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The More the Poorer? Resource Sharing and Scale Economies in Large Families

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Abstract

In large families, individuals must share resources with many others but may benefit from economies of scale. This paper studies individual consumption in different types of households, with a focus on family structures that are common in developing countries. Based on a collective household model, we develop a methodology to identify intra-household resource allocation and the extent of joint consumption. Unlike existing approaches, we do not require consumption data on single-person households, which are rare in low-income countries. We illustrate our methodology using data from Bangladesh and Mexico. We document intra-household consumption inequality in both countries and substantial economies of scale in consumption in Mexico but not Bangladesh. Using our estimates, we then compute poverty rates for men, women, and children. Contrary to existing poverty calculations that ignore either intra-household inequality or economies of scale in consumption, ours account for both dimensions.

JEL Codes: D13, D11, D12, C31, I32.

Keywords: collective model, household bargaining, resource shares, scale economies, Barten scales, indifference scales, poverty.

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1 Introduction

The composition of households may have important consequences for the well-being of their members. Contrary to developed countries, where the vast majority of households comprise either single adults or nuclear families with a small number of children, households in the developing world are large and typically include several generations and many children.¹ In these countries, the welfare state is often limited and families are the primary providers of material and non-material support to their members. In such contexts, understanding the relationship between family structure and individuals' welfare is of primary importance.

In this paper, we develop a framework to study the material well-being of individuals in different types of households, with a specific focus on family structures that are prevalent in developing countries. We aim to identify important aspects of intra-household consumption in order to answer the following questions: What is the income adjustment that would make an only child just as well off as if she was living in a larger household? How much income would a member of an extended family require to attain the same standard of living that she would have if she was living in a nuclear family? In larger households, individuals are allocated a smaller share of the household budget, but they tend to benefit from scale economies: food waste per person, for example, is likely lower in larger households, and more people jointly consume goods that can be shared (such as energy goods). Quantifying this trade-off is necessary to compare individuals' material well-being across households and may be important for the correct measurement of poverty and inequality.

Consumption data are typically collected at the household level. Therefore, it is difficult to observe how goods are allocated across individuals within families and the extent to which these goods are shared. Recent works have used the collective household model to overcome this limitation and estimate critical aspects of intra-household consumption that researchers usually do not observe. Beginning with the seminal work by [Chiappori \(1988, 1992\)](#), this literature has modeled households as a collection of individuals, rather than a single economic unit, under the assumption that households are Pareto efficient in their allocation of goods.

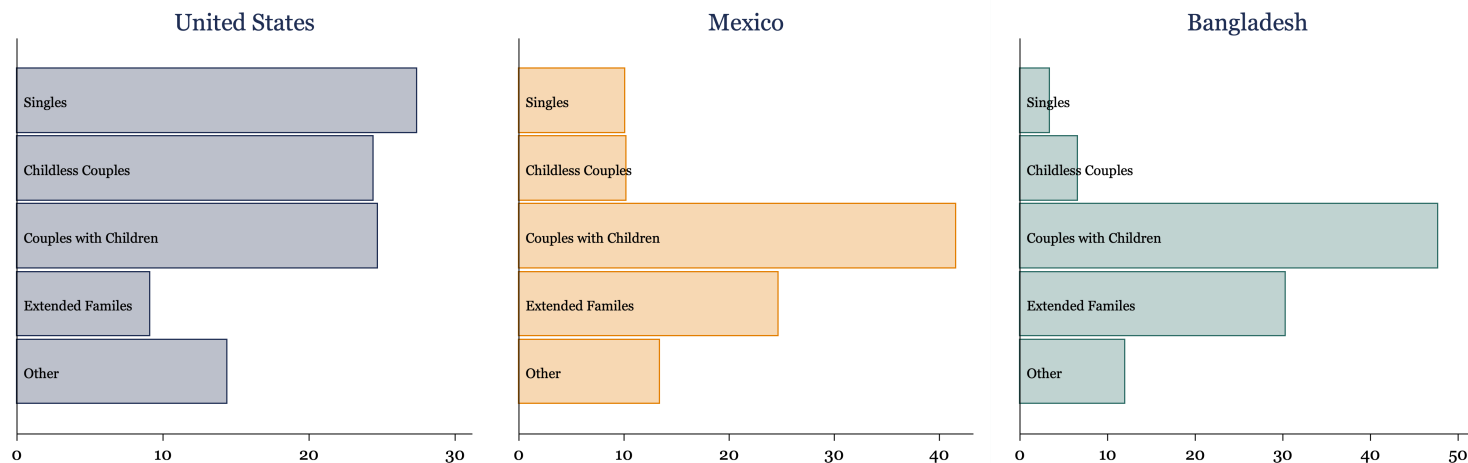
Our paper builds on these seminal works as well as more recent contributions by, e.g., [Lewbel and Pendakur \(2008\)](#), [Bargain and Donni \(2012\)](#), and [Browning et al. \(2013\)](#), who devised approaches to identify the allocation process and consumption sharing from household-level demand data. To recover the intra-household allocation of resources and scale economies in consumption, these works (which have mostly focused on couples) impose preference stability between single and married individuals. Stated differently, to identify resource allocation and economies of scale, the existing identification methods rely on the observability of consumption choices of single individuals and on the assumption that any change in consumption behavior between living alone and in a couple can be attributed to jointness of consumption and resource sharing rather than to changes in individual preferences.²

While effective, this approach has some drawbacks that we wish to avoid. First, as noted by [Dunbar](#)

¹In 2017, the average household size in the United States and Canada was 2.5. The Netherlands ranked last for household size, with only 2.2 members per family, on average. By contrast, families in South Asia and many African countries are much larger: Indian and Ethiopian households, e.g., consist of five members, on average; in Senegal, where the practice of polygamy is common, the average household size equals nine (*Household Size and Composition Around the World 2017*). Figure A1 in the Appendix shows the distribution of household size in selected countries.

²Parallel to our work, [Lewbel and Lin \(2020\)](#) and [Donni and El Badaoui \(2020\)](#) provide identification results that, at least partly, rely on preference stability between singles and individuals in couples or price variation. Alternative methods achieve set-identification of resource shares using axiomatic revealed preference methods ([Cherchye et al., 2011, 2015, 2016, 2017](#)).

Figure 1: Household Types in Selected Countries



Notes: Authors' calculations based on the most recent IPUMS data (2010 for US, 2015 for Mexico, and 2011 for Bangladesh).

et al. (2013), it cannot be applied to study children's well-being, as they do not live alone. This is true both in developed and developing countries. Second, in developing countries (the focus of our study), single-person households are rare (see Figure 1). Cultural norms in specific regions of the world may also attach a strong social stigma to women living alone. So, observing the consumption choices of singles (women in particular) may be extremely challenging in many such contexts. Third, tastes over consumption goods may change upon marriage and individual preferences over some goods may be fundamentally different when living alone and when living in larger households.

Our identification method relies on four main assumptions. First, to identify the allocation process without the assumption of preference stability between single individuals and individuals in multi-person families, we impose semi-parametric restrictions on individual preferences over one *private assignable* good (Dunbar et al., 2013).³ Second, we require the Engel curves of such goods to have a moderate degree of curvature (Lewbel and Pendakur, 2008; Blundell et al., 1998; Browning et al., 2013). Third, we assume that economies of scale in consumption can be summarized by a single parameter that inflates household expenditure (Blundell et al., 1998; Lewbel and Pendakur, 2008; Bargain and Donni, 2012). Fourth, we require that resource shares and scale economies are independent of household expenditure (Pendakur, 1999; Lewbel and Pendakur, 2008; Bargain and Donni, 2012). Under these assumptions, we can identify both resource allocation and scale economies for each family member without observing the consumption choices of single-person households. Specifically, the structural parameters of interest are identified by comparing the Engel curves of private assignable goods across family members and household compositions.

We illustrate our method using data from Bangladesh and Mexico. The choice of these countries is motivated by our interest in understanding consumption sharing at various stages of development: in poorer countries like Bangladesh, where food (which is largely private) is a larger share of the budget, economies of scale are likely to be less important than in middle-income countries like Mexico (Deaton and Paxson, 1997, 1998). Moreover, countries may differ substantially in their traditional gender norms and their societal attitudes towards women. Studying Bangladesh and Mexico allows for these types of comparisons. In Bangladesh, we find a modest amount of consumption sharing, suggesting that ignoring

³A good is private if it is not shared or consumed jointly. A good is assignable if it appears in just one (known) household member's utility function, and so is only consumed by that household member.

economies of scale is not likely to lead to a large degree of error in individual consumption estimates. By contrast, we estimate larger economies of scale in consumption in Mexico, which, on average, increase individual consumption in extended families or nuclear families with multiple children by 10 percent relative to nuclear families with one child. We also identify a non-monotonic relationship between economies of scale in consumption and household size in Mexico, which is driven by differences in the relative consumption of private and shareable goods across household types. Finally, we find that women in Mexican families are allocated a larger fraction of household resources relative to women in Bangladesh. In both countries, children command the smallest share of household resources, with the difference between adult and child resource shares being most pronounced in Bangladesh.⁴ These results can have policy-relevant implications for the measurement of poverty, which we illustrate in Section 5.

Based on the model estimates, we construct *indifference scales* (Browning et al., 2013), which measure the income adjustment applied to a person living in a household of a particular demographic composition to be just as well off as if they were living in a household with a different demographic composition. Indifference scales can be used in applied welfare analysis to answer questions related to the measurement of poverty, inequality, or cost of living indices. Moreover, indifference scales do not suffer from many of the problems inherent to equivalence scales, such as ignoring intra-household inequality and relying on untestable assumptions related to utility comparisons across households.⁵ To this point, existing research has applied indifference scales to compare the material welfare of adults living alone or in a couple. We add to this literature by identifying child indifference scales, which are defined as the income adjustment applied to a child living in a household with multiple children that would allow them to reach the same indifference curve as if they were an only child. We also add to the literature by identifying adult indifference scales in non-nuclear households.

In our application, we use indifference scales to construct empirically grounded poverty thresholds and compare them to commonly-used equivalence scales. Our poverty estimates improve upon recent works (Dunbar et al., 2013; Tommasi, 2019; Sokullu and Valente, 2019; Calvi, 2020; Penglase, 2020; Brown et al., 2021; Bargain et al., 2021; Lechene et al., 2021), who compute individual-level poverty rates for adults and children, but do not account for consumption sharing within the household. Closer to our work is Bargain et al. (2014), who apply the methodology of Bargain and Donni (2012) to estimate the intra-household allocation process and adult economies of scale in Côte d'Ivoire. We depart from their framework by identifying both adult and children economies of scale and not relying on singles' data. More broadly, our results shed light on the relationship between household size and poverty (Lanjouw and Ravallion, 1995), and on the relative merits of per-capita poverty measures, commonly used equivalence scales, and model-based poverty estimates.

The rest of the paper is organized as follows. In Section 2, we set out a collective household model. In Section 3, we present our identification results. In Section 4, we describe our empirical applications and estimation results. In Section 5, we conduct an individual-level poverty analysis based on the model estimates. Section 6 concludes. Detailed proofs and additional material are in an online Appendix.

⁴Previous estimates of individual consumption for Bangladesh and Mexico that account for intra-household allocation but not economies of scale are provided by Brown et al. (2021), Bargain et al. (2021), and Lewbel and Pendakur (2021), and Tommasi (2019), Sokullu and Valente (2019), and Hoehn-Velasco and Penglase (2019), respectively.

⁵See Chiappori (2016) and Pendakur (2018) for a detailed discussion of the relative merits of indifference scales and equivalence scales. See Fisher (1987) for a more general discussion of the limitations of using demand analysis to make interpersonal welfare comparisons.

2 Theoretical Model

In this section, we set up a collective household model for extended families. Our model is essentially the model of [Browning et al. \(2013\)](#) and [Dunbar et al. \(2013\)](#), but allows for more flexible living arrangements and for the presence of a large number of decision makers ([Calvi, 2020](#); [Brown et al., 2021](#)).

We model households as collections of individuals who jointly purchase and consume goods. A household consists of N members. Each member belongs to one of J categories (indexed by j), such as women, men, children, or the elderly. The number of household members of each category j is denoted by n_j so that $N = \sum_{j=1}^J n_j$. A household's composition or *type* is defined by the number of individuals in each category. Accordingly, we denote a household type by $\tau = (n_1, \dots, n_J)$. For simplicity, we assume that all household members of a specific category have identical, well-behaved preferences over consumption goods and are treated equally.⁶ As in [Browning et al. \(2013\)](#), we allow for altruism, so that one's utility may depend on the utility of other household members. However, for identification purposes, we rule out direct consumption externalities.

Household members have preferences over K goods with log market prices $p = (p^1, \dots, p^K)$. Let $z_\tau = (z_\tau^1, \dots, z_\tau^K)$ be the vector of observed quantities of goods purchased by each household of type τ at log total household expenditure x and $\tilde{z}_{j,\tau} = (\tilde{z}_{j,\tau}^1, \dots, \tilde{z}_{j,\tau}^K)$ be the vector of quantities of goods consumed by each individual of category j in a household of type τ (that is, her *private good equivalents*). We model joint consumption using Barten scales, which effectively increase the quantities of the goods available for consumption by the household members. Specifically, we consider a consumption technology function that can be summarized by a diagonal $K \times K$ matrix A_τ , such that $z_\tau = A_\tau \sum_{j=1}^J n_{j,\tau} \tilde{z}_{j,\tau}$. The diagonal entries of A_τ are the Barten scales and indicate to what extent, if at all, the sum of private good equivalents of a good k exceeds the purchased quantity z_τ^k . They also indicate how much cheaper each good is to household members relative to market prices.⁷

Let $\alpha_\tau = (\alpha_\tau^1, \dots, \alpha_\tau^K)$ be the vector of log Barten scales. Then, $\alpha_\tau + p$ is the vector of log shadow prices faced by the household members. Note that Barten scales are common to all household members and depend on the nature of good k : if good k is a private good (i.e., not jointly consumed), then the k^{th} diagonal element of A_τ is equal to one, $\alpha_\tau^k = 0$, and its shadow price equals its market price; if good k is jointly consumed (or at least partly shared), then $\alpha_\tau^k < 0$ and the shadow price is lower than the market price.

We denote by $W_\tau^k(p, x, \alpha_\tau)$ the household-level budget share for good k as a function of log prices, log expenditure and Barten scales, and by $w_{j,\tau}^k(p, x, \alpha_\tau)$ the individual-level budget share of each member of type j (that is, the budget share function of a household consisting just of one person of type j). [Browning et al. \(2013\)](#) show that the household-level budget shares take the following form:

$$W_\tau^k(p, x, \alpha_\tau) = \sum_j n_{j,\tau} \eta_{j,\tau}(p, x, \alpha_\tau) w_{j,\tau}^k(p + \alpha_\tau, x + \ln \eta_{j,\tau}(p, x, \alpha_\tau)), \quad (1)$$

where $\eta_{j,\tau}$ are *resource shares*, i.e., the fraction of the total household expenditure allocated to each

⁶In our empirical application, we allow households to differ along a wider set of observable attributes, including individual characteristics of their members. To reduce notational clutter, we omit these for now.

⁷Note that this framework allows for a simple household production technology with constant returns to scale through which market goods are transformed into household commodities.

member of category j in a household of type τ .

Now consider a private good that is *assignable*, in the sense that is not shared and is exclusively consumed by household members of known category j . Then, following [Dunbar et al. \(2013\)](#), the household-level budget shares for the assignable goods k_j are simpler than Equation (1) and are given by:

$$W_\tau^{k_j}(p, x, \alpha_\tau) = n_{j,\tau} \eta_{j,\tau}(p, x, \alpha_\tau) w_{j,\tau}^{k_j}(p + \alpha_\tau, x + \ln \eta_{j,\tau}(p, x, \alpha_\tau)). \quad (2)$$

Note that Equations (1) and (2) follow directly from the central assumption of collective models, that the intra-household allocation of goods is Pareto efficient. Applying duality theory and decentralization welfare theorems, the household decision process can be decomposed in two stages: in a first stage, resources are allocated among family members; in a second stage, each household member chooses $\tilde{z}_{j,\tau}$ as if they maximized their own utility function given a fraction $\eta_{j,\tau}$ of the household's total expenditure and facing log shadow prices $\alpha_\tau + p$.⁸ Note that one cannot just use $W_\tau^{k_j}$ as a measure of $\eta_{j,\tau}$ as different household members may have different tastes for their private assignable good.

Indifference Scales. Our objective is to shed light on the relationship between family structure (or household type, in the sense we defined above) and individual well-being.⁹ When comparing the well-being of individual j living in small versus large families, there are two factors to consider: in larger households there may be more economies of scale in consumption, but resources are by construction allocated in smaller proportions. To better quantify this tradeoff, we consider indifference scales ([Browning et al., 2013](#)), i.e., the income adjustment applied to a person living in a household of a particular type to be just as well off as if they were living in household with a different type. Note that [Browning et al. \(2013\)](#) introduced indifference scales to compare the welfare of an individual living alone versus living in a couple.¹⁰ We expand their definition to carry out more general welfare comparisons ([Pendakur, 2018](#)).¹¹

Suppose a household of type τ has Barten scales α_τ and each person in that household has resource share $\eta_{j,\tau}$. We denote by V_j the indirect utility function describing the preferences of a person of type j . Then, the indifference scales for an individual of type j in a household of type $\tau = t'$ relative to a

⁸While some papers provide evidence in favor of Pareto efficiency (see e.g. [Attanasio and Lechene \(2014\)](#) for Mexico and [Brown et al. \(2021\)](#) for Bangladesh), some others cast doubt on this assumption (see [Udry \(1996\)](#); [Baland and Ziparo \(2018\)](#); [De Vreyer et al. \(2020\)](#)). Note that most rejections of Pareto efficiency are based on decisions about production, not consumption. As discussed in [Rangel and Thomas \(2019\)](#), confounding these two aspects may be misleading. [Rangel and Thomas \(2019\)](#) also show that in nuclear families in Burkina Faso, resource allocations are consistent with efficiency. In more complex household structures, including polygamous households, efficiency in allocations is not rejected in models (like ours) that allow more than two decision makers. [Lewbel and Pendakur \(2021\)](#) develop a collective household model where households behave inefficiently, but show that this does not have a large effect on the estimates of resource shares in Bangladesh. [Chiappori and Naidoo \(2020\)](#) show that, in the absence of price variation, any demand that is compatible with a non-cooperative model is also compatible with at least one collective model. The converse, however, is not true.

⁹Our analysis focuses on material well-being (i.e., consumption). Of course, other dimensions of individual welfare, such as time use, health, or agency, may be relevant. While consumption is key measure of well-being and is the basis for poverty measurement, we do not attempt any extrapolation beyond this specific dimension of welfare.

¹⁰In [Browning et al. \(2013\)](#) as well as in [Lewbel and Pendakur \(2008\)](#) and [Bargain and Donni \(2012\)](#), indifference scales are defined as $V_j(p, x + \ln I_j) = V_j(p + \alpha, x + \ln \eta_j)$ and represent the amount of income needed by an individual living alone to make her as well-off as if she were living in a couple. Intuitively, the indifference scale between household types t and t' is equivalent to the ratio of the indifference scale between household types t and single-person household and the indifference scale between household t' and single-person household.

¹¹Participation constraints in connection to marriage and divorce are one clear application of indifference scales. There is merit in computing indifference scales for children too. Child indifference scales are important to understand household composition. For example, when parents decide whether to have an additional child, they may consider how much household income they would need to increase for their first-born child to be just as well off if they have a second child. Child indifference scales can also help determine how poverty lines should vary across household size and composition. Finally, indifference scales could be used for life insurance and wrongful death calculations ([Browning et al., 2013](#)), which may apply not only to adults but also to children. In context where child-support is enforceable, computing indifference scales for children may be useful for parental custody agreements after a divorce.

household of type $\tau = t$ are given by the solutions to the following equations:

$$V_j(\alpha_{t'} + p, x + \ln \eta_{j,t'} - \ln I_{j,t,t'}) = V_j(\alpha_t + p, x + \ln \eta_{j,t}). \quad (3)$$

If a person in category j living in a household of type t' was given an amount of income equal to $\eta_{j,t'} e^x / I_{j,t,t'}$, then she would be able to buy a bundle of goods that lies on the same indifference curve as the bundle of goods that she consumes as a member of a household of type t with total expenditure e^x and resource share $\eta_{j,t}$. This accounts for both the intra-household allocation of resources and the household economies of scale in consumption. If indifference scales were to equal 1, then the individual would be indifferent between living in household t or in household t' , and no income adjustment would be necessary. By contrast, if indifference scales were lower (greater) than 1, then household income e^x for an individual in household t' would need to be scaled up (down) to be just as well off as if they were living in household t with household income e^x .

Note that the definition of indifference scales provided in Equation (3) relies on the assumption that individuals' preferences, and hence indifference curves, are independent of household types (i.e., V_j has no τ subscript). This preference stability assumption is necessary for indifference scales (which rely on welfare comparisons) to have a meaningful interpretation. As we discuss in the next section, however, it is not required for the identification of resource shares and economies of scale in consumption. Moreover, as noted by [Lewbel and Pendakur \(2008\)](#), if preferences change in an identified manner, indifference scales can still maintain a valid interpretation.

3 Identification

Our goal is to identify the intra-household allocation process and the extent of joint consumption separately from individual preferences over consumption goods. Below, we summarize our identifying assumptions. Next, we present our identification results, starting with the simple case of nuclear households with children and then proceeding to more complex settings.

Our contribution is to identify both scale economies and resource shares (which, together, allow us to compute indifference scales) for all household members, including children. Previous papers have identified scale economies and/or resource shares, but not both at the same time for all household members. Moreover, we do so without relying on price variation nor data on singles (both of which are typically not available in a developing country context). Table 1, which we describe in detail later on, summarizes how our methodology relates to previous works.

3.1 Setup

We first require that the model discussed in Section 2 holds.

Assumption 1. *The collective model of [Browning et al. \(2013\)](#) holds.*

The implication of this assumption is that the decision process of the household results in a Pareto efficient allocation of goods. Further, the household budget share functions are given by Equations (1)

and (2).¹²

As in Dunbar et al. (2013) and Bargain and Donni (2012), we require the observability of household-level expenditures on private assignable goods. Consistent with what is available in many household consumption surveys (which typically collect expenditures that can be assigned to categories of individuals, such as women, men, or children, but not the identity of each consumer), we posit that all household members of a specific category have identical preferences over their assignable good and they consume the same amount of it. In principle, this restriction can be relaxed with richer data.

Assumption 2. *The econometrician observes the household-level budget shares for one private assignable good for each household member type $j = 1, \dots, J$, i.e., $W_\tau^{k_j}(\alpha_\tau + p, x)$.*

Note that private assignable goods provide a number of advantages over goods that are jointly consumed. First, by construction, their demand is only driven by the preferences of those household members who consume them; so, if we observe a household consuming more of women's clothing, we can exclude men's preferences for women's clothing as a potential determinant of this difference.¹³ Moreover, as a consequence of them being privately consumed, the shadow price of the good will not vary across household sizes and is equal to the market price.

Assumption 3. *Let $y = e^x$ be the household total expenditure, and $\omega_{j,\tau}^{k_j}(y)$ be the individual-level budget share equations for the private assignable goods as a function of total expenditure in one price regime. $\omega_{j,\tau}^{k_j}(y)$ are twice continuously differentiable with respect to y and, when evaluated at $y = 0$, are such that for $t \neq t'$ and $j \neq j'$:*

- i. $\nabla_y^2 \omega_{j,t}^{k_j}(0) = \nabla_y^2 \omega_{j,t'}^{k_j}(0)$ and $\nabla_y \omega_{j,t}^{k_j}(0) = \nabla_y \omega_{j,t'}^{k_j}(0)$,
- ii. $\nabla_y^2 \omega_{j,\tau}^{k_j}(0) = \nabla_y^2 \omega_{j',\tau}^{k_{j'}}(0)$,
- iii. $\nabla_y^2 \omega_{j,\tau}^{k_j}(0) \neq 0$.

A few important aspects of Assumption 3 deserve mention. First, this assumption does not require observing budget shares at zero expenditure. Rather, it imposes restrictions on the limits of the derivatives of the budget share functions in the neighborhood of zero. The assumptions could alternatively be written so that the restrictions hold at a particular value of y , but doing so at $y = 0$ facilitates the proof. Second, as shown in Table 1, existing identification methodologies typically rely on stronger preference stability requirements. Lewbel and Pendakur (2008) and Bargain and Donni (2012), for instance, constrain individuals' preferences over goods to be the same whether they are single or in a couple, so that changes in consumption behavior between living alone and with another person can be attributed to jointness of consumption and resource sharing rather than changes in preferences. We do not impose stability of preferences for adults across marital statuses. Instead, we require that individuals have similar (but not identical) preferences across household types (Assumption 3.i). So, e.g., mothers of two children

¹²Differently from Browning et al. (2013), the early formulations of the collective model may or may not include public goods and do not allow partial sharing of goods. Articles developing this framework include the seminal papers by Chiappori (1988, 1992), and subsequent works by Browning et al. (1994), Browning and Chiappori (1998), Blundell et al. (2005), and Chiappori and Ekeland (2006). In these early models, resource shares are not identified, but derivatives of the sharing rule with respect to distribution factors are.

¹³This is true in absence of direct consumption externalities, which is one of the assumptions of our model (see Section 2 for details).

have preferences over their clothing that are similar to those of mothers of three children. Here, “similar” means the first and second derivatives of the budget share functions for clothing are the same across household types, but not the entire function. In this regard, our assumption aligns more closely with the identification restrictions proposed by [Dunbar et al. \(2013\)](#). Third, while Assumption 3.ii posits similarity of preferences across different people, it allows for some degree of heterogeneity in individuals’ preferences over their private assignable good. We later show how this assumption can be weakened if the data includes childless couples or in the case of specific types of preferences (e.g., the Quadratic Almost Ideal Demand System of [Banks et al. \(1997\)](#)). Assumption 3.ii is crucial to identify preference parameters and resource shares without relying on singles data. [Dunbar et al. \(2013\)](#) achieve identification of resource shares by imposing an assumption that is similar in spirit (their Assumption A3). However, they do not identify economies of scale for children and adults.¹⁴ To this aim, we impose Assumption 3.iii, which requires a certain degree of non-linearity in the demand functions of the private assignable goods, as in [Lewbel and Pendakur \(2008\)](#), [Bargain and Donni \(2012\)](#), and [Browning et al. \(2013\)](#).

We also require our main objects of interest (resource shares and economies of scale) to satisfy some common properties, which we summarize in Assumption 4 and Assumption 5 below.

Assumption 4. *There exists a scalar-valued, differentiable function $s_{j,\tau}(\alpha_\tau, p)$, such that the following equality holds:*

$$V_j(\alpha_\tau + p, x) = V_j(p, x - \ln s_{j,\tau}(\alpha_\tau, p)). \quad (4)$$

The corresponding individual-level budget share functions for good k are given by:

$$w_{j,\tau}^k(\alpha_\tau + p, x) = \lambda_{j,\tau}^k + w_{j,\tau}^k(p, x - \ln s_{j,\tau}(\alpha_\tau, p)), \quad (5)$$

where $\lambda_{j,\tau}^k = \frac{\partial \ln s_{j,\tau}(\alpha_\tau, p)}{\partial p^k}$.

This assumption is the *independence of base* assumption of [Blundell et al. \(1998\)](#) and [Lewbel and Pendakur \(2008\)](#). The function $s_{j,\tau}(\alpha_\tau, p)$ can be interpreted as a measure of the cost-savings that person j experiences when living in a family instead of herself due to economies of scale. More accurately, we should expect $1/s_{j,\tau}$ to increase as economies of scale in consumption increase. Note that $s_{j,\tau}(\alpha_\tau, p)$ is independent of x , so economies of scale are assumed to be independent of the expenditure at which they are evaluated. If there are economies of scale in consumption, $s_{j,\tau}(\alpha_\tau, p) < 1$ and $\ln s_{j,\tau}(\alpha_\tau, p) < 0$; if all goods are private, then $s_{j,\tau}(\alpha_\tau, p) = 1$ and $\ln s_{j,\tau}(\alpha_\tau, p) = 0$.

The individual-level budget share functions provided in Equation (5) are derived by applying Roy’s identity to Equation (4). The implication of this assumption is that j ’s budget share function for good k has the same shape when evaluated at log market prices or at log shadow prices $\alpha_\tau + p$. The only difference is that they are translated horizontally by $\ln s_{j,\tau}(\alpha_\tau, p)$ and vertically by $\lambda_{j,\tau}^k$.

Assumption 5. *Resource shares are independent of x , so that $\eta_{j,\tau}(p, \alpha_\tau, x) = \eta_{j,\tau}(p, \alpha_\tau)$.*

This assumption mirrors Assumption A.1 of [Dunbar et al. \(2013\)](#).¹⁵ Empirical evidence supporting this assumption is provided by [Menon et al. \(2012\)](#), who show that for Italian households observed resource

¹⁴We note that the objective of their paper was to identify resource shares not scale economies in consumption.

¹⁵While Assumption 5 needs to be satisfied for low levels of household expenditure only, for simplicity, we assume it holds for all values of x .

shares do not exhibit much dependence on household expenditure, and [Bargain et al. \(2021\)](#), who find similar results in Bangladesh.¹⁶ Importantly, this restriction still permits resource shares to depend on other variables related to expenditure, such as wealth and assets.

Under the assumption that the structural components $\eta_{j,\tau}(\alpha_\tau, p)$ and $s_{j,\tau}(\alpha_\tau, p)$ are independent of expenditure, the indifference scales of individuals j across two household types τ and τ' are also independent of expenditure, and are defined according to the following Lemma.

Lemma 1. *Let Assumptions 4 and 5 hold. Then, indifference scales for an individual of group j in a household of type $\tau = t'$ relative to a household of type $\tau = t$ are independent of x and are given by:*

$$I_{j,t,t'}(p, \alpha_{t'}, \alpha_t) = \frac{\eta_{j,t'}(p, \alpha_{t'}) s_{j,t}(p, \alpha_t)}{\eta_{j,t}(p, \alpha_t) s_{j,t'}(p, \alpha_{t'})}.$$

Proof. See Appendix A.1. □

Lemma 1 implies that, once two of the three objects of interest (resource shares, economies of scale, and indifference scales) are identified, the third one can be immediately recovered.

3.2 Identification in Nuclear Households with Children

While our approach easily generalizes to extended households with multiple women and multiple men (see Section 3.3 for details), for simplicity, we start by illustrating identification for nuclear households with children. This is a special case of the general model presented in Section 2, with three categories of individuals $j = m, w, c$ (men, women, and children) and $n_m = n_w = 1$. In nuclear families, the man is the children's father and the woman is the mother, and a household type is determined by the number of children, so that $\tau = n_c = n$.

Suppose that demand data are observed in a unique price regime, as in cross-sectional data, so that the vector of prices p is constant. Suppose also that there are no singles and that we do not observe a sufficient number of couples without children to identify $s_{j,1}$, for $j = m, w, c$. Theorem 1 below shows that, under appropriate normalizations, the structural components of the model, such as $\eta_{j,n}$ and $s_{j,n}$, are identified for $j = m, w, c$ and $n = 1, \dots, N$. First, we normalize $s_{j,1} = 1$, so that $s_{j,n}$ with $n > 1$ and $j = m, w$ measures the cost-savings from economies of scale experienced by adults when living as a couple with with $n > 1$ children relative to living as a couple with one child. Second, we normalize $s_{c,1} = 1$. Thus, $s_{c,n}$ with $n > 1$ measures the cost-savings from economies of scale experienced by a child when living with her parents and siblings relative to being an only child in a nuclear family. Note that recovering relative (as opposed to absolute) scale economies may be sufficient for many policy applications of our method, such as specifying relative poverty thresholds. The poverty line for individuals in a reference household (a nuclear households with one child) is arbitrary. But, for a chosen poverty line for these individuals, the poverty line in larger households is *not* arbitrary, but rather dependent on economies of scale in consumption. Therefore, if one were to set a per-capita poverty line of US\$1.90 or US\$3.10

¹⁶Other tests which are based on model estimates rather than observed data are given by [Cherchye et al. \(2015\)](#) and [Botosaru et al. \(2020\)](#). [Cherchye et al. \(2015\)](#) show that revealed preferences bounds on women's resource shares in Denmark are independent of total household expenditure. Based on estimates from an intertemporal collective household model with unobserved heterogeneity, [Botosaru et al. \(2020\)](#) document a slight violation of this assumption in Bangladesh.

(which are common poverty lines used by the World Bank) for individuals living in a nuclear household with one child, then she would be able to determine how this line should change across household types (as we do in Section 5).

Theorem 1. *Consider a population of couples with $n = 1, \dots, N$ children. Let Assumptions 1-5 hold with $\tau = n$ and set $s_{j,1} = 1$ for $j = m, w, c$. Then, resource shares $\eta_{j,n}$ and economies of scale $s_{j,n}$ are identified for $j = m, w, c$, with household-level demand data under a single price regime.*

Proof. See Appendix A.2. □

The proof of Theorem 1 can be summarized in two steps. In a first step, we use reference households (nuclear households with one child) and the semi-parametric restrictions discussed before to identify individual preferences over the assignable good. In the second step, we exploit variation in consumption patterns across people and household types to identify resource shares and economies of scale. The non-linearity of the budget share equations enables us to separately identify intra-household allocation from the extent of joint consumption.

Now consider the same child in two different living situations: (1) as an only child ($n = 1$), and (2) as a child in a nuclear household with multiple children ($n > 1$). We define a child's indifference scales $I_{c,1,n}$ as the income adjustment applied to a child in a nuclear household with n children (including herself) that would allow her to reach the same indifference curve as if she was an only child:¹⁷

$$V_c(\alpha_n + p, x + \ln \eta_{c,n} - \ln I_{c,1,n}) = V_c(\alpha_1 + p, x + \ln \eta_{c,1}). \quad (6)$$

More generally, we can define indifference scales for individual j as the income adjustment needed for the individual living in a nuclear household with $n > 1$ children that would allow her to reach the same indifference curve as if she was living in a nuclear household with one child:

$$V_j(\alpha_n + p, x + \ln \eta_{j,n} - \ln I_{j,1,n}) = V_j(\alpha_1 + p, x + \ln \eta_{j,1}). \quad (7)$$

With economies of scale and resource shares identified by Theorem 1, we can use Lemma 1 to recover indifference scales for each individual category j across different household types.

3.3 Identification in Extended Families

As discussed in the previous sections, extended families (that is, non-nuclear families) are widespread in developing countries. In Bangladesh and Mexico, the focus of our empirical application, one in three and one in four families, respectively, include other relatives (such as grandparents, aunts, or uncles) in addition to the nuclear family. In other countries, particularly in Africa, polygamy is a common marriage practice. The identification results presented in the previous sections apply to nuclear households with children, but can be easily extended to a more general framework, in line with the model of extended

¹⁷A large literature has studied the relationship between child quantity and quality (e.g., Becker et al. (1960), Rosenzweig and Wolpin (1980), Black et al. (2005), Cáceres-Delpiano (2006), and Angrist et al. (2010)). While we do not directly address the quality-quantity tradeoff, our analysis is nonetheless related and can tell us by how much household income would need to be scaled up (or down) when child quantity increases to keep child quality (welfare) unchanged.

households of Section 2. Note that in this case, household size and household type do not necessarily coincide. Moreover, the cost-savings from economies of scale may depend on composition and not only on household size, as some goods may be more likely to be shared by similar individuals, i.e., individuals in the same category.¹⁸

Theorem 2. *Consider a population of households of type $\tau = 1, \dots, T$. Let Assumptions 1-5 hold for all τ . Then, under appropriate normalizations, resource shares $\eta_{j,\tau}$ and economies of scale $s_{j,\tau}$ are identified for $j = 1, \dots, J$, with household-level demand data under a single price regime.*

Proof. See Appendix A.3. □

Theorem 2 essentially says that the allocation process and the extent of joint consumption in extended families can be recovered from household-level demand data without price variation and without relying on singles' consumption choices nor assuming perfect preference stability across household types. Note that, as above, economies of scale are not absolute but relative to a reference household. The choice of reference household is ultimately arbitrary, but in the proof of Theorem 2 we select households with exactly one individual in each category $j = 1, \dots, J$. Stated differently, our reference household is of type $\tau = (1, \dots, 1)$ and economies of scale are defined relative to this type of households.¹⁹ With $s_{j,\tau}$ and $\eta_{j,\tau}$ identified for all household types τ and individual categories j , Lemma 1 identifies indifference scales for each family member across different household types. In this context, it is convenient to define indifference scales for individual j as the income adjustment needed for the individual living in non-reference that would allow her to reach the same indifference curve as if she was living in the reference household. If indifference scales were less than one, then household income would then need to be scaled up by $1/I_{j,1,\tau}$ for the individual in the non-reference household to be just as well off as if they were living in the reference household. By contrast, if indifference scales were above one, then household income would then need to be scaled down by $1/I_{j,1,\tau}$. So, indifference scales help quantify the trade-off between consumption sharing and intra-household resource allocation across household types.

To conclude this section, we briefly discuss how the identification results presented thus far contribute to the literature and how they relate to previous works. In Table 1, we compare our assumptions and results to four existing papers, listed chronologically based on their publications date.²⁰ While we identify more features of household behavior (Panel B), doing this does not come without a cost (Panel A). The papers closest to ours are Dunbar et al. (2013) and Bargain and Donni (2012). Like Dunbar et al. (2013) and unlike Bargain and Donni (2012), we impose preference similarity restrictions across individuals to

¹⁸For instance, electricity or heating are more likely and more often shared by individuals who spend substantial time at home. In contexts where, e.g., female labor force participation is low, we could expect the degree of joint consumption of such goods to be larger, the higher is the number of women in the family. So, given two households with equal household sizes, the cost-savings coming from economies of scale in consumption may be larger in the family with a larger share of female household members.

¹⁹This definition presupposes that there exists a household where all person types are present. This assumption is likely to hold in all empirical applications as the exact definition of the categories of family members to be considered is arbitrary and can be set by researcher based on data availability.

²⁰Other recent identification approaches include Dunbar et al. (2019), who identify resource shares for women, men, and children with *distribution factors* (i.e., factors that impact the decision making process, but not preferences nor the budget constraint) instead of similarity restrictions on preferences, Sokullu and Valente (2019), who weaken the preference restrictions of Dunbar et al. (2013) by using panel data, Brown et al. (2021), who do so by using multiple assignable goods, and Penglase (2020), who identifies resource shares using private goods that are only partially assignable. Lewbel and Pendakur (2021) relax the assumption of Pareto efficiency and introduce *cooperation factors* (i.e., factors that affect resource allocation and the households consumption technology, but not indifference curves). The authors compare households of the same type that happen to choose different resource shares and Barten scales based on cooperation factors. By contrast, we compare resource allocation and economies of scale across household types τ . So, similar to a cooperation factor, τ may impact resource allocation and joint consumption; differently from a cooperation factor, preferences can vary with τ (though in a restrictive way as in Assumption 3).

Table 1: Comparison to Existing Literature: Assumptions and Identification

	Lewbel- Pendakur (2008)	Bargain- Donni (2012)	Browning- Chiappori- Lewbel (2013)	Dunbar-Lewbel- Pendakur (2013)		This paper Theorems 1&2
				Theorem 1	Theorem 2	
<i>A) Assumptions</i>						
Browning et al. (2013) Model (A1)	✓	✓	✓	✓	✓	✓
Observability of Assignable Goods (A2)		✓		✓	✓	✓
Preference Similarity Across Types (A3.i)	✓	✓	✓		✓	✓
Preference Similarity Across People (A3.ii)				✓		✓
Non-linearity (A3.iii)	✓	✓	✓			✓
Independence of Base (A4)	✓	✓			✓	✓
Expenditure Invariance (A5)	✓	✓		✓	✓	✓
Preference Stability Across Types	✓	✓	✓			
Observability of Singles' Data	✓	✓	✓			
Observability of Price Variation			✓			
<i>B) Identified Objects</i>						
Resource Shares for Adults	✓	✓	✓	✓	✓	✓
Scale Economies for Adults	✓	✓	✓			✓
Indifference Scales for Adults	✓	✓	✓			✓
Resource Shares for Children		✓		✓	✓	✓
Scale Economies for Children						✓
Indifference Scales for Children						✓

Notes: This table summarizes how our identification results contribute to the literature and how they relate to previous works. One important detail about this set of assumptions is the following. Similarity Across Types is a weaker version of Preference Stability Across Types. So, any approach that requires Preference Stability Across Types implicitly imposes the Similarity Across Type assumption. While both involve restrictions on how preferences vary across household compositions, Similarity Across Types does not require preferences to be identical across household types. [Browning et al. \(2013\)](#) require non-linearity in either the consumption technology function or preferences, but not necessarily both. Finally, Theorem 2 of [Dunbar et al. \(2013\)](#) requires preferences be similar across household types. For them, this is a restriction on how the prices of the non-private goods enter the indirect utility function, and therefore may be classified as a weaker version of the Independence of Base assumption (Assumption A4), rather than our Preference Similarity Across Types (Assumption A3.i).

avoid relying on singles data. Note that these preference restrictions are quite weak, as they involve only preferences over the private assignable goods and not all goods and only the first and second derivatives of the budget share functions. [Dunbar et al. \(2013\)](#) impose similarity of preferences across types or across people, while we impose both. Like [Bargain and Donni \(2012\)](#) and unlike [Dunbar et al. \(2013\)](#), we identify both resource shares and economies of scale in consumption. Since we do not require observing the consumption choices of people living alone, we identify economies of scale not only for adults, but also for children. As discussed previously, we identify economies of scale relative to a reference household. Note that our method could be applied to identify absolute economies of scale for adults if singles data were available. Finally, [Dunbar et al. \(2013\)](#) implement their assumptions by placing restrictions on the indirect utility function. To better relate our assumptions to theirs, in [Appendix C](#), we provide an example indirect utility function that satisfies the restrictions imposed by Assumptions 3 and 4.

3.4 Additional Identification Results

Before turning to the empirical applications, we discuss some extensions to our main identification results. Recall that Assumption 3.ii requires preferences for the assignable good to be similar across people. Specifically, we require that the second derivatives of the individual-level budget share functions for such goods do not vary across household members. This assumption, which may be violated for some cate-

gories of assignable goods in some contexts,²¹ can be weakened or even disposed of with additional data or specific types of preferences. Below we describe extensions to Theorem 1 (i.e., nuclear families with children, with $\tau = n$). It is straightforward to apply these extensions to Theorem 2.

Corollary 1. *Consider a population of couples with $n = 1, \dots, N$ children, with at least three household sizes. Let Assumptions 1, 2, 3.i, 3.iii, 4, and 5 hold with $s_{j,1} = 1$. Moreover, let $w_{j,n}(p, x, \alpha_n)$ be polynomials of degree $l \geq 2$ in x . Then, resource shares $\eta_{j,n}$ and economies of scale economies $s_{j,n}$ are identified for $j = m, w, c$, with household-level demand data under a single price regime.*

Proof. See Appendix A.4. □

Corollary 1 states that, if the individual-level budget share functions for the private assignable goods in Equation (2) are polynomial functions of second (or higher) degree, then Assumption 3.ii (that preferences for the assignable good are similar between men, women, and children) can be dropped. This result is easily illustrated in the case of a Quadratic Almost Ideal Demand System (QUAIDS) of Banks et al. (1997), which we later use in our empirical applications. QUAIDS is a commonly used demand system with indirect utility function as follows:

$$V_j(p, x) = \left(\frac{P_j^2(p)}{x - \ln P_j^1(p)} + P_j^3(p) \right)^{-1}, \quad (8)$$

where P^1 , P^2 , and P^3 are defined so that the property of the indirect utility function V_j are satisfied (see Section C in the Appendix for more details.). Using Roy's identity, the individual-level budget share functions for the private assignable goods k_j are rank three quadratic in log expenditure:²²

$$\begin{aligned} w^{k_j}(p, x) &= -\frac{1}{P_j^1(p)} \frac{\partial P_j^1(p)}{\partial p} + \frac{\partial P_j^2(p)}{\partial p} \frac{(x - \ln P_j^1(p))}{P_j^2(p)} + \frac{\partial P_j^3(p)}{\partial p} \frac{(x - \ln P_j^1(p))^2}{P_j^2(p)} \\ &= a_j(p) + b_j(p)x + c_j(p)x^2. \end{aligned} \quad (9)$$

Substituting the QUAIDS individual-level budget share functions into Equation (2) and imposing the assumptions of Corollary 1 result in Engel curves for the private assignable goods k_j in a household of type n , with resource shares $\eta_{j,n}$ and scale economies $s_{j,n}$, that are as follows:

$$W_n^{k_j}(x) = \eta_{j,n} [a_{j,n} + b_j(x + \ln \eta_{j,n} - \ln s_{j,n}) + c_j(x + \ln \eta_{j,n} - \ln s_{j,n})^2]. \quad (10)$$

The second derivatives of Equation (10) with respect to x for $j = m, w, c$ identify resource shares and the preference parameters for the private assignable good b_j and c_j , while the first derivative identifies the scale economies parameters $s_{j,n}$. With $s_{j,n}$ and $\eta_{j,n}$ identified for all household types and individual categories, indifference scales are identified by Lemma 1.

²¹The empirical evidence on the validity of the Similarity Across People restriction of Dunbar et al. (2013) (which requires that first derivative of the individual-level budget share functions for such goods not to vary across household members) is mixed. Using data from Malawi, Dunbar et al. (2019) find evidence supporting this restriction with clothing expenditures as the assignable good. Bargain et al. (2021) analyze data from Bangladesh and reject this restriction both for clothing and food expenditures; Sokullu and Valente (2019) find similar results for clothing expenditures in Mexico and Brown et al. (2021) for expenditures on specific food items in Bangladesh.

²²Lewbel (1991) defines the rank of any demand system to be the dimension of the space spanned by its Engel curves.

Assumption 3.ii can also be weakened when the consumption choices of couples without children are observable. While not extremely common in developing countries, childless couples do exist in many contexts. With childless couples, individual preferences for the assignable goods need to only be similar among adults, but not among adults and children. This requirement can be formalized as follows:

Assumption 6. Let $y = e^x$ be total expenditure, and $\omega_{j,n}^{k_j}(y)$ be the individual-level budget share equations for the private assignable goods as a function of total expenditure in one price regime. $\omega_{j,n}^{k_j}(y)$ are twice continuously differentiable with respect to y and $\nabla_y^2 \omega_{w,n}^{k_w}(y) = \nabla_y^2 \omega_{m,n}^{k_m}(y)$.

In many cases, this may be a more attractive assumption than Assumption 3.ii. Adults' preferences for their assignable goods can then be identified using childless couples, while children's preferences, adults' and children's resource shares, and economies of scale would be identified following a strategy analogous (and hence omitted here) to that used to prove Theorem 1. A formal description of this result is provided by Corollary 2 below.

Corollary 2. Consider a population of couples with $n = 0, \dots, N$ children. Let Assumptions 1, 2, 3.i, 3.iii, 4, 5, and 6 hold for all n , and set $s_{j,0} = 1$ for $j = m, w$ and $s_{c,1} = 1$. Then, resource shares $\eta_{j,n}$ and scale economies $s_{j,n}$ are identified for $j = m, w, c$, with household-level demand data under a single price regime.

4 Empirical Application

4.1 Data

We apply the approach described in the previous section using data from Bangladesh and Mexico. These countries differ along a number of dimensions. First, the two countries are at different stages of economic development. For example, the large majority of Bangladeshi households live in rural areas, compared to a smaller fraction of Mexican households. Furthermore, in poorer countries like Bangladesh, food (which is largely private) typically represents a large share of the household budget. In these contexts, joint consumption may not play a critical role (Deaton and Paxson, 1997). By contrast, in middle-income countries like Mexico, the consumption of shared goods like energy or fuel for transportation may be more prevalent and economies of scale in consumption may be higher. Yet still, in poorer countries, households tend to be larger than in middle-income countries, which could result in more consumption sharing. Second, Mexico and Bangladesh differ substantially with respect to women's empowerment and societal attitudes towards women. According to the World Economic Forum's Gender Gap Index for 2020, e.g., Mexico ranked 25th out of 149 countries for gender equality, while Bangladesh ranked 50th. Our focus on these two countries is meant to shed light on how these differences can impact the assessment of individual well-being as well as the measurement of poverty.

Bangladesh. Data for Bangladesh come from the first two waves of the Bangladesh Integrated Household Survey (BIHS), which was conducted in 2011/12 and 2015. The survey was designed specifically to study issues related to intra-household inequality and is therefore ideal for our application. The data include detailed demographic information on all household members, a 24-hour recall module of

individual dietary intakes and food weighing, a 7-day recall of household-level food expenditures, and an annual consumer expenditure module.

The survey collects information for two sets of private assignable goods: clothing and food items. Clothing expenditures for children are recorded separately; for adults, we assign expenditures on sarees, blouses, and petticoats to women, and expenditures on lungis, dhutis, and salwaars to men. To construct individual expenditures on food, we rely on the 24-hour recall module of dietary intakes.²³ We compute total household expenditure based on the annual consumer expenditure module.

For computational reasons, we pool data from the two rounds of the BIHS dataset. We select a sample of 6,442 households as follows. To ensure comparability across household types, we exclude households with zero men, women, or children, or with more than five individuals in any category (4,247 households). To eliminate outliers, we exclude any households in the top or bottom one percent of total household expenditure. To avoid issues related to special events and food consumption, we drop households reporting having guests during the food recall day (1,563 households). A small number of households have individuals with food budget shares that take a value of zero due to illness, fasting, being an infant, or currently being away from the household. Households with such individuals are excluded from the analysis (549 households). Finally, households with missing data for any of the household characteristics or relevant expenditures are dropped from the sample. Table 2 presents descriptive statistics of the estimation sample. Households in Bangladesh are poor, with an average total expenditure of US\$5,311 (adjusted for PPP) over the year prior to the survey. Moreover, households spend a significant portion of their budget on food (66.2 percent). Households are large on average, with close to three adults and two children per household.

Mexico. Data for Mexico are from the 2018 wave of the Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH). This biannual survey includes detailed measures of household income and expenditures, as well as standard demographic characteristics for all household members. Unlike BIHS, ENIGH does not collect assignable food consumption. We therefore use men's, women's, and children's clothing as private assignable goods.²⁴ In this survey, expenditures on such goods are recorded separately for men, women, and children, so that we do not have to restrict our focus to gender-specific clothing items for adults (as we do for Bangladesh). Out of the 74,647 surveyed households surveyed, we select a sample of roughly 36,000 households after removing those that have no men, women, or children, or are uncommonly large (more than eight adults or eight children). Moreover, we drop households that are in the top or bottom household expenditure percentile, and households with missing data for any of the variables included in estimation.

Table 3 presents descriptive characteristics for the Mexican sample. As expected, households in Mexico are wealthier than in Bangladesh, with an average annual expenditure of approximately US\$16,000 and

²³To collect individual dietary intakes, BIHS enumerators interviewed the woman in the household most responsible for food preparation. They asked her about the household's food consumption over the most recent typical data (which in almost all cases was the previous day). Enumerators determined which meals were served for breakfast, lunch, and dinner, as well as any snacks. For each meal, the survey respondent provided recipes, which include the cooked and uncooked weights of all ingredients. Finally, the respondent determined how much of each meal was served to each person in the household. Additional information collected include whether any guests were present, whether any food was left over or given to animals, and the reason(s) why any individual did not consume a given meal. For a more detailed discussion of how the data was collected, the overall quality of the data (e.g., measurement error), and how we construct budget shares, see [Brown et al. \(2021\)](#).

²⁴Identification requires no direct consumption externalities, which may be questionable for clothing. Testing this assumption is challenging. However, using a unique dataset that includes total private expenditures for each household member, [Bargain et al. \(2021\)](#) show that resource shares estimated using clothing budget shares match the observed resource shares remarkably well, providing indirect support to using clothing as an assignable good.

Table 2: Descriptive Statistics: Bangladesh

	Mean	Median	Std. Dev	Obs.
<i>Household Expenditures:</i>				
Total Expenditure (PPP dollars)	5,311	4660	2,608	6,442
Food Budget Share	0.662	0.675	0.114	6,442
Men's Cereals, Pulses, Veg. Budget Share	0.104	0.096	0.048	6,442
Women's Cereals, Pulses, Veg. Budget Share	0.094	0.088	0.042	6,442
Children's Cereals, Pulses, Veg. Budget Share	0.078	0.066	0.055	6,442
<i>Household Composition:</i>				
Men	1.399	1.000	0.676	6,442
Women	1.459	1.000	0.691	6,442
Boys	0.979	1.000	0.827	6,442
Girls	0.959	1.000	0.887	6,442
<i>Household Characteristics:</i>				
Average Age Men	38.791	37.000	11.281	6,442
Average Age Women	34.710	33.000	9.302	6,442
Average Age Children	7.345	7.500	3.501	6,442
Average Education Men	1.419	1.000	1.338	6,442
Average Education Women	1.442	1.500	1.211	6,442
Working Men (share)	0.870	1.000	0.269	6,442
Working Women (share)	0.632	1.000	0.415	6,442
1 (Work in Rural Area)	0.826	1.000	0.379	6,442
1 (Dhaka)	0.305	0.000	0.460	6,442
Year=2011	0.529	1.000	0.499	6,442

Note: BIHS data (2011/12 and 2015). The table reports some descriptive statistics of the sample used in estimation. Expenditure data based on annual recall. Individual education ranges from 0 (no schooling) to 5 (completed secondary school). Employment is based on work for pay during the week prior to the survey.

a food budget share of 41 percent. Household size is similar to Bangladesh, with Mexican families on average consisting of three adults and two children. Note, however, that our definition of children is different in the Mexico sample relative to the Bangladesh sample. This choice is data-driven, since clothing expenditures are assigned to children aged 17 or younger in the ENIGH, while BIHS classifies children as individuals aged 14 or younger. As a result, the average age of children and adults is slightly higher in Mexico. The budget shares for assignable clothing are low, reflecting a shorter recall period relative to the BIHS. While the corresponding Engel curves display sufficiently high variation with household expenditure, we acknowledge that this feature of the data is a limitation.

4.2 Estimation

For our empirical application, we consider the Quadratic Almost Ideal Demand System of [Banks et al. \(1997\)](#). As discussed in Section 3.4, under QUAIDS, the budget share functions are quadratic in log total expenditure. Adding error terms, the system of Engel curves for the private assignable goods includes J equations as follows:

$$W_{h,\tau}^{k_j} = n_{j,h,\tau} \eta_{j,\tau} [d_{j,\tau} + b_j(x_{h,\tau} + \ln \eta_{j,\tau} - \ln s_{j,\tau}) + c_j(x_{h,\tau} + \ln \eta_{j,\tau} - \ln s_{j,\tau})^2] + \epsilon_{h,\tau}, \quad (11)$$

where $W_{h,\tau}^{k_j}$ is the household-level budget share for the assignable good of each person j in household h of type τ , $x_{h,\tau}$ is the household's log expenditure, and $n_{j,h,\tau}$ is the number of household members in each

Table 3: Descriptive Statistics: Mexico

	Mean	Median	Std. Dev	Obs.
<i>Household Expenditures:</i>				
Total Expenditure (PPP dollars)	16,104	13,313	10,688	35,056
Food Budget Share	0.410	0.405	0.152	35,056
Men's Clothing Budget Share	0.006	0.000	0.014	35,056
Women's Clothing Budget Share	0.007	0.000	0.014	35,056
Children's Clothing Budget Share	0.014	0.007	0.021	35,056
<i>Household Composition:</i>				
Men	1.341	1.000	0.620	35,056
Women	1.406	1.000	0.661	35,056
Boys	0.993	1.000	0.831	35,056
Girls	0.940	1.000	0.823	35,056
<i>Household Characteristics:</i>				
Average Age Men	38.930	37.000	11.368	35,056
Average Age Women	37.230	36.000	9.805	35,056
Average Age Children	8.773	9.000	4.498	35,056
Average Education Men	0.710	1.000	0.454	35,056
Average Education Women	0.726	1.000	0.446	35,056
Working Men (share)	0.901	1.000	0.258	35,056
Working Women (share)	0.511	0.500	0.456	35,056
1 (Rural)	0.326	0.000	0.469	35,056
1 (Mexico City)	0.024	0.000	0.153	35,056

Note: ENIGH data (2018). The table reports some descriptive statistics of the sample used in estimation. Expenditure data based on annual recall. Individual education equals 0 for no schooling and 1 for completed secondary school. Employment is based on work for pay during the week prior to the survey.

category j . Consistent with the requirements of Corollary 1, the preference parameters b_j and c_j do not vary across household types. By contrast, $d_{j,\tau} = a_{j,\tau} + \lambda_{j,\tau}$ can vary freely both across household and individual types.

Let X^τ be a vector of household composition variables, such as the number of men, women, boys and girls, and X be a vector containing a set of household socio-economic characteristics. These include the variables listed in Tables 2 and 3, such as age, education, the employment status of the household members, and place of residence. We model the resource shares $\eta_{j,\tau}$ and scale economies $s_{j,\tau}$ as linear functions of X and X^τ . Following Corollary 1, the preference parameters b_j and c_j are specified as linear functions of X , but do not depend on the household composition variables. Since the error terms may be correlated across equations, we estimate the system of Engel curves using non-linear Seemingly Unrelated Regression, which is iterated until the estimated parameters and the covariance matrix settle. Iterated-SUR with multivariate normal errors is equivalent to maximum-likelihood estimation. Consistent with the model, we impose a cross-equation restriction that the resource shares $\eta_{j,\tau}$ must sum to one.

We make four important simplifications to the system of Engel curves in (11) to ensure convergence. First, due to data limitations and for computational tractability, we focus on three categories of individuals: women, men, and children. Second, we specify $\eta_{j,\tau}$ and $s_{j,\tau}$ using an inverse logistic function that guarantees that they are bounded between zero and one. Third, we assume that preferences for the assignable goods are similar across people, i.e., $b_j = b$ and $c_j = c$. While not required for identification in the case of polynomial budget-share functions like QUAIDS, this restriction proved critical for the convergence of our estimation routine. Fourth, we estimate a single scale economy parameter for each household type, i.e.,

$s_{j,\tau} = s_\tau$. Stated differently, we assume that any gains from joint consumption are equally shared among all household members.²⁵ As it is common in non-linear models, we noticed that the sum-of-squared residuals function has multiple local minima. This is true both when using the Bangladeshi data and the Mexican data. We therefore performed grid searches over a wide range of starting values and selected the estimates corresponding to the minimum sum-of-squared residuals.

Pre-Estimation Tests. Before presenting our empirical results, we briefly discuss a series of pre-estimation tests aimed at selecting which private assignable goods in our samples are likely to satisfy the identifying assumptions. Recall from Section 3 that we require the Engel curves for private assignable goods to have non-zero second derivatives with respect to household expenditure (or log household expenditure in the case of QUAIDS). Engel curves that are “too linear” do not provide enough variation to separately identify scale economies from resource shares and preferences.²⁶ We implement two pre-estimation diagnostic tests to determine which assignable goods are likely to satisfy this condition.

First, we estimate household-level Engel curves for men’s, women’s and children’s assignable goods using a linear regression model, which we estimate using ordinary least squares. Doing this helps us determine which goods in our samples have significantly non-linear Engel curves, on average. However, it may mask some important heterogeneity across households. Since our empirical model allows for heterogeneity in preferences, resources shares, and scale economies (which essentially means that we estimate different Engel curves for different household types and observable characteristics), we also estimate the following fully-interacted linear regression model:

$$W_h^{k_j} = \alpha_0 + (X_h, X_h^\tau)' \alpha + (X_h, X_h^\tau)' \beta x_h + (X_h, X_h^\tau)' \gamma x_h^2 + \epsilon_h, \quad (12)$$

where X_h and X_h^τ are vectors of household composition variables and socio-economic characteristics, respectively, and x_h is the household’s log expenditure. This approach allows us to compute slope coefficients and curvature parameters for all household types and test that they are significantly different from zero conditional on household characteristics.

The full set of results are presented in Table A1 in the Appendix, which reports the estimates of simple household-level linear regression models as well as descriptive statistics of the empirical distributions of t-statistics of the slope coefficients and curvature parameters in Equation (12). The dataset from Mexico only records expenditures for assignable clothing, whose Engel curves display enough non-linearity to make it suitable for our approach. In Bangladesh, we find that cereals, pulses, and vegetables exhibit the highest degree of curvature among potential assignable goods. For proteins (meat, fish, and milk products) as well as assignable clothing, the Engel curves are essentially linear for the vast majority of households, which makes them ill-suited for our application. So, in what follows, we present estimates obtained using assignable food (cereals, pulses, and vegetables) for Bangladesh and assignable clothing for Mexico. Note that the specific empirical properties of the budget share functions may vary substantially

²⁵This is admittedly a strong assumption that we impose to guarantee a successful convergence of our estimation routine. Relaxing this assumption led to estimation problems with the data from Mexico, but not from Bangladesh. For Bangladesh, we estimated separate economies of scale in consumption for women, men, and children, and found them not to be largely different from each other (though we detect higher scope for consumption sharing among children and women relative to men). Descriptive statistics for our estimates for scale economies for women, men, and children in Bangladesh are reported in Table A5 in the Appendix.

²⁶In a similar spirit, Tommasi and Wolf (2018) point out that the identification approach of Dunbar et al. (2013) implicitly requires Engel curves for the private assignable goods to have a large non-zero slope. Our tests address this issue too.

by context and assignable good. For this reason, we recommend testing the validity of the identifying assumptions whenever possible.

4.3 Results

Table 4 below presents selected summary statistics for the estimated children’s, women’s and men’s resources shares as well as economies of scale and indifference scales. Recall that these are estimated conditional on a set of observable household characteristics and composition variables. The coefficients for each variable and the corresponding heteroskedasticity-robust standard errors are presented in Tables A2 and A3 in the Appendix, while the empirical distributions of the estimated resource shares and scale economies are plotted in Figure A2. In Table A4, we also report estimated resource shares and scale economies in a representative non-reference household, defined as non-reference household with all preference factors and household type variables at their median value (see Tables 2 and 3 for a list of these values). The associated standard errors are quite small (especially for Bangladesh), indicating that the parameters of interest are precisely estimated.²⁷

Panel A of Table 4 reports the mean, median, and standard deviation for the share of household consumption allocated to each child, woman, or man. In line with Brown et al. (2021) and Lewbel and Pendakur (2021), who also estimate resource allocation in Bangladesh, we find that in Bangladeshi families men consume significantly more than women, who in turn consume more than children. Our estimates are also consistent with the observed resource shares provided by Bargain et al. (2021).²⁸ Specifically, our estimates indicate that women on average are allocated only 77 percent of the resources allocated to men, while each child receives 44 percent of a man’s share. In Mexico, women consume a larger share of the household budget on average, which is consistent with previous estimates by Sokullu and Valente (2019) and Hoehn-Velasco and Penglase (2019).

In Panel B of Table 4, we present summary statistics for the estimated scale parameters \hat{s}_τ . Recall that scale economies measure the cost-savings experienced by individuals from living in a household of composition τ relative to living in a reference household (i.e., in households with one man, one woman, and one child), and lower values imply greater consumption sharing. By construction, scale economies will equal one in the reference household, so we omit those households from the presentation of the results. In Bangladesh, we find that relative to a nuclear family with one child, the total household expenditure in non-reference families is scaled up by approximately 2 percent ($1/0.979$), on average. This implies that the cost of living faced by an individual in the average non-reference household is 98 percent of what is faced by an individual living in the reference household. In Mexico, we estimate larger scale economies, with the total household expenditure in non-reference families being scaled up by approximately 10 percent relative to reference households. Note that scale economies in consumption may vary across household types due to household size (by construction public or shareable goods are

²⁷In Table A6 in the Appendix, we report descriptive statistics for the estimated resource shares and scale economies from specifications that account for endogeneity of household type (due, e.g., to selection) and endogeneity of household expenditure (related, e.g., to measurement error). In a first specification, we augment each Engel curve equation with an inverse Mills ratio (IMR) to address selection. Specifically, the IMR is obtained from the estimation of probit selection equation with an indicator for non-reference households as dependent variable and a community-level measure of prevalence of non-reference households as the excluded instrument. In a second specification, we follow previous literature (Dunbar et al., 2013; Attanasio and Lechene, 2014) and instrument household total expenditure with household income (for Mexico) and the total value of household assets (for Bangladesh). These results are largely in line with our baseline estimates.

²⁸Bargain et al. (2021) use a different dataset from Bangladesh, the Household Income and Expenditure Survey, that exceptionally contains individualized (private only) expenditure for all the members of 1,039 households in year 2004.

Table 4: Estimated Resource Shares, Scale Economies, and Indifference Scales

	Bangladesh				Mexico			
	Obs.	Mean	Median	Std. Dev.	Obs.	Mean	Median	Std. Dev.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>A) Resource Shares: $\hat{\eta}_{j,\tau}$</i>								
Children	6,442	0.147	0.130	0.069	36,075	0.157	0.123	0.089
Women	6,442	0.258	0.263	0.074	36,075	0.336	0.385	0.115
Men	6,442	0.335	0.361	0.086	36,075	0.289	0.314	0.085
<i>B) Scale Economies: \hat{s}_τ</i>								
	5,407	0.979	0.997	0.056	29,893	0.913	0.955	0.112
<i>C) Indifference Scales: $\hat{I}_{j,1,\tau}$</i>								
Children	5,407	0.548	0.504	0.231	29,893	0.652	0.469	0.636
Women	5,407	0.739	0.734	0.236	29,893	0.854	0.959	0.316
Men	5,407	0.781	0.840	0.230	29,893	0.925	0.977	0.295

Notes: The table shows selected summary statistics for the estimated children's, women's, men's resources shares as well as economies of scale and indifference scales. Estimates are conditional on a set of observable household characteristics and composition variables. Coefficients for each variable and the corresponding heteroskedastic-robust standard errors are presented in Tables A2 and A3 in the Appendix, while the empirical distributions of the estimated resource shares and scale economies are plotted in Figure A2. Panel A reports the mean, median, and standard deviation for the share of household consumption allocated to each child, woman, or man. Panel B presents summary statistics for the estimated scale parameters. Panel C reports the computed indifference scales. Note that mean and median of resource shares do not need to sum to one because there can be more than one individual of the same type in each family. Indifference scales are calculated as $\hat{I}_{j,1,\tau} = \frac{\hat{s}_{j,1}}{\hat{s}_{j,\tau}} \frac{\hat{\eta}_{j,\tau}}{E[\hat{\eta}_{j,1}]}$, where $\hat{s}_{j,1}$ equals one and $E[\hat{\eta}_{j,1}]$ is the average resource share for person type j across the reference households. In Bangladesh, $E[\hat{\eta}_{j,1}]$ for children, women, and men are 0.241, 0.338, and 0.420. In Mexico, for analogous figures are 0.255, 0.412, and 0.332, respectively. Since scale economies are normalized to one in reference households, we exclude these households from Panels B and C.

consumed by a larger number of people in larger families), but also due to differences in the relative consumption of private and shareable goods across family compositions. We will come back to this point later on.²⁹

While the extent of joint consumption appears minimal in Bangladesh and higher (but still limited) in Mexico, we wish to emphasize that our estimates of joint consumption are measured relative to a reference household that contains three individuals, and do not represent the true amount of joint consumption. If we were to incorporate single-person households into the analysis, and designate them as the reference household, we would expect greater economies of scale in consumption. Alternatively, one can view our estimates as a lower bound of the true degree of joint consumption. Note also that these estimates account for the fact that a large fraction of consumption in many households consists primarily of private goods. A simple back-of-the-envelope calculation, based on the estimates in Panel B of Table 4 and information from the household-level expenditures on private and non-private goods available in the data, allows us to compute a coarse estimate of the extent to which shareable goods are jointly consumed. In Bangladesh and Mexico, the average share of consumption spent on non-private goods (such as housing, transportation, or cleaning supplies) in the non-reference households equals 14.0 and 32.8, respectively. In Bangladesh, these budget shares imply scale economies for non-private goods equal to 0.85.³⁰ The comparable figure

²⁹While there are no previous estimates of scale economies in Mexico and Bangladesh to compare ours to, we indirectly check the validity of our estimates by examining the correlation between scale economies and the consumption of public goods. In Figure A4 in the Appendix, we report the results of non-parametric regressions of the estimates \hat{s}_τ on the budget share on public goods (energy, rent, and other housing expenses). It is reassuring that we estimate larger scale economies (lower \hat{s}_τ) when the budget share on public goods is large.

³⁰Due to data limitations, we cannot compute the exact degree to which goods are shared. Instead, we provide an ad hoc estimate of scale economies for the non-private goods. It is important to recognize that these estimates do not originate from the model, but are merely designed to allow us to better understand the relationship between expenditures on non-private goods and scale economies. In particular, let $s_\tau^1 = 1$ be the scale economy parameter for the private goods, and s_τ^2 be the scale economy parameter for the non-private goods. Further, let W^1 and W^2 be the household-level budget shares for the private and non-private goods, respectively. Then, $s_\tau^2 = \frac{s_\tau - W^1}{W^2}$.

in Mexico is 0.73. These measures are informative in determining why the countries differ in economies of scale in consumption. That is, are scale economies greater in Mexico due to increased expenditures on non-private goods, or are they greater because of the Barten scales for the non-private goods? These calculations imply that not only do Mexican households spend more on non-private goods, but those expenditures are shared more effectively.

Finally, in Panel C of Table 4, we compute indifference scales, which measure the scale to household expenditure required for an individual living in a (typically larger) household of type τ to be just as well off as if they were living in the reference household ($\tau = 1$). So, we compute indifference scales as $\hat{I}_{j,1,\tau} = \frac{\hat{s}_{j,1} \hat{\eta}_{j,\tau}}{\hat{s}_{j,\tau} E[\hat{\eta}_{j,1}]}$, where $\hat{s}_{j,1}$ equals one and $E[\hat{\eta}_{j,1}]$ is the average resource share for person type j across the reference households. Recall that if indifference scales were to equal one, then the individual would be indifferent between living in the non-reference household and the reference household: in this case, the consumption gains from living in the larger household or from any reallocation of resources exactly offset the decline in consumption due to the smaller resource share. If indifference scales are less than one, then the benefit of increased consumption sharing is outweighed by the “cost” associated with a smaller resource share; household expenditure would then need to be scaled up by $1/\hat{I}_{j,1,\tau}$ for the individual in the non-reference household to be just as well off as if they were living in the reference household.

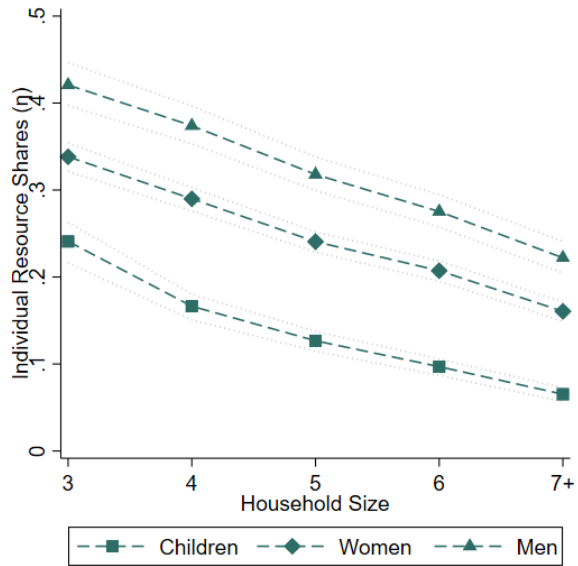
On average, we estimate indifference scales that are less than one. Since economies of scale are limited in Bangladesh, indifference scales are quite low, indicating that the expenditure adjustment for individuals living in non-reference households to be just as well off as they would be if they lived in a reference household would have to be quite high. Specifically, for a given expenditure level, on average, children, women and men in non-reference households would need to have their household’s expenditure scaled up by 82 percent ($1/0.548$), 35 percent, and 28 percent, respectively, to be just as well off as they would be in a nuclear family with one child. In Mexico, indifference scales are higher due to the greater degree of consumption sharing. We find that, for a given expenditure level, children in non-reference households would need to have their households’ expenditure scaled up by 53 percent, on average, to be just as well off as they would be in the reference household. By contrast, the average expenditure adjustment for women and men would amount to 17 and 8 percent, respectively.

Estimates by Household Type. In Table 4, we analyzed the distribution of estimated resource shares for children, women and men for all households in the Mexican and Bangladeshi samples as well as scale economies and indifference scales for non-nuclear households or nuclear households with multiple children relative to nuclear households with one child. We now examine how these estimates vary with household size (Figure 2) and composition (Figures A5 and A6 in the Appendix).

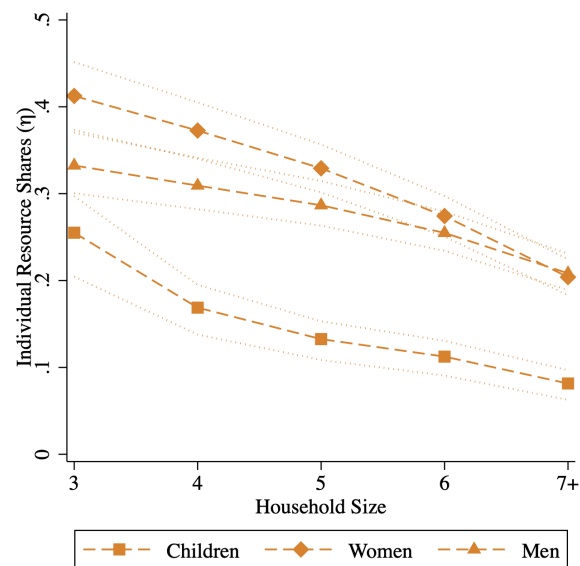
Three main features emerge from Figure 2, which plots the average estimated $\hat{\eta}_{j,\tau}$, \hat{s}_{τ} , and $\hat{I}_{j,\tau}$ by household size with the associated 95 percent confidence intervals. First, as expected, the share of resources devoted to each child, woman, or man decreases with household size, as resources need to be shared between more people in larger families. While the decline for children is similar across the two countries, the decline in women’s share in Mexico is steeper than in Bangladesh, suggesting that resource allocation among women and men is more equitable in larger households, on average.³¹

³¹Note that this may mask non-trivial inequality among women or among men. Given data limitations, however, we cannot analyze this possibility further.

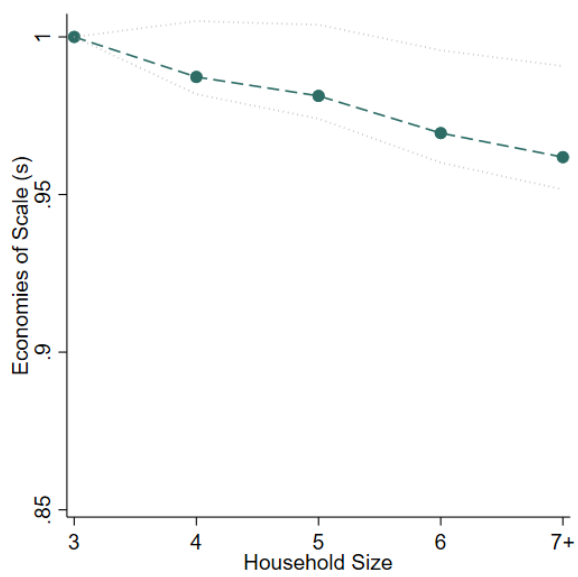
Figure 2: Resource Shares, Economies of Scale, and Indifference Scales by Household Size



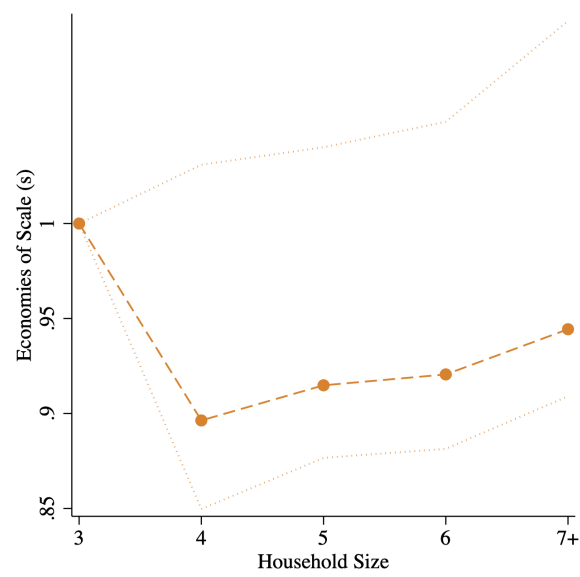
(A.1) Bangladesh: Resource Shares ($\hat{\eta}_{j,\tau}$)



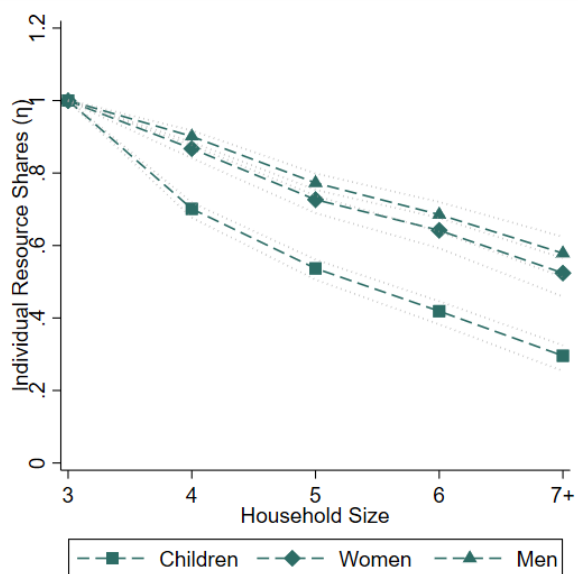
(A.2) Mexico: Resource Shares ($\hat{\eta}_{j,\tau}$)



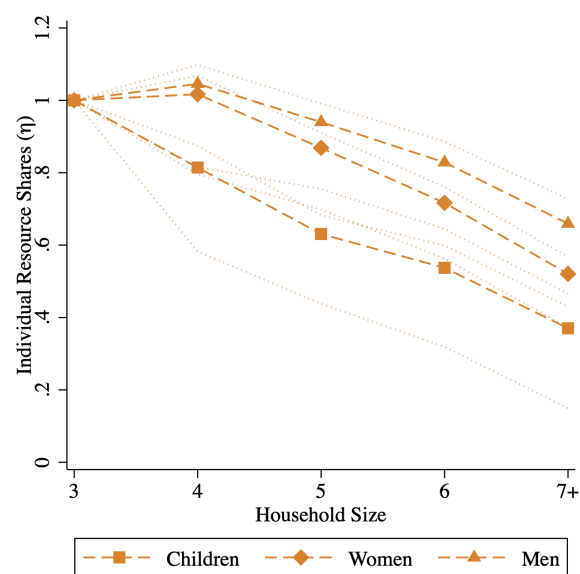
(B.1) Bangladesh: Economies of Scale (\hat{s}_τ)



(B.2) Mexico: Economies of Scale (\hat{s}_τ)



(C.1) Bangladesh: Indifference Scales ($\hat{I}_{j,1,\tau}$)



(C.2) Mexico: Indifference Scales ($\hat{I}_{j,1,\tau}$)

Note: The figure shows how resource shares, scale economies and indifference scales for children, women and men vary with household size. Indifference scales are computed following Lemma 1 and as discussed in Table 4. Confidence intervals are also included. The reference household is defined as having one of each person type (here, this implies one man, one woman, one child). Scale economies in the reference household are set to one. Resource shares in the reference household are set to the average across all reference households. To compute standard errors and confidence bands, we simulate a distribution of values for each statistic based on samples of the parameter vector. We obtain these samples by drawing from the normal distribution defined by the point estimate of the parameter vector and the associated estimated covariance matrix. We obtain confidence intervals by subtracting (adding) 1.959 times the standard deviation of the distribution of each statistic to the value of the statistic implied by the point estimate of the parameter vector.

Second, scale economies increase (that is, \hat{s}_τ decreases) with household size in Bangladesh, which is consistent with larger families benefiting the most from the joint consumption of public goods. By contrast, we estimate a non-monotonic relationship between scale economies and household size in Mexican families. Note that, for a given composition of the household budget (i.e., for given budget shares for private versus jointly consumed goods), we would expect scale economies to increase as the number of family members increases. So, scale economies that are decreasing in household size for families with more than four members may arise from differences in household composition and the relative consumption of private and shareable goods across household sizes. To test this hypothesis, we leverage the detailed breakdown of expenditures provided by the ENIGH and explore how the budget shares on private and public (or partially shared) goods change with household size. As shown in Figure A3 in the Appendix, the share of budget allocated to private goods (food, clothing, and personal accessories) is the lowest and the budget share of partly shared goods (fuel for transportation and other vehicle expenses, excluding purchase) is the highest in Mexican families of size four compared to smaller or larger families. This non-monotonicity helps rationalize the higher economies of scales in families of size four relative to larger or smaller families. We further note that these estimates are imprecisely estimated (as illustrated by the width of the confidence intervals). As a result, we cannot rule out that there is, in fact, a monotonic decline in scale economies in Mexico as one might expect.

Third, while the estimated indifference scales in Bangladesh are below one, on average, in all household sizes, in Mexico adults' indifference scales are slightly larger than one for households of size four. This means that for women, men, and children in Bangladeshi families, for children in Mexican families, and for adults in Mexican families with more than four members, the impact of scale economies on their consumption level (or of any reallocation of resources across household sizes) is outweighed by them having to share resources with more people as household size increases. So, their expenditure would need to be scaled up to be just as well off as if they were living in a nuclear household with one child with the same household expenditure level. By contrast, for adults in Mexican families of size four, the expenditure adjustment would be zero or possibly negative.

As previously discussed, in extended families, household size and household type may not coincide. To better understand how indifference scales vary with the composition of the family, in Figures A5 and A6 in the Appendix, we plot the average indifference scales by the number of children and adults in the family. In both countries, we find that adults' indifference scales decline substantially as the number of adults increases. By contrast, for a given number of adults, the decline is minimal as the number of children increases, suggesting that the amount of resources allocated to each adult does not vary significantly with the number of children. Turning to children, we estimate indifference scales that are decreasing in both the number of children and adults in Bangladesh, and decreasing in the number of children but not adults in Mexico. This means that any expenditure adjustment required to make a child in a non-reference household as well off as if she was an only child in a nuclear household increases with the number of children and adults in Bangladesh, and with the number of children (but not adults) in Mexico.³²

³²With the available data, it is not possible to fully understand what drives this difference. Mexico, however, is "more nuclear" than Bangladesh, in the sense that the vast majority of individuals are identified in the household roster as mother, father, or child. So, a substantial fraction of the third or fourth adults in Mexico are adult children (of age higher than 17), living with their parents. It is unclear that this helps explain the pattern of indifference scales by household types, but it is a difference worth noting.

5 Poverty Analysis

Standard methods for measuring poverty (e.g., World Bank per-capita measures) entirely ignore intra-household allocation and economies of scale. Other approaches (e.g., OECD equivalence scales) deal with economies of scale in largely atheoretical ways and do not account for intra-household inequality. With very few exceptions, previous methods that rely on collective household models to estimate individual-level poverty rates successfully tackle the issue of intra-household allocation, but not of joint consumption. In what follows, we begin by summarizing various existing methods to measure poverty. We then use the structural estimates presented in Section 4.3 to conduct an individual-level poverty analysis that considers both the intra-household allocation of consumption and scale economies. We conclude by comparing poverty estimates based on different methods and by discussing some policy implications.

Per-capita Poverty Rates. The World Bank primarily relies on per-capita measures of poverty (World Bank, 2015). Accordingly, an individual is classified as poor if their household per-capita expenditure is below a poverty line (e.g., US\$1.90/day). This approach implicitly assumes that everyone is allocated the same share of total household expenditure and that there is no consumption sharing. Importantly, the poverty line does not vary across household sizes: an individual living alone faces the same threshold as an individual living in a larger household. A single-person household spending US\$2/day, e.g., is assumed to be just as well off as if she were living in a five-person household that together spend US\$10/day. Even in the absence of intra-household inequality in how resources are allocated among family members, this would not be the case if the five-person household consumed any public goods or any goods that can be jointly consumed.³³ So, while per-capita *expenditure* is equal across household sizes, per-capita *consumption* may be substantially different. Poverty calculations based on household per-capita expenditures are unable to account for this important difference. Moreover, when using such an approach, either everyone in a household lives below the poverty line or no one does, which may be unrealistic when intra-household inequality is high.

Equivalence Scale-Adjusted Poverty Rates. An alternative approach to measuring poverty is to adjust household expenditure across household compositions using equivalence scales. An equivalence scale transforms expenditure in a multi-person household into an equivalent expenditure in a one-person household by accounting for both household size and differences in needs between children and adults. As discussed in Chiappori (2016) and Pendakur (2018), equivalence scales suffer from important weaknesses. First, they ignore intra-household allocations. Second, they are generally constructed based on *ad hoc* assumptions. Third, since an equivalence scale is defined as the household expenditure divided by the expenditure of a single person that enjoys the same standard of living (i.e., the same utility level) as the household, the concept of equivalence scales relies on comparisons between individual and household utilities. This is troublesome in theory because it is individuals, not households, who have preferences and hence utility functions.³⁴ Nevertheless, equivalence scales have been widely used to measure poverty

³³To see this, suppose households divide their expenditures equally between a single purely private good and a second good that is purely public. In the single-person household, the US\$2 expenditure results in US\$2 consumption. In the five-person household, the US\$10 expenditure (US\$5 spent on the public good and US\$5 spent on the private good) results in a total consumption of US\$30 for all individuals, or US\$6 per person (assuming no intra-household inequality).

³⁴Equivalence scales also suffer from serious econometric identification issues, which are discussed in, e.g., Deaton and Muellbauer (1980), Blundell and Lewbel (1991), and Lewbel (1997).

both in developed and developing countries. A common example of equivalence scales is the OECD scale (or Oxford scale), which equals 1 for the first adult household member, plus 0.7 for each additional adult, plus 0.5 for each child. So, a typical family of four, with two parents and two children, would be assigned an equivalence scale of 2.7. An alternative three-parameter equivalence scale is used in the United States (Betson, 2007; Garner and Short, 2010).³⁵

Model-Based Poverty Estimates. Individual-level consumption is typically not available in most surveys. An increasing number of papers have used the collective household model to structurally estimate the intra-household allocation of resources and overcome the deficiencies of per-capita and equivalence scale-based approaches to measure poverty. For example, Dunbar et al. (2013) estimate poverty in Malawi separately for men, women, and children, and find that child poverty rates are substantially understated when ignoring inequality within the household. Subsequent applications and extensions of Dunbar et al. (2013) provide estimates of individual-level poverty rates that account for intra-household resource allocation for several countries worldwide. Penglase (2020), for example, estimates higher poverty rates for foster children relative to non-foster children in Malawi. Calvi (2020) shows that poverty rates for women in India are substantially higher than for men, especially at older ages. Brown et al. (2021) find that, as a result of intra-household inequality, one-third of poor individuals in Bangladesh live in families with per-capita expenditure above the poverty line. Tommasi (2019) and Sokullu and Valente (2019) study changes in poverty for men, women, and children in Mexico following the introduction of PROGRESA in the late 1990s. Lechene et al. (2021) confirm previous estimates of individual poverty rates for Bangladesh and Malawi and compute poverty rates for men, women, and children in Albania, Iraq, and Bulgaria, unveiling substantial heterogeneity across countries.

While Dunbar et al. (2013) and all the other applications mentioned above provide individual-level poverty rates adjusted for intra-household inequality, they do not account for scale economies in consumption.³⁶ Ignoring scale economies, however, may result in an over-estimation of poverty rates. The novelty of our method is that it delivers individual-level poverty estimates for women, men, and children, that account for both intra-household inequality and scale economies.

A simple example may help illustrate how individual-level poverty rates are affected by intra-household resource allocation and economies of scale. Consider two households with household expenditure y equal to US\$10/day: a reference household with one man, one woman, and one child, and no economies of scale in consumption;³⁷ and a (possibly larger) non-reference household of type τ . Suppose the woman's resource share in the reference household, $\eta_{w,1}$, is 0.30, so that her individual expenditure equals US\$3/day; also, suppose each woman's resource share in the non-reference household is 0.17, so that their individual expenditure is US\$1.70/day. If there were no economies of scale in consumption and $s_\tau = 1$ (e.g., if consumption in both households was limited to private goods), the amount of expenditure allocated to each woman would coincide with how much she consumes. So, the woman in the reference household would not be classified as poor (based on the US\$1.90/day threshold), while each woman in the non-reference household would. However, if the non-reference household experienced economies of scale from the

³⁵The OECD scale converts household expenditure in an n -person household to a single-person household by taking total household expenditure and dividing by $1 + 0.7(n_a - 1) + 0.5n_c$, where n_a is the number of adults and n_c is the number of children. The three-parameter equivalence scale used in the US is given by $(1 + 0.8 + 0.5(n_c - 1))^{0.7}$ for single-parent households, and by $(n_a + 0.5n_c)^{0.7}$ for households with multiple adults.

³⁶The underlying model of Dunbar et al. (2013) accounts for scale economies, but that component of the model is not identified or estimated.

³⁷For a detailed discussion of relative scale economies and the normalization required for identification in our framework, see Section 3.

joint consumption of public goods, each woman's actual level of consumption would exceed US\$1.70. Specifically, if $s_\tau = 0.80$, each woman's consumption in the non-reference household would amount to $\text{US\$}1.70/0.80 = \text{US\$}2.13$, and she would not be classified as poor.

To implement our approach, we first select a poverty line for the reference household. This is the level of per-capita consumption below which the reference household as a whole is classified as poor based on standard per-capita poverty measures. Admittedly, this choice is quite arbitrary. Even when relying on a standard poverty line, the assumption that this is the relevant poverty line for a nuclear family with one child cannot be easily tested. However, this issue is mostly irrelevant when focusing on the relative poverty rates of men, women, and children and on poverty rates relative to a reference household. In what follows, we use the absolute poverty line of US\$1.90/day and apply the same poverty threshold for men, women, and children. Next, we compute each household member's individual consumption, which accounts for resource allocation and the extent of economies of scale in consumption relative to the reference household. Specifically, for each individual in our sample, we compute her individual consumption as $\hat{\eta}_{j,\tau}y/\hat{s}_\tau$. Note that this is different from previous works that, by ignoring scale economies in consumption, cannot distinguish between individual expenditure (i.e., $\hat{\eta}_{j,\tau}y$) and individual consumption. Also, note that since we estimate scale economies relative to a reference household, individual consumption and individual expenditure would coincide in nuclear families with one child.³⁸ Finally, we classify individuals as poor if their individual consumption is below the poverty line: the shares of women, men or children below the poverty line yield individual-level poverty rates that are adjusted for intra-household inequality and scale economies.

Alternatively, one could first adjust the poverty line for different household types for economies of scale in consumption and then compare individual expenditures $\hat{\eta}_{j,\tau}y$ to the adjusted poverty lines. Clearly, both approaches yield the same poverty estimates. Figure A8 in the Appendix shows how the poverty lines for Bangladesh (Panel A) and Mexico (Panel B) should vary by number of children and adults to account for joint consumption based on our estimates. In the figure, for each household composition, the US\$1.90/day poverty line is multiplied by the average level of scale economies \hat{s}_τ in each household type. An analogous figure for the US\$3.10/day poverty line is also provided in the Appendix (Figure A9).

In Tables 5 and 6, we illustrate how poverty rates vary by household size using the four approaches described above for Bangladesh and Mexico, respectively.³⁹ In Panel A, poverty rates are based on household per-capita expenditure, so they ignore both intra-household allocation and scale economies. In Panel B, we compute poverty using the popular OECD equivalence scale; when using this approach, we divide household expenditure by $1 + 0.7(1 - n_a) + 0.5n_c$. In Panels C and D, we additionally provide model-based poverty rates together with their 95 percent confidence intervals: in Panel C, poverty rates account for resource allocation among family members, but not economies of scale; in Panel D, we present poverty rates that account for both dimensions. When analyzing individual-level poverty in Panels C and D, using the same line for everyone may lead to welfare-inconsistent poverty comparisons if some individuals (such as children or the elderly) require fewer resources to achieve the same level of welfare as others.

³⁸If there were scale economies in reference households (which is likely to be the case), we would overestimate poverty. This bias, however, would be smaller than if economies of scale in consumption were ignored altogether.

³⁹Figure A7 in the Appendix presents the empirical distributions of household per-capita expenditure, household expenditure adjusted using the OECD equivalence scale, model-based individual expenditure and model-based individual consumption for Bangladesh and Mexico.

Table 5: Poverty Rates (%) By Household Size in Bangladesh

	Household Size					
	All	3	4	5	6	7+
<i>A) Per-capita Expenditure</i>						
Children	18.91	6.08	14.60	20.98	22.43	23.09
Women	15.34	6.08	12.55	17.46	17.46	18.18
Men	14.82	6.08	13.47	15.32	17.62	17.48
<i>B) Equivalent Expenditure (y/n_{eq})</i>						
Children	1.17	0.00	0.64	0.95	1.67	2.11
Women	1.02	0.00	0.60	0.84	1.39	1.88
Men	0.89	0.00	0.61	0.87	1.36	1.27
<i>C) Individual Expenditure ($\hat{\eta}_{j,\tau}y$)</i>						
Children	31.61 [22.44-40.79]	4.62 [0.00-9.66]	21.19 [13.41-28.97]	29.40 [20.49-38.32]	36.94 [25.69-48.19]	53.38 [39.49-67.27]
Women	6.96 [4.35-9.56]	3.41 [0.23-6.58]	6.40 [4.12-8.69]	8.02 [5.30-10.74]	7.98 [4.66-11.29]	6.90 [3.51-10.28]
Men	1.67 [0.65-2.69]	0.00 [0.00-0.67]	2.27 [0.94-3.61]	1.48 [0.42-2.54]	2.61 [1.27-3.94]	1.04 [0.00-2.21]
<i>D) Individual Consumption ($\hat{\eta}_{j,\tau}y/\hat{s}_\tau$)</i>						
Children	29.43 [20.35-38.51]	4.62 [0.00-9.66]	20.55 [12.92-28.18]	27.31 [18.75-35.88]	33.77 [22.51-45.04]	49.17 [35.04-63.30]
Women	6.63 [4.07- 9.18]	3.41 [0.23-6.58]	6.32 [4.20-8.44]	7.94 [5.24-10.64]	7.40 [4.03-10.77]	6.06 [2.72-9.40]
Men	1.60 [0.63 - 2.57]	0.00 [0.00-0.67]	2.10 [0.85-3.35]	1.48 [0.44-2.52]	2.48 [1.28-3.69]	1.04 [0.00-2.17]

Notes: The table presents poverty rates by household size for Mexico computed using four approaches: household per-capita expenditure, household expenditure adjusted using the OECD equivalence scale, and model-based individual expenditure and individual consumption (with 95 percent confidence intervals in brackets). Per-capita expenditure is obtained by dividing total household expenditure by the number of individuals in the household. Equivalent expenditure is calculated by dividing total household expenditure by $1 + 0.7 * (n_m + n_w - 1) + 0.5 * n_c$ where n_j gives the number of men, women, and children for $j = m, w, c$, respectively. Individual expenditure is obtained by multiplying total annual household expenditure by individual resource shares. Individual consumption is obtained by dividing individual expenditure by scale economies. Only households surveyed in 2015 are included. Poverty lines correspond to the 1.90 dollar/day poverty line. In Panels C and D, we set the child poverty line to be 0.60 of the prime-age adult poverty line. Similarly, we scale the poverty line for individuals age 46 and older by 0.80.

To account for differences in needs between individuals, we adjust the poverty line for children and the elderly. Following [Brown et al. \(2021\)](#), we fix the poverty line for children (individuals 14 and younger) at 60 percent of the extreme poverty line (US\$1.14/day). Recognizing that elderly adults may have different consumption needs relative to working-age adults, we set the poverty line for adults over the age of 45 at 80 percent of the extreme poverty line (US\$1.52/day). This is important to keep in mind when interpreting our results and comparing poverty rates across the four different approaches.⁴⁰

A few observations stand out. Starting with Bangladesh in [Table 5](#), we see across all measures that poverty is increasing in household size (although there are a few exceptions for women and men). Comparing Panels A and D, we find that per-capita poverty rates substantially understate child poverty relative to our preferred measure of individual consumption, particularly at larger household sizes. However, per-capita poverty rates are higher than our model-based estimates for adults across all household sizes. This result suggests that ignoring intra-household inequality and economies of scale in consumption may lead to misclassification of poor individuals as non-poor (or vice versa), a phenomenon we investigate in further details in the online [Appendix](#). The poverty rates based on equivalent expenditure are the lowest. This result is not surprising given that we here apply the OECD equivalence scale, which is the most popular but may be ill-suited for lower income countries. When comparing Panels C and D, we observe very similar poverty rates when using individual expenditure and individual consumption across all household sizes. The two sets of confidence intervals are largely overlapping, which is consistent with the low degree

⁴⁰For completeness, we provide poverty estimates with no age adjustment for any person type in the online [Appendix](#).

Table 6: Poverty Rates (%) By Household Size in Mexico

	Household Size					
	All	3	4	5	6	7+
<i>A) Per-capita Expenditure</i>						
Children	2.42	0.10	0.79	1.91	2.83	6.05
Women	1.64	0.10	0.64	1.39	2.10	3.93
Men	1.67	0.10	0.69	1.51	2.09	4.06
<i>B) Equivalent Expenditure (y/n_{eq})</i>						
Children	0.53	0.00	0.02	0.20	0.80	1.70
Women	0.38	0.00	0.04	0.21	0.60	1.12
Men	0.37	0.00	0.04	0.21	0.60	1.13
<i>C) Individual Expenditure ($\hat{\eta}_{j,\tau}y$)</i>						
Children	9.75	0.02	2.31	7.77	14.46	23.07
	[5.72-13.79]	[0.00-0.26]	[0.55-4.07]	[3.83-11.71]	[8.66-20.26]	[14.62-31.51]
Women	0.63	0.00	0.16	0.46	1.08	1.53
	[0.29-0.97]	[0.00-0.01]	[0.05-0.27]	[0.22-0.70]	[0.54-1.62]	[0.60-2.46]
Men	0.71	0.26	0.41	0.72	0.88	1.29
	[0.35-1.06]	[0.00-0.59]	[0.13-0.68]	[0.35-1.09]	[0.43-1.33]	[0.68-1.91]
<i>D) Individual Consumption ($\hat{\eta}_{j,\tau}y/\hat{s}_\tau$)</i>						
Children	9.52	0.02	2.11	7.47	14.20	22.83
	[5.56-13.49]	[0.00-0.26]	[0.47-3.75]	[3.64-11.30]	[8.45-19.94]	[14.37-31.29]
Women	0.51	0.00	0.11	0.29	0.87	1.35
	[0.21-0.81]	[0.00-0.01]	[0.04-0.19]	[0.08-0.50]	[0.35-1.39]	[0.52-2.18]
Men	0.48	0.26	0.24	0.40	0.64	0.96
	[0.15-0.81]	[0.00-0.59]	[0.02-0.47]	[0.08-0.72]	[0.22-1.07]	[0.31-1.62]

Notes: The table presents poverty rates by household size for Mexico computed using four approaches: household per-capita expenditure, household expenditure adjusted using the OECD equivalence scale, and model-based individual expenditure and individual consumption (with 95 percent confidence intervals in brackets). Per-capita expenditure is obtained by dividing total household expenditure by the number of individuals in the household. Equivalent expenditure is calculated by dividing total household expenditure by $1 + 0.7*(n_m + n_w - 1) + 0.5*n_c$ where n_j gives the number of men, women, and children for $j = m, w, c$, respectively. Individual expenditure is obtained by multiplying total annual household expenditure by individual resource shares. Individual consumption is obtained by dividing individual expenditure by scale economies. Poverty lines correspond to the 1.90 dollar/day poverty line. In Panels C and D, we set the child poverty line to be 0.60 of the prime-age adult poverty line. Similarly, we scale the poverty line for individuals age 46 and older by 0.80.

of consumption sharing that we estimate in the Bangladeshi context. So, while ignoring intra-household inequality may lead to misleading poverty measures, ignoring economies of scale in consumption does not appear to impact poverty calculations in a meaningful manner.

Moving to Mexico in Table 6, we again see that poverty is increasing in household size across all four poverty measures. Moreover, poverty is understated for children and overstated for adults using a per-capita poverty measure. Using an equivalence scale results in lower poverty rates, as it assumes some degree of joint consumption. However, our preferred measure of individual consumption suggests that the degree of joint consumption using an equivalence scale is overstated. Lastly, the estimated poverty rates are lower (mechanically) using individual consumption relative to individual expenditure. Although the confidence intervals in Panels C and D do overlap, the overlap is less precise relative to Table 5.

A few caveats to our analysis deserve mention. First, poverty rates may vary by household size because of differences in household composition and expenditure and, when accounted for, because of the degree of consumption sharing and intra-household inequality. Second, we do not wish to stress the absolute levels of poverty too much since they depend on our adjustment for the relative needs of each household member. Instead, we are mainly interested in comparing how poverty rates vary across household size across our different poverty measures. Finally, our poverty estimates are based on selected samples (see Section 4) and should not be interpreted as national poverty statistics.

6 Conclusion

We develop an identification method to recover intra-household resource allocation and economies of scale in consumption in a collective household framework. Our method requires the observability of household-level consumption choices over private assignable goods and relies on semi-parametric restrictions over individual preferences for such goods. We compute indifference scales for children and indifference scales for adults in extended households or nuclear families with multiple children, which help us shed light on how individual well-being may change across family structures that are most prevalent in developing countries.

To illustrate the relative importance of intra-household resource allocation and scale economies in countries at different stages of economic development, we estimate our model using data from Bangladesh and Mexico. We find a higher degree of scale economies in Mexico relative to Bangladesh, which is consistent with the importance of shared goods relative to private consumption in each country.⁴¹ Moreover, while scale economies are unambiguously increasing in household size in Bangladesh, we estimate a non-monotonic relation between scale economies and household size in Mexico. Further, we show that women are allocated fewer resources than men in Bangladesh, while the opposite holds true in Mexico, on average. In both countries, children command the smallest share of household resources, but their disadvantage is more pronounced in Bangladesh. Based on the model estimates, we conduct a poverty analysis that accounts for both intra-household inequality and economies of scale in consumption. Existing methods, such as per-capita measures, equivalence scale-based measures, and previous model-based measures, ignore one or both of these factors. Our results demonstrate that these are not harmless omissions in certain contexts.

Future work can apply our approach to various settings and policy areas. For example, one could use our estimates to improve the design of cash transfer programs by determining how cash transfer payments should optimally vary across household sizes and compositions. Similarly, one could use our methodology to compute the size of child support payments following a divorce. Child support is often determined by the number of children being supported (Bartfeld, 2000). We provide a way to assess how these payments should vary across the number of children being supported, which may be important as divorce rates are increasing in many developing countries.

There are some limitations of our analysis that deserve mention. First, while we can identify several essential aspects of intra-household consumption, our model proved somewhat difficult to estimate and has relatively demanding data requirements. Future work should investigate simplifications that facilitate estimation (in the spirit of Lechene et al. (2021)). Second, our analysis is primarily descriptive and does not examine why resources are allocated unequally within families. However, understanding the cultural, social, and economic reasons behind intra-household inequality is essential for policy design. Third, while we attempt to address estimation issues related to selection using conventional approaches (Heckman, 1979, 1990), future work may focus on explicitly modeling the household formation process. Finally, although our approach allows for an elementary production technology, it ignores more complex types of household production. Incorporating time use into the model is a promising avenue for future research.

⁴¹Consumption gains from living together are a commonly cited reason in the developed world for cohabitation (Browning et al., 2013). Our results suggest that similar reasoning does not necessarily apply to a low-income setting such as Bangladesh. Other drivers, such as risk diversification or economies of scale in production may be more important.

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