on individual member preferences. In seminal contributions, Chiappori (1988, 1992) contends that the key to unlock the black box is the sharing rule with which the family allocates available resources across its members. When such a rule exists, efficiency of the collective decision process is implied and exogenous bargaining process within the household is captured. One can thus consider intrahousehold inequality in resource allocation and make individual welfare analyses.

Consequently, there has been an increased interest, both in academic and global policy fronts, to measure resource shares and welfare of household members including children. Academia continues documenting inequality in intrahousehold resource allocation (Bourguignon et al., 1993; Browning et al., 1994; Lise and Seitz, 2011; Dunbar et al., 2013; Bargain et al., 2014; Mangiavacchi et al., 2018). Globally, Commission on Global Poverty recently recommended the World Bank to compute poverty rates at women, children and young adults levels. However, until the seminal article of Bourguignon (1999), children had no bargaining power and were considered as public or private goods for their parents. As they do not enter households by choice and generally bring little to household resources, children could be the most vulnerable to intrahousehold inequality (Dunbar et al., 2013). On the other hand, they may benefit from parental altruism (Bhalotra, 2004) especially from mothers.

Yet, only few empirical evidence is available from developing countries on resource shares and welfare of children allowing them to bargain with adults in a collective framework.

And the existing scant evidence is mixed. Dunbar et al. (2013) and Bargain et al. (2014) apply almost similar collective consumption models, though with different identification strategies, on data from Malawi and Cote d'Ivoire respectively. Very recently, the methodologies in these studies are applied using data from two more sub-African countries: Bose-duker (2018) in Ghana and Bargain et al. (2018) in South Africa. All, except Bose-duker (2018), find that child resource shares are lower than adults and vary by family size and structure, and that conventional poverty measures understate the incidence of child poverty. In contrast, Mangiavacchi et al. (2013), fitting a complete collective demand system model, document children enjoying higher resource shares than adult females but traditional poverty indices slightly overstating child poverty in Albania. This goes in line with the findings of Bose-duker (2018) for Ghana.[1] The current study aims to contribute to this debate by estimating the sharing rule of children from a complete collective demand system and analyzing their poverty status using data from Ethiopia.

One source of debate in the collective consumption model literature is identification of the sharing rule. As almost all surveys collect consumption data at household level, the issue is on how one can recover from household level consumption data information about individual members. While some of the recommended structural models are highly restrictive (e.g., consumption of purely private and private goods) and easy to estimate resource shares such as Chiappori (1992), others are liberal but difficult such as Browning et al. (2006). Yet, others propose models at the middle that are only a little restrictive and easy to estimate from Engel curves (Lewbel and Pendakur, 2008; Dunbar et al., 2013). A crucial identifying restriction, for example, is that resource shares are independent of total household expenditure which Menon et al. (2012) and Bargain et al. (2018) empirically validate it.

In this study, we use a similar restriction but follow the estimation procedures of a collective Almost Ideal Demand System model as in Menon et al. (2017) and Mangiavacchi et al. (2013, 2018) to recover the resource sharing rules of children and adults. The demand system consists of four commodity groups: food and beverages, clothing, utilities and energy, and other non-durable goods. The sharing rule is allowed to depend on individual observed assignable expenditures and distribution factors where the former are scaled by a function that captures the within-household resource transfer. Private assignable expen-

[1] In fact, the issue of overstatement or understatement of child poverty across authors and methods needs to be examined cautiously since that depends on the assumption made on children's needs. Child poverty line is lower with lower needs so that poverty is lower. Thank you Olivier Bargain for raising this issue.

ditures are found from assignable clothing and footwear, education, certain personal care items, and other adult goods (alcohol, tobacco, chat/Khat). In addition to the traditional distribution factors in the literature (parental differences in education and age), we use as distribution factors other variables pertinent to children (if all children attend school, proportions female children and women, and number of non-biological children).

Our empirical exercise uses data from the 2013/14 wave of the Ethiopia Socioeconomic Survey (ESS), conducted as part of the LSMS-ISA project by the World Bank and Ethiopia's Central Statistical Agency (CSA). Missing prices are also obtained from prices surveys of the CSA. We choose a sample of families with children, composed of two subsamples (two-parent male-headed and single-parent female-headed families). Ethiopia is an interesting case study for our issue as it is one of the poorest countries in the world with a sizable child population, over 52% according the latest census. Official adult-equivalent-based child poverty incidence (32.4%) is higher than that at the household level (29.6%) (MoFED, 2012; CSA et al., 2015). Multidimensional poverty incidence is also among the highest in the world (87%) and human development index remains one of the least (0.396). These are despite the government pursuing various anti-poverty and 'transformation' strategies over the past couple of decades and the economy growing fast, for instance at 8% in per-capita terms over the period 2004–2014 (World Bank, 2016). Moreover, the ESS provides many household and individual consumption and other details which we exploit for implementing our theoretical framework.

Once children's resource shares are estimated and analyzed, we use them to compute poverty measures of incidence, depth and severity. These intrahousehold inequality-robust rates are then compared with those based on equal resource sharing (household level). A needs-based national poverty line is preferred to dollar/day thresholds. We also test the hypotheses by Haddad and Kanbur (1990) that poverty depth and severity measures which ignore intrahousehold resource allocation understate the level of poverty and that the fate of the headcount ratio is an empirical matter. In addition, we aim to provide some evidence on the gender and family structure aspects of intrahousehold resource allocation as we estimate child resource shares and poverty indices for married male-headed and single female-headed families. As a further benefit of the new method to child poverty estimation using resource shares, we look at the overlap between the poverty of children, adults and the household. What proportion of poor children live with non-poor adults? What portion of poor children live in non-poor households? Do these differ when the head is a female? We also provide some evidence on the overlap between child undernutrition and monetary poverty at child, adult and household levels. We lastly answer the question of how our estimates vary with the number of children and over space.

Our results generally confirm inequalities in intrahousehold resource allocation and poverty which vary with number of children, family structure and space. The allocation is significantly affected by parental differences in education and age, child education, proportions of female children and women and number of non-biological children. In particular, older mothers assign more resources to children. Children's expenditure shares are also higher if they are all in school and when there are more girls relative to boys. We find that children have lower expenditure shares (16% or 30%) than adults (23% or 32%) depending on family type (male-headed or single-mother). Monetarily, these correspond to monthly non-durable per-child outlays of ETB 339 or 433 and per-adult outlays of ETB 491 or 457 in male-headed or single-mother families respectively. Consistent with Bargain et al. (2014), results show that single-mothers are more altruistic to children than male-heads.

Using resource shares to estimate poverty incidence, depth and severity measures, we find that children are poorer than adults which also vary with family type and space. In a sample of families with children, prevalence of child poverty increases from 65% when there is only one child to 93% when families host more than four children. Single-mothers, besides being more altruistic to their children, host less poorer children than male-heads. Inline with previous literature and hypotheses by Haddad and Kanbur (1990), traditional poverty measures, which by construction ignore intrahousehold resource allocation, are found to understate child (and adult) poverty compared to those based on resource shares.

Our estimates also show that up to a fifth of non-poor households and adults host poor children, unlike the general belief that poor children live only with poor adults and households. Changing the poverty measure to undernourished children also provides similar conclusion, in particular and consistent with Brown et al. (2017), that up to a tenth of monetarily non-poor adults or households host stunted children. Moreover, less portion of poor children live with non-poor adults in female-headed families than in male-headed ones, in line with our previous evidence that single mothers in general are more equal to their children than adults in male-headed families. These overlaps question the effectiveness of using household information to target children's welfare. Finally, we observe regional and rural-urban disparities in resource shares and poverty. The remaining part of the first essay is organized as follows. In the next section, we discuss the theoretical framework as well as empirical and post-estimation issues. After describing the data in the third section, we present and discuss the results in the fourth section. The last section provides concluding remarks.

2 Theoretical Framework and Estimation Issues

In this section, we provide the theoretical framework with the underlying assumptions and identification strategies of the sharing rule. This is followed by brief discussion of empirical issues pertinent to estimation of a collective Almost Ideal Demand System. Post-estimation matters related to recovering of resource shares and poverty measurement are also highlighted.

2.1 The Collective Household Consumption Model

Consider a household consisting of adults and children, indexed by $k = 1, 2$ respectively.[2] Private goods could either be assigned to each member, e.g., clothing, or non-assigned, e.g., food. Represent adults' assignable consumption by c^1 and children's by c^2 and aggregate non-assignable consumption by q so that total household consumption becomes[3] $C = c^1 + c^2 + q$.

In a centralized setting, the budget constraint of the collective household is $p_{c^1}c^1 + p_{c^2}c^2 + p_q q = e$, where p_h , $h = c^1, c^2, q$, are associated prices of assignable and non-assignable goods and e is total household expenditure. Unlike assignable goods, one cannot observe individual quantities and prices of non-assignable goods $(q^1, q^2, p_{q^1}, p_{q^2})$. Only $q(= q^1 + q^2)$ and p_q are observable.

Preferences of each household member are assumed to be caring type in which the utility of one member depends on the sub-utility of the other; i.e. for each $k = 1, 2$ we consider $U^k(c^1, c^2, q^1, q^2; \boldsymbol{d}) = U^k[u^1(c^1, q^1; \boldsymbol{d}), u^2(c^2, q^2; \boldsymbol{d})]$ where $\boldsymbol{d}$ represents a vector of

[2]The very scant literature that estimates a collective consumption model with public goods makes a strong assumption that people in different marital status have similar preferences, as done for singles and married ones by Browning et al. (2013). However, such an assumption fails to identify the model when children are considered as decision makers, as we do in this paper, and it is difficult to observe children living alone. Moreover, in our empirical application, the vast majority of goods are private, for e.g. food and beverages, clothing, and other goods categories constitute a total share of over 92%.

[3]Note that if index $k = 1, 2$ is superscript, it indicates an endogenous variable and if it is subscript, it is associated with an exogenous variable. Also note that i and j index goods.

demographic variables[4] that affect preferences of the members directly so that observed heterogeneity is captured. Note that $\boldsymbol{d} = (d_1, d_2, d_{12})$ where d_1 and d_2 are characteristics specific to adults and children respectively while d_{12} are household-level characteristics. We also assume that utilities u^k are continuously differentiable as a consequence of which demand functions of each member will ultimately be smooth.

We assume that household decisions are Pareto-efficient (Chiappori, 1988, 1992). This alternatively means that family decisions are made in a decentralized fashion in two stages: (i) Members decide on how to share the total household expenditure e so that each member receives a sharing rule ϕ_k with $\phi_k > 0$ and $e = \phi_1 + \phi_2$. (ii) Given the sharing rule ϕ_k, each member maximizes her own utility function $u^k(c^k, q^k; \boldsymbol{d})$ subject to her individual budget constraint $p'_{c^k} c^k + p'_c q^k = \phi_k$ thereby choosing her optimal (Marshallian) consumptions of assignable goods $\widehat{c}^k = c^k(p_{c^k}, p_q, \phi_k, \boldsymbol{d})$ and non-assignable goods $\widehat{q}^k = q^k(p_{c^k}, p_q, \phi_k, \boldsymbol{d})$.

Household-level (aggregate) Marshallian demand systems of assignable and non-assignable goods are obtained as

$$\widehat{c}(p_{c^1}, p_{c^2}, p_q, e, \boldsymbol{d}) = c^1(p_{c^1}, p_q, \phi_1, \boldsymbol{d}) + c^2(p_{c^2}, p_q, \phi_2, \boldsymbol{d})$$

and

$$\widehat{q}(p_{c^1}, p_{c^2}, p_q, e, \boldsymbol{d}) = q^1(p_{c^1}, p_q, \phi_1, \boldsymbol{d}) + q^2(p_{c^2}, p_q, \phi_2, \boldsymbol{d}).$$

Note that individual-level optimal Marshallian demands are observed as functions of prices, the sharing rule and demographic attributes. Optimal consumption levels of the non-assignable goods are only observed at the household level.

2.1.1 The Collective Complete Demand System

The demand system model we specify follows from Menon et al. (2017) and Mangiavacchi et al. (2013, 2018) who extend the QUAIDS of Banks et al. (1997) to the collective framework and hence named the Collective Quadratic Almost Ideal Demand System (CQUAIDS). The model begins with a specification of an individual expenditure function in terms of price aggregators and a demographically-translating household technology to ultimately get individual Hicksian and Marshallian budget share demands. The sharing

[4] They are also termed "preference factors" (Bourguignon et al., 2009).

rule is specified as a function of observed individual expenditure and a vector of distribution factors. Individual expenditures are also scaled (Chavas et al., 2017) in a way that guarantees independence of the sharing rule and total expenditure (Menon et al., 2012). However, we fit a linear version of the model to our data. For a detailed derivation of the model, see Appendix ??.

Given continuous and concave price p aggregators taking up the usual functional forms, $lnA_k(\boldsymbol{p}) = \frac{1}{2}\left(\alpha_0 + \sum_i \alpha_i lnp_i + \frac{1}{2}\sum_i\sum_j \gamma_{ij} lnp_i lnp_j\right)$; $B_k(\boldsymbol{p}) = \beta_0 \Pi_i p_i^{\beta_i^k}$, and $\lambda_k(\boldsymbol{p}) = \sum_i \lambda_i^k p_i$, additionally assumed to be a differentiable, homogeneous function of degree zero of prices.

The demographically-modified demand for good i in terms of budget share w_i is aggregated from member demands w_i^k as

$$w_i = \alpha_i + t_i(\boldsymbol{d}) + \sum_j \gamma_{ij} lnp_j + \beta_i^1[lne_1^* - lnA_1(\boldsymbol{p})] + \lambda_i^1 \frac{[lne_1^* - lnA_1(\boldsymbol{p})]^2}{B_1(\boldsymbol{p})}$$

$$+ \beta_i^2[lne_2^* - lnA_2(\boldsymbol{p})] + \lambda_i^2 \frac{[lne_2^* - lnA_2(\boldsymbol{p})]^2}{B_2(\boldsymbol{p})} \tag{1}$$

where lne_1^* and lne_2^* are modified logarithmic individual total expenditures from observed ones (lne_k) given by a translating household technology:

$$lne_k^* = lne_k - \sum_i t_i(\boldsymbol{d}) lnp_i. \tag{2}$$

Demographic augmenting of the demand system helps capture observed heterogeneity among households and is done by introducing a translating technology $t_i(\boldsymbol{d})$ so that demographic attributes $\boldsymbol{d}$ enter additively with expenditures (Lewbel, 1985; Perali, 2003). They are defined for simplicity as $t_i(\boldsymbol{d}) = \sum_r \tau_{ir} d_r$ for $r = 1, ...R$. Note that we can estimate, for each good i, income parameters (β_i^1, β_i^2, λ_i^1 and λ_i^2) at the individual level while the rest at the household level (i.e. intercepts α_i, price parameters γ_{ij} and demographic scaling effects $t_i(\boldsymbol{d})$).

2.1.2 The Sharing Rule

Until now, we have made an implicit assumption that individual total expenditures e_k are observed. Such information, nonetheless, is barely collected, as is the case in many household surveys and in the survey we use in this study. As a solution to this issue, one can exploit expenditures on exclusive or assignable goods $\boldsymbol{p_c'c^k}$ to learn about how much each member receives from total household resources and then correct for the resulting measurement error (Caiumi and Perali, 2015; Menon et al., 2017; Mangiavacchi and Piccoli, 2017). Obviously, the lower the proportion of non-assignable expenditures $\frac{\boldsymbol{p_q'q}}{e_k}$, the lower will be the measurement error. We will get back to this correction issue in a moment.

In our case, we have exploited all available expenditure information in the survey if some goods are consumed exclusively by adults or children. Expenditures on clothing, which are collected at male, female, girl and boy levels, as well as on education, which are collected at each individual level, are clearly assignable expenditures. Moreover, we make an assumption to regard consumption of the following items exclusively by adults: alcoholic drinks, stimulants (specifically, chat and cigarettes) and certain personal care items. Once assignable individual expenditures are taken into account, non-assignable expenditures are assumed to be shared equally by adults and children.[5] Hence, one can consider $e_k = \frac{\boldsymbol{p_c'c^k}}{h_k} + \frac{\boldsymbol{p_q'q}}{h}$ where h_k is the number of persons in adult and children groups and h is household size (Chavas et al., 2017). Consequently, observed resource shares become $\sigma_k = \frac{e_k}{\sum_k e_k}$ where $\sigma_1 + \sigma_2 = 1$, so that we can write

$$lne_k = \sigma_k lne. \tag{3}$$

Returning to the awaiting correction issue of e_k, a modifying function $m(\boldsymbol{z}) \in \left(0, \frac{e}{e_k}\right)$ is used to correct any measurement error related to e_k which leads to specification of the sharing rule. The arguments of this function are distribution factors $\boldsymbol{z}$ which affect the intrahousehold bargaining between adults and children but not their preferences.[6] The m-function can optionally be thought to capture the magnitude and direction of transfer of resources from adults to children or vice versa (Menon et al., 2017): if $m < 1$, the expenditure transfer goes from member 1 (adult) to member 2 (child) and the direction is reversed if $m > 1$.

This enables to define the sharing rule, which explains a shadow intrahousehold resource

[5]Chavas et al. (2017) test the innocence of such an assumption; they show that assuming a fair distribution of non-assignable goods among family members does not affect parameter estimates of the sharing rule (see their Proposition 5 and Appendix B).

[6]Note that the scaling function does not depend on expenditures, a separability property in line with the theoretical properties of independence of income of the sharing rule by Dunbar et al. (2013) and Chavas et al. (2017) and the empirical validation by **?**.

allocation, as a function of individual expenditures and distribution factors, i.e. for member 1 (adult), we have $\phi_1(e_1, \boldsymbol{z}) = e_1 \cdot m(\boldsymbol{z})$ which in log becomes linear as[7]

$$ln\phi_1(e_1, \boldsymbol{z}) = lne_1 + lnm(\boldsymbol{z}) = \sigma_1 lne + lnm(z). \tag{4}$$

Since by definition $lne = ln\phi_1 + ln\phi_2 = lne_1 + lne_2$, we have the sharing rule for member 2 (child) equal to

$$ln\phi_2(e_2, \boldsymbol{z}) = lne - ln\phi_1 = \sigma_2 lne - lnm(\boldsymbol{z}). \tag{5}$$

The functional form of the scaling function $m(\boldsymbol{z})$ is assumed to be of Cobb-Douglas type for empirical purposes so that in log form, it becomes linear as:

$$lnm(\boldsymbol{z}) = \sum_{l=1}^{L} \phi_{z_l} lnz_l \tag{6}$$

where L is the dimension of distribution factors vector $\boldsymbol{z}$.

The introduction of the expenditure-scaling function $m(\boldsymbol{z})$, and consequently the sharing rule, has the effect of modifying the system specified in 1 into

$$\begin{aligned} w_i = \alpha_i + t_i(\boldsymbol{d}) + \sum_j \gamma_{ij} lnp_j + \beta_i^1[ln\phi_1^* - lnA_1(\boldsymbol{p})] + \lambda_i^1 \frac{[ln\phi_1^* - lnA_1(\boldsymbol{p})]^2}{B_1(\boldsymbol{p})} \\ + \beta_i^2[ln\phi_2^* - lnA_2(\boldsymbol{p})] + \lambda_i^2 \frac{[ln\phi_2^* - lnA_2(\boldsymbol{p})]^2}{B_2(\boldsymbol{p})} \end{aligned} \tag{7}$$

where, from (2), (4) and (5), $ln\phi_1^*$ and $ln\phi_2^*$ are given by $ln\phi_1^* = \sigma_1 lne + lnm(\boldsymbol{z}) - \sum_i t_i(\boldsymbol{d}) lnp_i$ and $ln\phi_2^* = \sigma_2 lne - lnm(z) - \sum_i t_i(\boldsymbol{d}) lnp_i$. In our empirical application, we fit to our data the linear version of the above model where the quadratic terms λ_i^1 and λ_i^2 are not estimated.

[7] Since ϕ_k should not exhaust all household total expenditures e, i.e. $\phi_k < e$, the m-function is restricted to stay between 0 and $\frac{e}{e_k}$.

2.2 Empirical Estimation and Post-estimation Issues

Endogeneity of Total Expenditure

We address endogeneity of total expenditure primarily due to measurement errors by instrumenting total expenditure using wealth indicators as an instrument.[8] However, wealth may still be mismeasured as a result, for example, of omission or incorrect valuation of its components. As far as these mismeasurements are independent of consumption recall errors and if wealth is correlated with true total expenditures, our proposed instrument remains valid (Dunbar et al., 2013). A control function procedure is used, which uses as regressors the residuals of an auxiliary regression of total expenditure on a set of socio-demographic variables and our instrument into the demand system model (Dauphin et al., 2011; Mukasa, 2015; Mangiavacchi et al., 2018). The procedure is executed in two steps: the log of total expenditure lne is first estimated using OLS on a vector η of socio-demographic variables and the instrument as $lne = \eta.\delta + \upsilon$ and then the residual $\widehat{\upsilon} = lne - \eta.\delta$ enters in the estimation of the demand system.

This gives the CAIDS model in budget shares as

$$w_i = \alpha_i + t_i(\boldsymbol{d}) + \sum_j \gamma_{ij} lnp_j + \beta_i^1[ln\phi_1^* - lnA_1(\boldsymbol{p})] + \beta_i^2[ln\phi_2^* - lnA_2(\boldsymbol{p})] + \rho_i\widehat{\upsilon} + \xi_i \tag{8}$$

where ρ_i captures any endogeneity of total expenditure and ξ_i is the error term.

The system is finally estimated using feasible generalized nonlinear least squares method and imposing the QUAIDS standard regulatory conditions: adding-up ($\sum_i \alpha_i = 1$), homogeneity ($\sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0$, $\sum_i \tau_{ir} = 0$ and $\sum_i \beta_i^k = 0$ for each $k = 1, 2$) and symmetry ($\gamma_{ij} = \gamma_{ji}, \forall i \neq j$).

In our empirical exercise, we estimate the model for two sub-samples of families with children: married male-headed and single female-headed families. The basic motivation behind our choice of the two sub-samples is that our assumption that children may be

[8] We also note that prices too may potentially be endogenous due, for example, to common unobserved shifts in preferences affecting both prices and quantities. However, lack of plausible instruments for a host of prices leads us to assume that they are exogenous. In fact, we are not alone in this respect (see, for instance, Dauphin et al. (2011) and Mangiavacchi and Piccoli (2017) for recent ones who only consider endogeneity of total expenditure but assume exogeneity of prices).

treated differently in the two family structures and hence their bargaining power and welfare may vary.[9]

Post-estimation Issues

Once the estimated resources of adults ϕ_1^* and children ϕ_2^* are recovered, aggregate resource shares S_k are given by

$$S_k = \frac{\phi_k^*}{e}, \quad k = 1, 2$$

where e is total household expenditure. Per-child and per-adult resources r_k and resource shares s_k are given by

$$r_k = \frac{\phi_k^*}{h_k} \;\; and \;\; s_k = \frac{S_k}{h_k}$$

where h_k is the number of adults or children.

The identification of resource shares allows us the measurement of poverty and inequality at individual level. Unlike the traditional method, which relies on counting of families with children living below the poverty line to identify children as poor, this new method provides the "true" poverty of children. It also provides better estimation of the depth and severity of poverty. In the empirical estimation, we consider the national poverty line that is based on the Cost of Basic Needs and takes into account both food and non-food needs. Two types of poverty estimates are computed for each index: one group based on estimated resources r_k for children and adults, which take into account the intrahousehold resource allocation, and another based on equal-sharing expenditures y at the household level (adult-equivalents in our case). Haddad and Kanbur (1990) show that poverty measures which ignore intrahousehold allocation understate the level of poverty.

Consider two expenditure gap functions, $g(r_k, z)$ convex in estimated individual resources r_k and $g(y, z)$ convex in household level expenditures y, defined as

$$g(r_k, z) = \begin{cases} \left(\frac{z - r_k}{z}\right)^\alpha, & r_k \leq z \\ 0, & r_k > z \end{cases} \quad and \quad g(y, z) = \begin{cases} \left(\frac{z - y}{z}\right)^\alpha, & y \leq z \\ 0, & y > z \end{cases}$$

[9]Estimating a single model merging married male-headed and married female-headed together suffers from very low sample sizes for the latter. For drawing better gender-based comparisons, we exclude married female-headed and single male-headed households, both of which are very negligible. Hence, we separately estimate for married male-headed and for single-mother families with children. This is also due to the fact that some of our distribution factors account for parental (wife-husband) differences in age and education which cannot be defined for single-mothers. Bargain et al. (2014) do similarly in their alternative estimations.

where z is poverty line. α is a measure of poverty aversion. When $\alpha = 0$, the function g measures headcount. $\alpha = 1$ implies depth, and $\alpha = 2$ indicates severity of poverty. Note also that it is only when $\alpha \geq 1$ that $g(r_k, z)$ and $g(y, z)$ become convex in r_k and y respectively. Hence, the FGT (Foster et al., 1984) poverty indices based on individual resources r_k and adult-equivalent household level expenditure y are given by

$$P_{\alpha k}(r_k, z) = \frac{1}{N} \sum_{n=1}^{N} g(r_k, z) \quad and \quad P_{\alpha}(y, z) = \frac{1}{N} \sum_{n=1}^{N} g(y, z)$$

where $n = 1, 2, ..., N$ is the number of households with children. For convex $g(r_k, z)$ and $g(y, z)$ (i.e. $\alpha = 1, 2$), Haddad and Kanbur (1990) show that $P_{1k}(r_k, z) > P_1(y, z)$ and $P_{2k}(r_k, z) > P_2(y, z)$. These say that both poverty depth and severity measures that ignore intrahousehold resource allocation understate the level of poverty. Nonetheless, where convexity fails (i.e. $\alpha = 0$), Haddad and Kanbur (1990) argue that $P_{0k}(r_k, z) \gtrless P_0(y, z)$, implying a headcount ratio with no account of intrahousehold resource allocation can overstate or understate poverty and is an empirical matter. Later, we will verify these hypotheses using data from Ethiopia.

3 Ethiopian Expenditure Data

Data for the study come from the 2013/14 wave of Ethiopia Socioeconomic Survey (ESS) collected jointly by the World Bank and the Central Statistical Agency of Ethiopia (CSA) as part of the Living Standard Measurement Study-Integrated Surveys of Agriculture (LSMS-ISA). ESS is a panel survey with three waves to date (2011/12, 2013/14 and 2015/16). While the sample design of the first wave provides representative estimates for rural-area and small-town households, subsequent waves include medium and large towns and cities so that they have become nationally-representative. It uses a stratified, two-stage design where regions of Ethiopia serve as the strata. The first stage involves the selection of primary sampling units (or enumeration areas) using simple random sampling. The second stage of sampling entails the selection of households. ESS contains household-level data on a range of modules including expenditure, assets, shocks, non-farm enterprises, credit and farm production. Individual data on demographics, education, health, some expenditure items and time use are also collected. Moreover, community-level data as well as data on prices from local markets are available. However, in addition to being a rural-only survey, the 2011/12 wave lacks expenditure data on education, health, housing and food away from home. Lack of price data for assignable clothing and other goods such as education and personal care also forced us to exclude the 2015/16 wave.

This study, therefore, employs the 2013/14 wave in which data came from 5,262 households were collected. All of the waves of ESS do not collect expenditures on durable goods except on home furniture. Only information on the number of ownership of more than 35 assets is gathered. A wealth index from these assets is used to instrument total household expenditure. Individual-level labor incomes and household-level income from various non-labor sources, transfers and non-farm enterprises are aggregated with farm income which is extracted from the production, sales, home consumption and associated costs of various crops, livestock and their by-products. The wealth index aggregate of ESS by FAO's Rural Income Generating Activities (RIGA) project is used in this study.

We aggregate the various non-durable expenditure items into four expenditure groups: food at home and alcohol, clothing, household utilities and energy, and other goods. The details are available in Table 9 of the Appendix. The food and alcohol expenditure group is aggregated from 26 food items and a sub-group of alcoholic drinks. The second group in our expenditure aggregation is clothing. It is composed of non-assignable linen as well as assignable clothes, shoes and fabric for men, women, boys and girls. The third expenditure group consists of household utilities and energy.[10] All other non-durable expenditures are aggregated in the fourth group: other goods, composed of spending on education, food away from home, cigarettes, laundry and other personal care, and transport.

Prices data come in various forms. For food at home items, we calculate unit values from expenditure and quantity information. For the majority of non-food items, local market prices collected in ESS price questionnaire are employed. For alcoholic drinks, food away from home and for non-food items whose prices are missing in ESS (namely, water, electricity, communication, education, personal care items, matches, and assignable and non-assignable clothing), we resort to the 2013/14 CSA's average retail prices. We first aggregate them up to the *zone* (provincial) level and then match them to the ESS data.

From a total of 5,262 households, we select 3,196 families with children composed of two sub-samples: two-parent male-headed (2,467 households) and single-parent female-headed

[10] We exclude housing rents because only 13% of households with children reported rents and no housing prices are available. Given that over 70% of our sample are of rural households and over 92% have their own home so that they do not pay rents, this assumption of equal treatment of rents will not pose a serious problem. The associated welfare differences could be captured by differences in spending on various household utilities and energy items.

(729 households). Exclusive/assignable consumption is based on a host of non-durable expenditure items. Clothing and footwear expenditures, collected at male, female, girl and boy levels as well as education expenditures, collected at individual level, are clearly assignable. Further, we assign expenditures on alcoholic drinks, stimulants (*chat/khat* and cigarettes) and some personal care items to adults.

Table 1 presents the descriptive statistics of key variables by family structure and for the whole sample. As expected, the vast majority of household resources (about 70 percent in male-headed and 65 percent in single-mother households) are spent on food at home and alcohol. However, compared to the male-headed, single-mother families spend a little higher share on non-necessities (household utilities and energy and other goods). Moreover, t-test results for mean differences in observed resource and shares of each child and adult exhibit statistical differences in the two family types.

We consider 15 demographic variables referring to the household in general and its members (head and children) in particular. If the head sick and Christian (Muslim and other religions being the reference category) capture the head's characteristics. The number of children who fell sick and, to account for the age factor, the number of older children (aged between 15 and 17) are incorporated to control for children's attributes. Two household level characteristics are used to control for economic status: female employment ratio (working females over household total labor of 14-60 years) and if the household has safe water source. Presence of other adults than parents is also controlled. Whether seasonal differences matter is captured by a dummy if the household was interviewed in February. Exposures to price shock and natural shocks are also accounted for. Finally, spatial differences in demand are controlled by incorporating dummies for rural areas as well as five regions (Amhara, Oromia, SNNP, Tigray and Other regions), with living in the capital, Addis Ababa, being the reference category.

Table 1: Descriptive statistics of key variables: ESS 2013/14

Variable	Male-headed HHs (N = 2467)					Single-mother HHs (N = 729)					Whole sample (N = 3196)			
	Zero%	Mean	S.d.	Min.	Max.	Zero%	Mean	S.d.	Min.	Max.	Mean	S.d.	Min.	Max.
Expenditures, shares and prices														
Food***	0.08%	0.69	0.15	0.07	0.98	0.28%	0.66	0.17	0.07	0.97	0.68	0.16	0.0678	0.979
Clothing***	3.66%[b]	0.11	0.04	0.02	0.68	9.66%[c]	0.09	0.04	0.02	0.24	0.10	0.04	0.0152	0.681
Utilities***	0.91%	0.07	0.07	0.00	0.69	1.99%	0.10	0.09	0.00	0.55	0.08	0.08	0.0002	0.688
Other goods***	0.54%	0.13	0.12	0.00	0.82	1.00%	0.16	0.14	0.00	0.88	0.14	0.13	0.0006	0.884
Log of food prices***		2.56	0.67	-5.30	4.70		2.41	0.71	-4.25	4.28	2.52	0.68	-5.2983	4.697
Log of clothing prices***		5.25	0.13	4.92	5.79		5.21	0.14	4.93	5.77	5.24	0.13	4.9166	5.787
Log of utilities prices**		2.35	1.73	-4.80	6.77		2.13	1.79	-4.00	6.36	2.30	1.74	-4.8007	6.771
Log of other goods prices***		3.28	0.56	-0.29	6.11		3.44	0.58	0.69	5.17	3.31	0.57	-0.2877	6.106
Expenditure and member shares														
Log of total expenditure***		7.51	0.70	4.18	9.63		7.22	0.73	4.52	9.39	7.44	0.72	4.1805	9.634
Share of assignables***		0.16	0.09	0.02	0.79		0.13	0.07	0.02	0.55	0.16	0.09	0.0175	0.786
Observed share: children		0.50	0.14	0.11	0.85		0.50	0.16	0.14	0.86	0.50	0.15	0.1083	0.856
Each child's share***		0.18	0.07	0.04	0.49		0.29	0.12	0.08	0.67	0.21	0.10	0.0393	0.667
Observed share: adults		0.50	0.14	0.15	0.89		0.50	0.16	0.14	0.86	0.50	0.15	0.1439	0.892
Each adult's share***		0.21	0.07	0.07	0.72		0.31	0.13	0.09	0.76	0.24	0.10	0.0728	0.757
Demographic variables														
Head is Christian***		0.65	0.48	0	1		0.74	0.44	0	1	0.67	0.47	0	1
Head sick***		0.20	0.40	0	1		0.38	0.49	0	1	0.24	0.43	0	1
# of sick children***		0.50	0.91	0	8		0.28	0.61	0	6	0.45	0.85	0	8
A stunted child in household***		0.31	0.46	0	1		0.12	0.32	0	1	0.26	0.44	0	1
# of children aged 15-17y**		0.39	0.59	0	3		0.47	0.59	0	3	0.41	0.59	0	3
Female employment ratio***		0.51	0.16	0	1		0.65	0.34	0	1	0.54	0.22	0	1
Other adult in household**		0.32	0.47	0	1		0.37	0.48	0	1	0.33	0.47	0	1
HH has safe water source***		0.67	0.47	0	1		0.79	0.41	0	1	0.70	0.46	0	1
HH interviewed in February*		0.90	0.30	0	1		0.87	0.33	0	1	0.89	0.31	0	1
HH faced price shock***		0.18	0.39	0	1		0.23	0.42	0	1	0.19	0.39	0	1
HH faced natural disaster shock		0.15	0.36	0	1		0.13	0.33	0	1	0.14	0.35	0	1
HH lives in rural area***		0.75	0.43	0	1		0.55	0.50	0	1	0.71	0.46	0	1
HH lives in Addis Ababa***		0.03	0.17	0	1		0.07	0.26	0	1	0.04	0.20	0	1
HH lives in Amhara region*		0.19	0.39	0	1		0.22	0.42	0	1	0.20	0.40	0	1
HH lives in Oromia region**		0.21	0.41	0	1		0.16	0.37	0	1	0.20	0.40	0	1
HH lives in SNNP region***		0.26	0.44	0	1		0.19	0.39	0	1	0.24	0.43	0	1
HH lives in Tigray region***		0.10	0.30	0	1		0.19	0.39	0	1	0.12	0.33	0	1
HH lives in other regions***		0.21	0.41	0	1		0.16	0.37	0	1	0.20	0.40	0	1
Distribution factors														
Education diff. of parents (w - h)[a]		-1.29	3.19	-15	10		-	-	-	-	-	-	-	-
Age diff. of parents (w - h)[a]		-8.48	6.48	-40	25		-	-	-	-	-	-	-	-
All children in school***		0.61	0.49	0	1		0.70	0.46	0	1	0.63	0.48	0	1
Proportion of female children		0.51	0.33	0	1		0.52	0.41	0	1	0.52	0.35	0	1
Proportion of women***		0.49	0.10	0	1		0.84	0.23	0	1	0.57	0.21	0	1
Number of non-biological children***		0.19	0.48	0	4		0.82	1.11	0	8	0.33	0.73	0	8
Household size***		5.78	1.97	2	15		3.96	1.76	2	11	5.36	2.07	2	15
# of children***		3.28	1.71	1	10		2.05	1.27	1	8	3.00	1.70	1	10
Wealth index*		1.17	3.27	-4.42	28.37		0.93	3.73	-3.22	28.09	1.12	3.38	-4.4182	28.37

Notes: [a] Not used in model estimation in single-mother sub-sample. [b] Clothing zero values are before Tobit regressions were run to correct for them. *, ** & *** show significance in mean difference of variables in the two samples at 10%, 5% & 1% levels respectively. For region dummies, the left-out category in regressions is living in the capital, Addis Ababa. SNNP=Southern Nations, Nationalities and Peoples.

In total, 71% of our sample households live in rural areas, 75% for the traditional male-headed and 55% for single-mother ones. Moreover, a fifth of them are drawn from each of Amhara region, Oromia region and other smaller regions, a quarter from SNNP region, a tenth from Tigray and the rest from Addis Ababa. Both family types statistically differ in almost all of the demographic variables considered. Notably, average household size in married male-headed families is 5.8, of whom 3.3 (57%) are children, while these figures are 4.0 and 2.1 (53%) in single-mother families. For the total sample, children account for 56% of the 5.4 family size. The latest available census shows that children constitute over 52% of the population in Ethiopia.

We use six distribution factors to partly capture the rule governing bargaining between children and their parents: education and age differences between wife and husband (only for the male-headed sub-sample), if all children are in school, proportion of female children, proportion of women, and number of non-biological children. Distribution factors, by definition, do not affect preferences but do influence bargaining power. As that feature of not affecting preferences is difficult to verify, we prefer motivating the choice of the majority of the distribution factors from the literature. Education and age differences or ratios of couples are quite popular determinants of intrahousehold resource allocation (Dercon and Krishnan, 2000; Menon et al., 2017; Chavas et al., 2017). To capture the role played by gender in intrahousehold resource allocation, we use two ratios - proportions of female children and female adults, the first of which is also employed by Mangiavacchi and Piccoli (2017). Lastly, we consider as exogenous the number of extended or non-biological children which may also affect bargaining power in the household without affecting consumption choices.

Note that, as demonstrated in Table 1, the various budget shares significantly differ in the two family types implies that it is wrong to analyze intrahousehold bargaining of children with adults merging the two sub-samples and using single-motherhood as a distribution factor. For married male-headed households, the husband on average has 1.3 more years of education than his wife, which could reach up to 15 years. There is also a substantial age gap between couples, the wife being 8.5 years younger on average, and ranging between 40 years younger and 25 years older.[11] In over 70 percent of single-mother households, school-age children attend school which is significantly higher than in male-headed households

[11] This is not in fact surprising as women in Sub-Saharan Africa typically marry older men, with median difference of 7 years (UN Population Division, 2001, World Marriage Patterns, New York). Bargain et al. (2014) also find for Cote d'Ivoire that mean difference ranges between 8.2 to 8.7 depending on the number of children.

(60 percent). While the proportion of girls and boys is almost balanced in both family structures, single-mother families have obviously more adult women. Moreover, not all children live with their biological parents: as many as four and eight children in male-headed and single-mother households are non-biological (extended) respectively. These distribution factors are proposed to play a role in the resource allocation between children and their parents.

4 Results and Discussion

This section presents the results of our estimations and discussions are also made where deemed necessary. After briefly presenting our intermediate results from the demand system estimations, we present and discuss our estimates on child resource shares and poverty. Analyses are also made disaggregating the estimates by number of children, region and rural/urban residence.

4.1 Demand System Estimation Results

We estimate two collective AIDS models: a quadratic version for married male-headed households and a linear version for single female-headed households. These specifications are dictated by the Engel curves shown in Figure 2 and estimation results are summarized in Table 11 in the Appendix. In addition to having the expected sign, the majority of price- and expenditure-related parameters are significantly different from zero at conventional levels. Control parameters ρ_i capturing endogeneity of total expenditure are significant in three-fourths of both sub-sample regressions indicating that the log of total expenditure would have been endogenous had it not been instrumented. Results of the regression of log of total expenditure on the wealth index instrument and other variables, whose residuals enter in the demand systems regressions for our controlling exercise, are summarized in Table 10 in the Appendix.

Some significant non-spatial demographic effects on non-durable consumption are observed. For example, religion plays a role where families headed by a Christian male, relative to Muslims and other believers, have lower spending on food and alcohol but higher on household utilities and energy. While the sickness of the head increases food spending and reduces clothing, more number of sick children does the opposite. And as expected, both family types with more older children (15 to 17 years) as well as other adults have higher clothing demands. Households hit by price shocks adjust by reducing consumption of food alcohol and increasing that of other goods. These correlations reverse direction when shocks are natural disasters.

Regarding spatial effects, there exist significant differences in demand across regions. As expected, compared to living in the capital city, living in less urbanized regions of Amhara, Oromia, SNNP and other smaller regions is associated with higher food expenditure shares and lower demands for utilities and energy and other goods categories.

The associated income and prices elasticities are also estimated and they are summarized, along with their standard errors, in Table 12 of the Appendix. The signs are in line with theory. Both children and adults reveal almost similar income elasticity patterns: inelastic for food and clothing, almost unitary for utilities and elastic for other goods. Magnitude wise, adults are a little more elastic than children for clothing and utilities. Consistent with consumption theory, all own-price elasticities (uncompensated and compensated) are also negative. In particular, own-price effects indicate that except the other goods category, which is elastic, all categories are inelastic. The compensated cross-price elasticities generally suggest substitutability: food and alcohol category is a significant substitute for clothing category and other goods category, and the latter are substitutes for food, clothing and utilities categories in traditional families.

The estimated coefficients of the sharing function are presented in Table 2. Five out of six distribution factors in married male-headed and and two out of four in single female-headed families significantly affect the bargaining power between children and adults. The years of schooling difference between parents (wife minus husband) positively and significantly affects adults' sharing rule, against the expectation that educated mothers, relative to fathers, are more altruistic towards their children. In contrast, Dunbar et al. (2013) find that higher mother's education is associated with higher bargaining power (resource shares) for both children and women in Malawi. The negative coefficient of the difference in age between the wife and the husband also implies that older mothers tend to keep more resources to children.

Table 2: Coefficients of the sharing rule's expenditure scaling m-function: bargaining

Variable	**Male-headed**		**Single-mother**	
	Coeff.		**Coeff.**	
Educ. diff. (wife-husb.)	0.187***	(0.037)	-	
Age diff. (wife-husb.)	-0.069***	(0.015)	-	
All children in school	-0.324*	(0.166)	1.200**	(0.504)
% of female children	-0.409*	(0.228)	-0.181	(0.327)
% of women	1.188	(0.862)	3.178***	(2 .940)
# of non-biol children	0.291**	(0.145)	0.120	(0 .122)

Notes: *, ** & *** show significance at 10%, 5% & 1% levels respectively. Standard errors, corrected for clustering and sampling weights, are in parentheses.

When all children are in school, their relative resource sharing rules are higher in traditional families where the male is the head though this effect is reversed in single-mother families. On the other hand, parents with more female children keep less resources to themselves, as shown by the negative coefficient attached to the proportion of female children, also suggesting a boy-girl discrimination as documented elsewhere (Deaton, 1989; Gibson and Rozelle, 2004; Dunbar et al., 2013). This distribution factor nonetheless is not significant in single-parent families. Also as expected, the proportion of women reduces children's sharing rule. Lastly, the number of non-biological (extended) children is also another distribution factor and it reduces the resource share of children in both family types though it is not statistically significant in single-mother households. This is in line with discrimination by adults against children who are not their own biological daughters or sons. These findings have important policy implications such as in income transfer programmes targeted at child poverty since their effectiveness is largely conditional on parental altruism (Bhalotra, 2004).

4.2 Estimated Children's Resources and Poverty

4.2.1 Children's Resources

Based on observed individual expenditures and estimated expenditure-scaling function coefficients, which are demographically-augmented, we compute the sharing rule or the shadow resource allocation between children and adults. The average estimates for both family structures and the whole sample, along with observed shares for comparison, are presented in Table 3.

Table 3: Means of estimated resources and shares by family type

	Male-headed		**Single-mother**		**Whole sample**	
Total expenditure (ETB) (e)	2221	(53.04)	1664	(87.82)	2115	(46.33)
Resources in ETB:						
Children's resources (ϕ_2)	1033***	(28.02)	804***	(56.76)	989	(25.18)
Each child	339***	(8.87)	433***	(20.00)	357	(8.37)
Adults' resources (ϕ_1)	1188***	(35.38)	860***	(44.23)	1126	(30.01)
Each adult	491	(14.82)	457	(19.70)	485	(12.57)
Resource shares:						
Children's resource share ($S_2 = \phi_2/e$)	0.47*	(0.005)	0.49*	(0.008)	0.48	(0.005)
Each child ($r_2 = S_2/h_2$)	0.16***	(0.002)	0.30***	(0.007)	0.19	(0.002)
Adults' resource share ($S_1 = \phi_1/e$)	0.53*	(0.005)	0.51*	(0.008)	0.52	(0.005)
Each adult ($r_1 = S_1/h_1$)	0.23***	(0.003)	0.32***	(0.007)	0.24	(0.003)

Notes: *** & * show significance of mean difference in male-headed and single-mother sub-samples at 1% & 10% levels respectively. ETB = Ethiopian Birr; 1 ETB = 0.0524 US$ (2013/14 Avg.) (NBE). All observations are weighted to make estimates nationally representative. Standard errors, corrected for clustering and sampling weights, are in parentheses.

Our estimates generally reveal significant inequalities in intrahousehold resource allocation. In aggregate terms, children command slightly less resources (48% of total expenditure in the whole sample, 47% in male-headed and 49% in single-mother families). These are not of course surprising, given that children constitute 55%, 56%, 53% in the total sample, male-headed and single-mother households respectively. Recall that the observed aggregate shares indicate equal allocations between children and adults in all family structures.

The distributions of children's and adults' resource shares in the space of total expenditure are depicted in Figure 3 in the Appendix. For the whole of the expenditure distribution, the trends in the shares remain generally similar. The finding of almost horizontal curves is very important as it goes inline with our identification restriction that the sharing rule is not affected by total household expenditure.

Aggregate child and adult resource shares are affected by the number of children and adults and hence are less informative. As a result, we need to consider the average per-child resource shares in households of different sizes. Intrahousehold inequalities between children and adults widen when one considers average per-member shares. In the whole sample, while each child claims less than a fifth of household resources, each adult gets about a quarter. Not only a child in single-mother families (30%) commands more resources than that in male-headed families (16%) but also the gap between children and adults is lower in the former than in the latter. This finding is in line with that elsewhere in Africa. Bargain et al. (2014) find, for instance in Cote d'Ivoire, that in single-mother families, children claim higher share of household resources (31%) than in two-parent families (23%) which are likely to be male-headed. As expected, families headed by unmarried females have lower total household expenditure (1664 ETB) than those headed by married males (2221 ETB). However, single-mothers spend more for each child (433 ETB per month) than male-headed couples (339 ETB per month) suggesting that female heads are more altruistic to their children than male heads.

4.2.2 Child Poverty

While resource shares provide information on who gets what from the household's cake, they do not tell whether the allocated cake to each member is enough to satisfy their needs. A step computing member's welfare and any intrahousehold disparity therein is needed. For instance, in addition to analyzing poverty among children, one can assess any existing inequality between child and adult poverty.

Accordingly, we use the estimated per-member resources to compute FGT rates of poverty incidence, gap and severity among children and adults for both family types and the whole sample of households with children. For comparison, rates are also computed based on adult-equivalent (equivalent scale) expenditures where resources are assumed to be shared equally among members. The poverty threshold considered is the (official) national poverty line computed using the Cost of Basic Needs approach.[12] Results are presented in Table 4. Note that the new approach of employing estimated resources in poverty measurement provides us with more disaggregations in the indices compared to the traditional approach (shown here by an extra row per family member group and poverty index).[13]

Some immediate results are worth noting. Firstly, it is comforting to notice from columns 1, 3 and 5 that indicators of poverty incidence, gap and severity are higher for children

[12] We use the national poverty line (MoFED, 2012) since it is used to target the poor in the country and is based on their needs. In 2010/11, the poverty line was 315 ETB/person/month (3781 ETB/person/year) and after adjusted for inflation, it becomes 501 ETB/person/month in 2013/14.

[13] We do not need to make a fixed adjustment to the poverty line to consider the lower needs of children such as the OECD scale. Our estimation of the intrahousehold resource allocation is such that a fair distribution of goods not assigned to members is corrected by our expenditure-scaling function (Menon and Perali, 2012) whose estimates were presented in the previous section. Note also that Bargain et al. (2014) question the relevance of the OECD scale to adjusting child poverty lines.

Table 4: Poverty measures based on new method and traditional approaches (%)

	Male-headed families		Single-mother families		Whole sample	
	New Method	Household level	New Method	Household level	New Method	Household level
	(1)	(2)	(3)	(4)	(5)	(6)
Child poverty headcount P_0	83.8***	66.5^u	72.9***	61.2^u	81.7	65.5^u
Adult poverty headcount P_0	70.2		69.7		70.1	
Child poverty gap rate P_1	45.9***	27.8^u	33.0***	22.7^u	43.4	26.8^u
Adult poverty gap rate P_1	32.3***		28.2***		31.5	
Child poverty severity P_2	29.6***	14.6^u	18.8***	11.2^u	27.6	14.0^u
Adult poverty severity P_2	18.4***		14.4***		17.6	

Notes: *, ** & *** show significance of mean difference of poverty rates (based on estimated resources) between male-headed and single-mother sub-samples at 10%, 5% & 1% levels respectively. ^{u}shows household level or equal sharing-based poverty rates are less (or understate poverty) than estimated resources-based rates at 1%. MoFED (2012)'s 2010/11 CBN-based national poverty line, adjusted for inflation, is considered. All observations are weighted to make estimates nationally representative.

than for adults. In the whole sample, about 84% of children live below the national poverty line, lower at 70% among adults.[14] Such gaps between child and adult poverty incidence also exist in both family types though the one in single-mothers is lower. This finding strengthens the previous evidence of intrahousehold inequality in resource allocation. Secondly, the incidence, depth and severity of poverty among children in male-headed families are significantly higher than those in female-headed families.

Thirdly, in all cases, our estimated resources count more poor children (and adults) than what household level or equal-sharing methods do; and the same is true for higher child poverty measures (compare estimates in columns 1, 3 and 5 correspondingly with those in columns 2, 4 and 6). All the differences are statistically significant at the 1% level. This shows that the traditional approach of measuring poverty based on equal resource sharing, which by default ignores intrahousehold distribution among members, understates poverty situation. We thus verify the hypotheses of Haddad and Kanbur (1990). Recent collective consumption model studies also document similar conclusions from other sub-Saharan Africa countries although their analyses are restricted only to poverty headcount ratio. Dunbar et al. (2013) on Malawi and Bargain et al. (2014) on Cote d'Ivoire find that standard poverty indices understate the incidence of child poverty.

[14] Care must, however, be exercised in taking these figures. The 2013/14 round of the ESS considers a select of consumer goods, missing certain food aggregates. The poverty estimates here primarily aim to show use of resources share as an alternative method to the traditional ones, and hence cannot easily be compared with other estimates such as those in MoFED (2012).

Table 5: Child poverty headcount rates (%) by number of children

	One child	Two children	Three children	Four children	Over four children	Overall
Male-headed households:						
Poverty rate: child	65.5	78.8	87.2	87.5	92.9	83.8***
Poverty rate: adult	47.4***	61.5**	71.0	78.8	84.1	70.2
Pov. rate: household level	41.1**	57.5**	68.3	72.2	83.4	66.5***
Single-mother households:						
Poverty rate: child	64.1	76.7	78.1	86.5	92.7	72.9***
Poverty rate: adult	62.5***	71.7**	76.5	81.1	86.5	69.7
Pov. rate: household level	53.2**	67.3**	63.6	66.4	79.1	61.2***
Whole sample:						
Poverty rate: child	64.9	78.3	86.2	87.4	92.9	81.7
Poverty rate: adult	53.9	64.1	71.6	79.0	84.2	70.1
Pov. rate: household level	46.3	60.0	67.7	71.6	83.2	65.5

Notes: *, ** & *** show significance of poverty difference between male-headed and single-mother sub-samples at 10%, 5% & 1% levels respectively. All observations are weighted to make estimates nationally representative.

Child poverty estimates discussed so far do not tell any existing disparity in poverty status with a change in family size. One may also be interested to see what sacrifices parents and/or children have to pay when more children join the family. Table 5 summarizes poverty headcount estimates by number of children.[15]

As expected, child poverty increases with the number of children in the household. In the whole sample of families with children, incidence of child poverty increases from 65% when there is only one child to 93% when families host more than four children. Dunbar et al. (2013) also find similar positive relationship between child poverty and number of children. Similar trends are observed in the two family structures. However, the previous finding that children in single-mother families are less likely to be poor than those in male-headed couples no more stays when disaggregated by the number of children. No difference in child poverty incidence rates is statistically significant except the overall rate. On the

[15] We are aware that modeling multi-children and multi-adults households is challenged by economies of scale. For instance, children may share clothing, books, etc. thereby underestimating child resource shares and overestimating poverty among larger families. Our current estimations cannot consider this and it remains a limitation of the paper. In fact, this issue of joint consumption by children is a limitation of collective consumption models to date (Bargain et al., 2014; Mangiavacchi et al., 2018) and forms a future research agenda. Some prefer to use a very restrictive sample such as households with just one child (?) or separate estimations by size (Bargain et al., 2014). While we provide results for families with one child as well as with two, three, four and over four children, the estimates should be taken with caution.

Table 6: Overlap between child, adult and household poverty by family structure

		Male-headed families				Single-mother families				Whole sample			
		Adult is poor		HH is poor		Adult is poor		HH is poor		Adult is poor		HH is poor	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Child	Yes	0.67	0.17	0.66	0.18	0.65	0.08	0.60	0.13	0.67	0.15	0.67	0.17
is		(0.013)	(0.011)	(0.013)	(0.011)	(0.024)	(0.014)	(0.025)	(0.017)	(0.011)	(0.009)	(0.011)	(0.009)
poor	No	0.03	0.13	0.00	0.16	0.05	0.22	0.01	0.26	0.04	0.15	0.01	0.18
		(0.005)	(0.008)	(0.002)	(0.009)	(0.009)	(0.020)	(0.004)	(0.021)	(0.004)	(0.008)	(0.002)	(0.009)
Status match*		0.80		0.82		0.87		0.86		0.82		0.83	
Poor in ALL three		**0.63** (0.013)				**0.59** (0.025)				**0.62** (0.012)			

Notes: *Status match implies the proportion of children with similar status in two measures. All estimates are weighted to make them representative of the corresponding population. Standard errors in parentheses.

other hand, like in the overall case, poverty among children consistently remains worse than that among adults though the gap falls with an increase in the number of children. If intrahousehold resource allocation was ignored, poverty would be understated with any number of children, once again confirming the Haddad and Kanbur (1990) hypotheses.

4.2.3 Child Poverty, Household Poverty and Undernutrition Overlap

A further benefit of the new method to child poverty estimation using resource shares is that it helps to look at the existing overlap between the poverty of children, adults and other members. What proportion of poor children live with non-poor adults? What portion of poor children live in non-poor households? Do these differ when the head is a female? We also provide some evidence on the overlap between child undernutrition and monetary poverty at child, adult and household levels.

Table 6 summarizes estimates of the overlap between child-, adult- and household-level poverty by family structure. Two-thirds of poor children live with poor adults or households in general, irrespective of family structure. However, the proportion of poor children living with non-poor adults is non-negligible: 15 percent in the whole sample. Far less portion of poor children live with non-poor adults in female-headed families (8 percent) than in male-headed ones (17 percent), supporting our previous evidence that single mothers in general are more equal to their children than male-heads. Note that these estimates only slightly change when child poverty is allowed to overlap with household poverty. Our estimates also show that the match in poverty status of children and either of adults or households in general ranges between 80 to 87 percent depending on the family type

Table 7: Overlap between child undernutrition and poverty of children, adults and the household

		Child poverty		Adult poverty		Household poverty	
		Poor	Non-poor	Poor	Non-poor	Poor	Non-poor
		(1)	(2)	(3)	(4)	(5)	(6)
Child stunting	Any stunted	0.24 (0.010)	0.03 (0.004)	0.21 (0.010)	0.06 (0.005)	0.19 (0.009)	0.09 (0.006)
	No stunted	0.58 (0.012)	0.15 (0.008)	0.50 (0.012)	0.24 (0.010)	0.47 (0.012)	0.26 (0.010)
Status match*		0.39		0.45		0.45	

Notes: *Status match implies the proportion of children with similar status in two measures. All estimates are weighted to make them representative of the corresponding population. Standard errors in parentheses.

and comparison group considered. Moreover, only about 60 percent of poor children reside with a poor adult and in a poor household which is slightly higher in male-headed households.

Table 7 provides further evidence on other overlaps for the whole sample, this time the overlap of child stunting with child poverty, adult poverty and household poverty where stunting here refers to prevalence of any under-7 child who is stunted. Two interesting results stand out. First, undernourished children still exist in monetarily non-poor households which is also consistent with recent findings across Africa (Brown et al., 2017). Second, the prevalence of undernourished children decreases from 9%, 6% and 3% as one changes the child stunting overlap with household-, adult- and child-level poverty estimates respectively.

These evidences lend support to the burgeoning literature on the role of inequality in intrahousehold resource allocation on household member's welfare (Haddad and Kanbur, 1990; Dunbar et al., 2013; Bargain et al., 2014). In particular, it adds to the rejection of the widely held view that poor children live with/ in poor adults/ households (Brown et al., 2017, 2018).. From a policy perspective, it questions the effectiveness of targeting poor households for a social protection aiming at improving child welfare.

4.3 Spatial Distribution of Child Resource Shares and Poverty

Answering the question of where on the map children make the most/least decisions on home resources and locating poor children aid policymakers interested on the issue. Hence, average resource share and poverty estimates are disaggregated by region and place

Table 8: Spatial distribution of resource shares and poverty headcount rate (%)

	Regions						Rural/urban		
	Addis Ababa	**Amh-ara**	**Oro-mia**	**SNNP**	**Tig-ray**	**Other regions**	**Rural**	**Small towns**	**Medium & large**
Male-headed:									
Per-child resource share	0.21***	0.16***	0.16***	0.15***	0.15***	0.16***	0.16***	0.17***	0.17***
Per-adult resource share	0.26	0.24***	0.22***	0.22***	0.23***	0.24***	0.22***	0.24***	0.28***
Poverty headcount: child	50.9*	85.2**	84.0	87.2	78.5***	80.7***	87.5**	74.2	58.7
Poverty headcount: adult	26.9**	73.2	69.5	77.7*	61.1	59.0	76.1	56.2*	29.6***
Poverty headcount: household	16.5	72.1	64.6	72.8	59.2**	57.0	73.2	47.1	21.7***
Single-mother:									
Per-child resource share	0.26***	0.33***	0.27***	0.30***	0.30***	0.29***	0.29***	0.32***	0.32***
Per-adult resource share	0.24	0.35***	0.30***	0.33***	0.31***	0.32***	0.32***	0.32***	0.32***
Poverty headcount: child	35.6*	76.1**	76.4	86.3	66.9***	63.7***	80.6**	63.7	54.9
Poverty headcount: adult	46.0**	73.8	69.4	85.2*	58.6	54.0	76.2	68.7*	52.2***
Poverty headcount: household	27.2	65.0	65.1	73.4	46.7**	52.1	69.7	52.3	40.9***
Whole sample:									
Per-child resource share	0.23	0.20	0.17	0.17	0.20	0.18	0.18	0.21	0.22
Per-adult resource share	0.25	0.26	0.23	0.23	0.20	0.25	0.23	0.26	0.29
Poverty headcount: child	44.7	83.1	82.9	87.1	73.0	77.8	86.4	71.3	57.4
Poverty headcount: adult	34.5	73.3	69.5	78.8	60.3	58.1	76.1	59.3	37.4
Poverty headcount: household	20.9	70.5	64.7	72.9	55.1	56.2	72.7	48.5	28.5

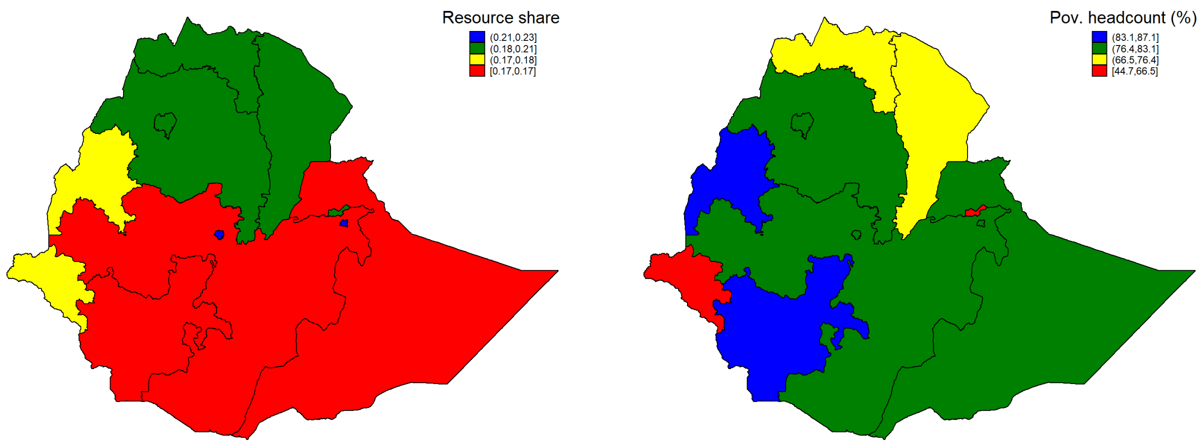
Notes: *, ** & *** show significance of mean difference in male-headed and single-mother sub-samples at 10%, 5% & 1% levels respectively. All observations are weighted to make estimates representative.

of residence (rural, small towns, and medium and large towns).[16] Table 8 summarizes the results.

Looking at the average resource share estimates, three findings stand out. Firstly, in line with our previous finding, a child has less resource share than an adult across regions and rural/urban residence. Secondly, a child's resource share shows no systematic relation with urbanization. For a map of regional disparities in child resource shares for the whole sample, see the left panel of Figure 1. Average per-adult expenditure shares vary across regions between 20% and 26% in the whole sample. Thirdly, across all regions and residence types, single-mothers significantly allocate more resources children compared with married males.

[16]Based on the 2007 Population Census, the ESS defines a small-sized town as one with population of less than 10,000; medium-sized between 10,000 and 100,000 and big-sized greater than 100,000.

Figure 1: Regional distribution of child resource shares and poverty headcount rates (%)



Note: Estimates are representative only to regions of Addis Ababa, Amhara, Oromia, SNNP and Tigray.

Regarding poverty incidence, disaggregated estimates in Table 8 similarly disclose presence of large spatial disparities. For instance, the chance of children falling in poverty in male-headed (resp. single-mother) families ranges between 88% (81%) in rural areas to 59% (55%) in medium and large towns, and falling as low as 51% (46%) in the nation's largest city and capital, Addis Ababa. There is significant difference in child poverty incidence between male-headed and single-mother households in the majority of the regions and rural areas. On the other hand, if intrahousehold resource allocation was ignored, poverty would once again be understated and we would notice no significant poverty prevalence difference between the two family structures in all regions (except Tigray) and rural/urban areas (except medium and large towns). Figure 1 (right panel) visually maps the disparities in child poverty across regions for the whole sample of families with children.

5 Concluding Remarks

Children have long been sidelined in the literature as decision makers in household resources. While they could be a victim of the widely-evidenced intrahousehold inequality, parental altruism may benefit them. The scant collective model evidence on children's shares of household resources and poverty in developing countries that are sizably populated by children is inconclusive. We estimate a complete collective demand model to recover children's resource shares and analyze poverty in married male-headed and single female-headed families in Ethiopia. Identification strategy of the sharing rule relies on use of private exclusive goods and distribution factors.

Results generally confirm disparities in intrahousehold resource allocation and poverty which vary with the number of children, family type and space. The allocation is significantly affected by parental differences in education and age, child education, proportions of female children and women as well as number of non-biological children. Children command less household resources than adults and children in single-mother families have higher resource shares than those in male-headed families.

After using resource shares for computing incidence, depth and severity of poverty, we also find that children are poorer than adults. Single-mothers not only are more altruistic to their children, they also avoid higher child poverty than married male heads although this seems to disappear when the number of children increases. We find that traditional poverty measures, which by construction ignore intrahousehold allocation, understate child (and adult) poverty compared to those based on our resource shares. Our estimates also show that non-poor families also host poor children, unlike the general belief that poor children live only with poor adults and households. We also find that monetarily non-poor adults and households host stunted children. Finally, regional and rural-urban disparities exist in both child resource shares and poverty.

Our results are important for few intervention issues. Firstly, by disclosing intrahousehold inequalities in resource allocation and poverty that children do better only at low family size, the results lend support to fertility interventions. Ignoring this inequality means a misleading picture of the incidence, depth and severity of poverty. Secondly, gender of the household head matters to children as mothers found to be more pro-child. Thirdly, the overlaps between child poverty, adult poverty, household poverty and child stunting question the effectiveness of targeting just poor households for a social protection aiming at improving child welfare. Lastly, pro-rural spatial redistributive efforts are implied to reduce disparity between children in rural and urban areas.

The study contributes to the methodological and evidence gap in system-wide estimation of resource shares and use of them in poverty estimation and analysis. Yet, given that child well-being is multidimensional, the overlap between the new monetary child poverty and multidimensional poverty as well as impact of social protection on children's resource shares and well-being remain as future research agenda.

References

Banks, J., R. Blundell, and A. Lewbel (1997). Quadratic Engel Curves and Consumer Demand. *The Review of Economics and Statistics 79*(4), 527–539.

Bargain, O., O. Donni, and P. Kwenda (2014). Intrahousehold distribution and poverty: Evidence from Côte d'Ivoire. *Journal of Development Economics 107*, 262–276.

Bargain, O., P. Kwenda, and M. Ntuli (2018). Gender Bias and the Intrahousehold Distribution of Resources: Evidence from African Nuclear Households in South Africa. *Journal of African Economies 27*(2), 201–226.

Bargain, O., G. Lacroix, and L. Tiberti (2018). Validating the Collective Model of Household Consumption Using Direct Evidence on Sharing. *Centre de recherche sur les risques les enjeux économiques et les politiques publiques* (July).

Bhalotra, S. (2004). Parent altruism, cash transfers and child poverty. *University of Bristol, Department of Economics Discussion Paper* (04/562).

Bose-duker, T. (2018). Intra-household Resource Allocation and Poverty: The Ghanaian Case. *Paper presented at The CSAE Conference on Economic Development in Africa.*

Bourguignon, F. (1999). The cost of children: May the collective approach to household behavior help? *Journal of Population Economics 12*, 503–521.

Bourguignon, F., M. Browning, and P.-A. Chiappori (2009). Efficient Intra-Household Allocations and Distribution Factors: Implications and Identification. *The Review of Economic Studies 76*(2), 503–528.

Bourguignon, F., M. Browning, P.-A. Chiappori, and V. Lechene (1993). Intra Household Allocation of Consumption: a Model and some Evidence from French Data. *Annales d'Economie et de Statistique* (29), 137–156.

Brown, C., R. Calvi, and J. Penglase (2018). Sharing the Pie: Undernutrition , Intrahousehold Allocation, and Poverty.

Brown, C., M. Ravallion, and D. Van de Walle (2017). Are Poor Individuals Mainly Found in Poor Households? Evidence Using Nutrition Data for Africa. *NBER Working Paper No. 24047*.

Browning, M., F. Bourguignon, P.-A. Chiappori, and V. Lechene (1994). Income and Outcomes: A Structural Model of Intrahousehold Allocation. *Journal of Political Economy 102*(6), 1067–1096.

Browning, M., P.-A. Chiappori, and A. Lewbel (2006). Estimating Consumption Economies of Scale, Adult Equivalence Scales, and Household Bargaining Power. *Boston College Department of Economics Working Paper 588*.

Browning, M., P.-A. Chiappori, and A. Lewbel (2013). Estimating consumption economies of scale, adult equivalence scales, and household bargaining power. *Review of Economic Studies 80*(4), 1267–1303.

Caiumi, A. and F. Perali (2015). Who bears the full cost of children? Evidence from a collective demand system. *Empirical Economics 49*(1), 33–64.

Chavas, J.-P., M. Menon, and F. Perali (2017). The Sharing Rule: Where Is It? *Working Paper Series, Department of Economics, University of Verona*.

Chiappori, P.-A. (1988). Rational Household Labor Supply. *Econometrica 56*(1), 63–90.

Chiappori, P.-A. (1992). Collective Labor Supply and Welfare. *Journal of Political Economy 100*(3), 437–467.

CSA, UNICEF, and OPM (2015). Child Well-Being in Ethiopia: Analysis of Child Poverty Using the HCE/WMS 2011 Datasets. *Central Statistical Agency, UNICEF and Oxford Policy Management*.

Dauphin, A., A.-r. E. Lahga, B. Fortin, and G. Lacroix (2011). Are Children Decision-Makers Within the Household? *Economic Journal 121*(553), 871–903.

Deaton, A. (1989). Looking for Boy-Girl Discrimination in Household Expenditure Data. *The World Bank Economic Review 3*(1), 1–15.

Deaton, A. and J. Muellbauer (1980). An Almost Ideal Demand System. *The American Economic Review 70*(3), 312–326.

Dercon, S. and P. Krishnan (2000). In Sickness and in Health: Risk Sharing within Households in Rural Ethiopia. *Journal of Political Economy 108*(4), 688–727.

Dunbar, B. G. R., A. Lewbel, K. Pendakur, G. R. Dunbar, A. Lewbel, K. Pendakur, and B. College (2013). Children's Resources in Collective Households: Identification, Estimation, and an Application to Child Poverty in Malawi. *American Economic Review 103*(1), 438–471.

Foster, J., J. Greer, and E. Thorbecke (1984). A class of decomposable poverty measures. *52*(3), 761–766.

Gibson, J. and S. Rozelle (2004). Is it better to be a boy? A disaggregated outlay equivalent analysis of gender bias in Papua New Guinea. *Journal of Development Studies 40*(4), 115–136.

Haddad, L. and R. Kanbur (1990). How Serious Is the Neglect of Intra-Household Inequality? *Economic Journal 100*(402), 866–81.

Lewbel, A. (1985). A Unified Approach to Incorporating Demographic or Other Effects into Demand Systems. *The Review of Economic Studies 52*(1), 1–18.

Lewbel, A. and K. Pendakur (2008, dec). Estimation of collective household models with Engel curves. *Journal of Econometrics 147*(2), 350–358.

Lise, J. and S. Seitz (2011). Consumption Inequality and Intra-household Allocations. *The Review of Economic Studies 78*(1), 328–355.

Mangiavacchi, L., F. Perali, and L. Piccoli (2013). Lucia Mangiavacchi Federico Perali Luca Piccoli November 15, 2013. pp. 1–31.

Mangiavacchi, L., F. Perali, and L. Piccoli (2018). Intrahousehold distribution in migrant-sending families. *Journal of Demographic Economics*, forthcoming.

Mangiavacchi, L. and L. Piccoli (2017). Gender inequalities among adults and children in collective households. *WIDER Working Paper 2017/109*.

Menon, M., K. Pendakur, and F. Perali (2012). On the expenditure-dependence of children's resource shares. *Economics Letters 117*, 739–742.

Menon, M. and F. Perali (2012). The Sharing Rule: Where Is It? *Working Paper Series Department of Economics University of Verona 16*(April), 1–34.

Menon, M., F. Perali, and L. Piccoli (2017). Collective Consumption: An Application to the Passive Drinking Effect. *Review of Economics of the Household*, forthcoming.

MoFED (2012). Ethiopia's Progress Towards Eradicating Poverty: An Interim Report on Poverty Analysis Study (2010/11). Technical Report March, Ministry of Finance and Economic Development, Addis Ababa.

Mukasa, A. N. (2015). *Welfare Effects of Food Price Changes in Uganda under Non-separability: How Relevant is the Net Market Position?* Ph. D. thesis, Trento.

Perali, F. (2003). *The Behavioral and Welfare Analysis of Consumption: The Cost of Children, Equity and Poverty in Colombia.* Springer Science+Business Media Dordrecht.

Schultz, T. P. (1990). Testing the Neoclassical Model of Family Labor Supply and Fertility. *The Journal of Human Resources 25*(4), 599–634.

Thomas, D. (1990). Intra-Household Resource Allocation: An Inferential Approach. *The Journal of Human Resources 25*(4), 635–664.

World Bank (2016). Ethiopia's Great Run: The Growth Acceleration and How to Pace It.

A Appendix

A.1 Derivation of the Collective Demand System Model

The derivation is based on Menon et al. (2017) and Mangiavacchi et al. (2013, 2018). Consider an extended PIGLOG individual expenditure function:

$$lne_k(u_k, \boldsymbol{p}) = lnA_k(\boldsymbol{p}) + \frac{\varphi(u_k)B_k(\boldsymbol{p})}{1-\varphi(u_k\lambda_k(\boldsymbol{p})} = lnA_k(\boldsymbol{p}) + \frac{B_k(\boldsymbol{p})}{\Psi(u_k)-\lambda_k(\boldsymbol{p})}$$

where $\Psi(u_k) = \varphi(u_k)^{-1}$ is decreasing in utility $\varphi(u_k)$; $\boldsymbol{p} = \{p_{c^1}, p_{c^2}, p_q\}$; and the continuous and concave price aggregators take up the usual functional forms: $lnA_k(\boldsymbol{p}) = \frac{1}{2}\left(\alpha_0 + \sum\limits_i \alpha_i lnp_i + \frac{1}{2}\sum\limits_i\sum\limits_j \gamma_{ij} lnp_i lnp_j\right)$, $B_k(\boldsymbol{p}) = \beta_0 \mathit{\Pi}_i p_i^{\beta_i^k}$ and $\lambda_k(\boldsymbol{p}) = \sum\limits_i \lambda_i^k p_i$, assumed to be a differentiable, homogeneous function of degree zero of prices. $\alpha_i, \gamma_{ij}, \beta_i^k$ and λ_i^k are parameters to be estimated. One can interpret the price aggregator $A(\boldsymbol{p})$ as that level of subsistence expenditure [or poverty expenditure (Deaton and Muellbauer, 1980)] of member k when her utility $u_k = 0$. The remaining two price aggregators, $B_k(\boldsymbol{p})$ and $\lambda_k(\boldsymbol{p})$, are associated with expenditure levels of each household member whose variations allow identification of the corresponding parameters β_i^k and λ_i^k.

Shephard's lemma gives individual Hicksian demand of good i as budget share:

$$w_i^k = \frac{\partial lne_k(u_k, \boldsymbol{p})}{\partial lnp_i} = \frac{\partial lnA_k(\boldsymbol{p})}{\partial lnp_i} + \frac{\frac{\partial B_k(\boldsymbol{p})}{\partial lnp_i}[\Psi(u_k)-\lambda_k(\boldsymbol{p})] + B_k(\boldsymbol{p})\frac{\partial \lambda_k(\boldsymbol{p})}{\partial lnp_i}}{[\Psi(u_k)-\lambda_k(\boldsymbol{p})]^2}.$$

Inverting this individual expenditure function gives indirect utility function:

$$\Psi(u_k) - \lambda_k(\boldsymbol{p}) = \frac{B_k(\boldsymbol{p})}{lne_k(u_k,\boldsymbol{p}) - lnA_k(\boldsymbol{p})}.$$

Substituting this gives the individual budget share of good i

$$w_i^k = \frac{\partial lnA_k(\boldsymbol{p})}{\partial lnp_i} + \frac{\frac{\partial B_k(\boldsymbol{p})}{\partial lnp_i}[\frac{B_k(\boldsymbol{p})}{lne_k(u_k,\boldsymbol{p})-lnA_k(\boldsymbol{p})}] + B_k(\boldsymbol{p})\frac{\partial \lambda_k(\boldsymbol{p})}{\partial lnp_i}}{[\frac{B_k(\boldsymbol{p})}{lne_k(u_k,\boldsymbol{p})-lnA_k(\boldsymbol{p})}]^2}$$

which could be expressed as:

$$w_i^k = \frac{\partial lnA_k(\boldsymbol{p})}{\partial lnp_i} + \beta_i^k[lne_k - lnA_k(\boldsymbol{p})] + \lambda_i^k\frac{[lne_k - lnA_k(\boldsymbol{p})]^2}{B_k(\boldsymbol{p})}.$$

Given the aforementioned informational constraint that quantities and prices of non-assignable goods are not observed, the above decentralized budget shares are aggregated at the household level for good i as follows:

$$w_i = \alpha_i + \sum_j \gamma_{ij} lnp_j + \beta_i^1[lne_1 - lnA_1(\boldsymbol{p})] + \lambda_i^1 \frac{[lne_1 - lnA_1(\boldsymbol{p})]^2}{B_1(\boldsymbol{p})}$$

$$+\beta_i^2[lne_2 - lnA_2(\boldsymbol{p})] + \lambda_i^2 \frac{[lne_2 - lnA_2(\boldsymbol{p})]^2}{B_2(\boldsymbol{p})}.$$

Following Lewbel (1985) and Perali (2003), the demand system is augmented to capture observed heterogeneity among households by introducing a translating technology $t_i(\boldsymbol{d})$ so that demographic attributes $\boldsymbol{d}$ enter additively with expenditures. This provides the demographically-modified demand system as follows:

$$w_i = \alpha_i + t_i(\boldsymbol{d}) + \sum_j \gamma_{ij} lnp_j + \beta_i^1[lne_1^* - lnA_1(\boldsymbol{p})] + \lambda_i^1 \frac{[lne_1^* - lnA_1(\boldsymbol{p})]^2}{B_1(\boldsymbol{p})}$$

$$+\beta_i^2[lne_2^* - lnA_2(\boldsymbol{p})] + \lambda_i^2 \frac{[lne_2^* - lnA_2(\boldsymbol{p})]^2}{B_2(\boldsymbol{p})}$$

where lne_1^* and lne_2^* are modified logarithmic individual total expenditures given by the translating household technology $lne_k^* = lne_k - \sum_i t_i(\boldsymbol{d}) lnp_i$. The demographic functions are simply defined as $t_i(\boldsymbol{d}) = \sum_r \tau_{ir} d_r$ for $r = 1, ...R$. Note that from the above demand system, we can estimate, for each good i, income parameters (β_i^1, β_i^2, λ_i^1 and λ_i^2) at individual level while the rest at household level (i.e. the intercepts α_i, price parameters γ_{ij} and demographic scaling effects $t_i(\boldsymbol{d})$).

While price elasticities remain the same as in the unitary setting, income elasticities capturing Engle effects for $x_i = c_i, q_i$ and for each household member $k = 1, 2$ are given in the decentralized CQUAIDS by:

$$\epsilon_i^{e_k} = \frac{\partial lnx_i}{\partial lne_k} = 1 + \frac{\beta_i^k}{w_i} + \frac{2\lambda_i^k}{B_k(\boldsymbol{p})} \frac{1}{w_i} (lne_k - lnA_k(\boldsymbol{p})).$$

A.2 Appendix Tables and Figures

Table 9: Aggregation of consumption expenditure items: ESS 2013/14

Expenditure group/sub-group and item			Recall*	Price type
I. FOOD AT HOME AND ALCOHOL				
1. Teff	10. Lentils	19. Milk	All monthly	Unit values (For alcoholic drinks: CSA retail prices)
2. Wheat	11. Haricot beans	20. Cheese		
3. Barley	12. Niger seed	21. Eggs		
4. Maize	13. Linseed	22. Sugar		
5. Sorghum	14. Onion	23. Salt		
6. Millet	15. Banana	24. Coffee		
7. Horse beans	16. Potato	25. Bula		
8. Chick pea	17. Kocho	26. Chat/Kat		
9. Field pea	18. Meat	27. Alcoholic drinks		
II. CLOTHING			All annually	CSA retail prices
2.1. Adult clothing				
1. Clothes/shoes/fabric for men				
2. Clothes/shoes/fabric for women				
2.2. Child clothing				
1. Clothes/shoes/fabric for boys				
2. Clothes/shoes/fabric for girls				
2.3. Non-assignable clothing (Linen: sheets, towels, blankets)				
III. HOUSEHOLD UTILITIES AND ENERGY				ESS local prices and CSA retail prices
3.1. Utilities: water, electricity & cell phone/landline use			Monthly	
3.2. Household energy		5. Firewood	Monthly (Annually for lamp)	
1. Matches	3. Batteries	6. Kerosene		
2. Candles (tua'f), incense	4. Charcoal	7. Lamp/torch		
IV. OTHER GOODS				CSA retail prices (For transport: ESS local prices)
4.1. Education: fees, books, uniforms, stationery, assistance, etc.			Monthly	
4.2. Food away from home and cigarettes			Weekly	
1. Full meals: breakfast, lunch, dinner				
2. Snacks (kolo, bread, biscuits, cakes, etc.)				
3. Dairy products (milk, yoghurt, etc.)				
4. Vegetables and roasted/boiled items				
5. Non-alcoholic drinks (coffee, tea, fruit juice, soda, etc.)				
6. Cigarettes, tobacco, suret and gaya				
4.2. Laundry and personal care			Annually	
4.3. Transport			Monthly	

Notes: *Recall periods here are as available in the ESS; all are finally converted to monthly values.

Figure 2: Engel curves of commodity groups by family type

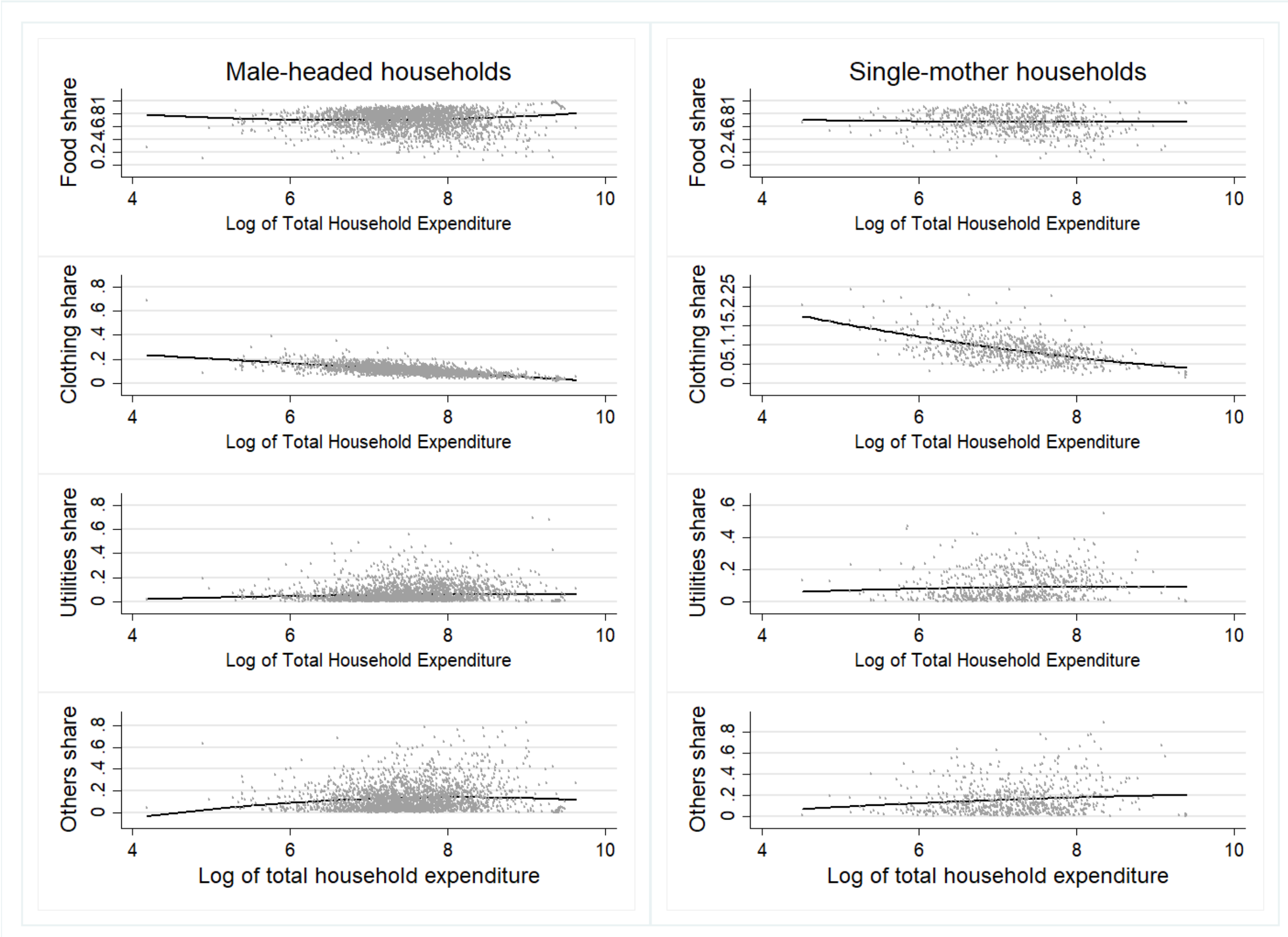


Table 10: Regression of total household expenditure: First stage

Variable	Male-headed HHs			Single-mother HHs		
Log of food prices	0.398	***	(0.034)	0.371	***	(0.061)
Log of clothing prices	-0.073		(0.166)	0.342		(0.215)
Log of utilities prices	0.029	***	(0.010)	0.008		(0.018)
Log of other goods prices	-0.128	***	(0.034)	-0.092	*	(0.053)
Head is Christian	-0.122	*	(0.072)	-0.117		(0.086)
Head sick	-0.039		(0.037)	0.024		(0.063)
# of sick children	0.024		(0.017)	0.055		(0.040)
# of children aged 15-17y	0.081	***	(0.021)	0.155	***	(0.048)
Female employment ratio	-0.098		(0.091)	0.187	*	(0.108)
Other adult in household	0.140	***	(0.032)	0.197	***	(0.063)
HH has safe water source	0.096	**	(0.048)	0.055		(0.081)
HH interviewed in February	-0.075		(0.059)	-0.060		(0.093)
HH faced price shock	-0.115	**	(0.049)	0.059		(0.075)
HH faced natural disaster shock	0.127	**	(0.061)	0.238	**	(0.107)
HH lives in Amhara region	0.186	**	(0.092)	0.161		(0.128)
HH lives in Oromia region	0.243	***	(0.075)	0.302	***	(0.113)
HH lives in SNNP region	0.098		(0.085)	0.139		(0.125)
HH lives in Tigray region	0.322	***	(0.089)	0.318	***	(0.115)
HH lives in other regions	0.217	**	(0.094)	0.321	**	(0.123)
Education diff. of parents (w - h)	-0.015	***	(0.005)	-	-	-
Age diff. of parents (w - h)	-0.003	*	(0.002)	-	-	-
All children in school	0.042		(0.037)	-0.026		(0.077)
Proportion of female children	0.077	*	(0.042)	0.001		(0.079)
Proportion of women	0.065		(0.153)	-0.572	***	(0.163)
Number of non-biological children	0.042	*	(0.023)	-0.020		(0.024)
Wealth index	0.066	***	(0.007)	0.061	***	(0.009)
Constant	6.840	***	(0.936)	4.822	***	(1.154)

Notes: Dependent variable is log of household total expenditure. *, ** & *** show significance at 10%, 5% & 1% levels respectively. Standard errors, corrected for clustering and sampling weights, are in parentheses. SNNP=Southern Nations, Nationalities and Peoples.

Table 11: Collective AIDS regression results

Variable	Male-headed households (N = 2367)				Single-mother households (N = 729)			
	Food	Clothing	Utilities	Other goods	Food	Clothing	Utilities	Other goods
Intercepts α_i	1.175 *** (0.061)	0.177 *** (0.013)	0.027 (0.025)	-0.379 ** (0.053)	1.162 *** (0.116)	0.116 *** (0.023)	0.040 (0.047)	-0.319 *** (0.111)
Price effects γ_{ij}	-0.055 *** (0.016)	-0.056 *** (0.004)	0.003 (0.004)	0.107 *** (0.015)	-0.032 (0.027)	-0.040 *** (0.005)	-0.004 (0.007)	0.076 *** (0.026)
		0.028 *** (0.002)	0.006 *** (0.001)	0.022 *** (0.003)		0.023 *** (0.004)	0.004 *** (0.002)	0.013 *** (0.005)
			0.004 *** (0.002)	-0.013 (0.004)			0.003 (0.003)	-0.004 (0.005)
				-0.116 *** (0.015)				-0.085 *** (0.027)
Adults' income effects β_i^1	-0.107 *** (0.012)	-0.046 *** (0.004)	0.020 *** (0.005)	0.133 *** (0.011)	-0.098 *** (0.023)	-0.031 *** (0.006)	0.022 ** (0.010)	0.106 *** (0.023)
Children's income effects β_i^2	-0.110 *** (0.012)	-0.038 *** (0.004)	0.020 *** (0.005)	0.128 *** (0.011)	-0.070 *** (0.024)	-0.024 *** (0.006)	0.011 (0.010)	0.084 *** (0.023)
Head is Christian	-0.046 *** (0.012)	-0.001 (0.002)	-0.001 (0.004)	0.048 *** (0.011)	-0.035 (0.028)	0.002 (0.003)	-0.002 (0.011)	0.036 (0.028)
Head sick	0.017 ** (0.008)	-0.002 * (0.001)	-0.005 ** (0.003)	-0.010 (0.007)	0.006 (0.018)	-0.008 *** (0.002)	-0.015 *** (0.006)	0.017 (0.016)
# of sick children	-0.013 *** (0.004)	0.002 *** (0.001)	0.001 (0.002)	0.010 ** (0.004)	0.016 (0.011)	0.004 ** (0.002)	-0.006 (0.005)	-0.014 (0.010)
# of children aged 15-17y	-0.009 * (0.005)	0.007 *** (0.001)	-0.002 (0.002)	0.004 (0.005)	0.003 (0.018)	0.008 *** (0.002)	-0.002 (0.006)	-0.009 (0.016)
Female employment ratio	0.021 (0.021)	-0.005 (0.004)	0.004 (0.006)	-0.021 (0.020)	-0.021 (0.028)	0.017 *** (0.004)	0.019 * (0.011)	-0.015 (0.027)
Other adult in household	0.004 (0.008)	0.014 *** (0.001)	0.000 (0.002)	-0.019 ** (0.008)	0.044 ** (0.019)	0.014 *** (0.003)	-0.008 (0.008)	-0.049 *** (0.019)
HH has safe water source	0.002 (0.010)	0.000 (0.001)	0.020 *** (0.003)	-0.022 ** (0.010)	-0.048 ** (0.022)	0.001 (0.003)	0.046 *** (0.009)	0.001 (0.022)
HH interviewed in February	0.004 (0.015)	0.003 * (0.002)	-0.003 (0.006)	-0.004 (0.013)	0.014 (0.029)	0.004 (0.003)	-0.014 (0.014)	-0.004 (0.025)
HH faced price shock	-0.031 *** (0.011)	-0.002 (0.002)	0.010 ** (0.005)	0.022 ** (0.010)	-0.001 (0.025)	-0.004 * (0.002)	0.000 (0.010)	0.005 (0.026)
HH faced natural disaster shock	0.037 *** (0.012)	0.000 (0.002)	-0.018 *** (0.003)	-0.020 * (0.012)	0.033 (0.030)	-0.004 (0.003)	-0.030 *** (0.009)	0.001 (0.032)
HH lives in Amhara region	0.118 ** (0.025)	0.021 *** (0.002)	-0.083 *** (0.010)	-0.055 *** (0.020)	0.036 (0.039)	0.013 *** (0.004)	-0.104 *** (0.018)	0.055 (0.038)
HH lives in Oromia region	0.124 *** (0.026)	0.036 *** (0.002)	-0.080 *** (0.010)	-0.081 *** (0.020)	0.084 ** (0.036)	0.021 *** (0.004)	-0.098 *** (0.018)	-0.006 (0.036)
HH lives in SNNP region	0.117 *** (0.026)	0.021 *** (0.002)	-0.072 *** (0.010)	-0.066 *** (0.021)	0.080 ** (0.036)	0.005 (0.004)	-0.108 *** (0.016)	0.024 (0.036)
HH lives in Tigray region	0.092 *** (0.027)	0.047 *** (0.003)	-0.073 *** (0.011)	-0.066 * (0.022)	0.025 (0.037)	0.036 *** (0.005)	-0.086 *** (0.018)	0.026 (0.038)
HH lives in other regions	0.087 *** (0.028)	0.033 *** (0.003)	-0.055 *** (0.012)	-0.066 *** (0.023)	0.023 (0.040)	0.024 *** (0.005)	-0.050 ** (0.023)	0.003 (0.037)
Endog. of total expenditure	0.155 *** (0.014)	-0.002 (0.004)	-0.031 *** (0.006)	-0.122 * (0.012)	0.110 *** (0.029)	-0.007 (0.006)	-0.035 *** (0.010)	-0.067 ** (0.029)

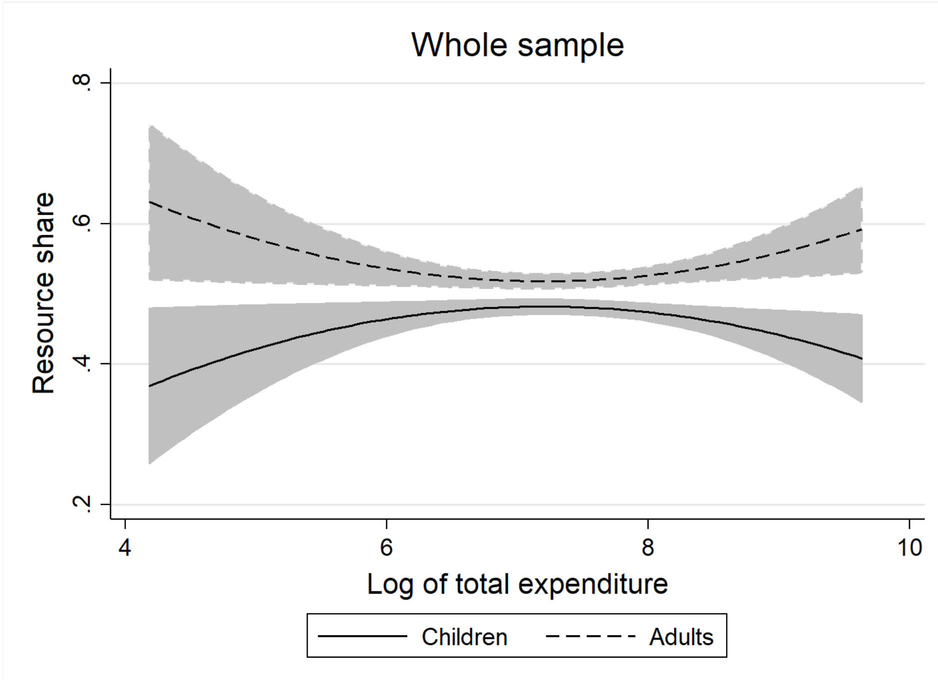
Notes: *, ** & *** show significance at 10%, 5% & 1% levels respectively. Standard errors, corrected for clustering and sampling weights, are in parentheses. 'Other regions' includes the small regions of Afar, Benishangul-Gumuz, Dire Dawa, Gambella, Harari and Somali; the left-out category is the capital, Addis Ababa. SNNP=Southern Nations, Nationalities and Peoples.

Table 12: Income and price elasticity estimates

	Male-headed households				Single-mother households			
	Food	Clothing	Utilities	Others	Food	Clothing	Utilities	Others
Income elasticities								
Adults	0.92***	0.65**	1.03***	1.67***	0.92***	0.70***	1.11***	1.52***
	(0.032)	(0.274)	(0.310)	(0.470)	(0.013)	(0.143)	(0.130)	(0.551)
Children	0.93***	0.63***	0.98***	1.65***	0.92***	0.59***	1.093***	1.59***
	(0.008)	(0.213)	(0.184)	(0.386)	(0.013)	(0.198)	(0.114)	(0.625)
Uncompensated price elasticities								
Food	-0.94***	-0.03***	-0.02***	0.06***	-0.95***	-0.03***	-0.02**	0.08***
	(0.012)	(0.005)	(0.005)	(0.012)	(0.009)	(0.005)	(0.007)	(0.021)
Clothing	-0.07	-0.58	0.04	0.03	-0.13	-0.41	0.02	-0.02
	(0.106)	(1.968)	(0.070)	(0.379)	(0.914)	(4.097)	(0.211)	(0.279)
Utilities	-0.30	0.07	-0.82	0.05	-0.30	0.01	-0.91***	0.08
	(0.746)	(0.172)	(0.448)	(0.104)	(0.626)	(0.030)	(0.204)	(0.176)
Other goods	-0.25	-0.06	0.03	-1.37***	-0.13	-0.09	0.05	-1.40***
	(0.263)	(0.059)	(0.063)	(0.175)	(0.267)	(0.092)	(0.128)	(0.368)
Compensated price elasticities								
Food	-0.28***	0.04*	0.05	0.19***	-0.34***	0.04*	0.08	0.22***
	(0.792)	(0.022)	(0.045)	(0.052)	(0.104)	(0.023)	(0.059)	(0.073)
Clothing	0.33	-0.53	0.08	0.11	0.23	-0.36	0.08	0.05
	(0.075)	(1.964)	(0.083)	(0.073)	(0.171)	(4.094)	(0.217)	(0.626)
Utilities	0.41	0.15	-0.75*	0.19*	0.45	0.10***	-0.80***	0.2609
	(0.692)	(0.171)	(0.437)	(0.106)	(0.436)	(0.035)	(0.187)	(0.229)
Other goods	0.94***	0.07**	0.13***	-1.15***	0.94***	-0.02	0.21	-1.17***
	(0.178)	(0.032)	(0.050)	(0.206)	(0.314)	(0.044)	(0.132)	(0.404)

Notes: *, ** & *** show significance at 10%, 5% & 1% levels respectively. Bootrapped standard errors in parentheses.

Figure 3: Sharing rules of children and adults over the income distribution



Notes: Shaded areas are 95% confidence intervals. Observations are weighted to make estimates nationally representative.