INSTITUTE OF DEVELOPING ECONOMIES

IDE Discussion Papers are preliminary materials circulated
to stimulate discussions and critical comments

IDE DISCUSSION PAPER No. 915

Intrahousehold Consumption Inequality, Economies of Scale, Indifference Scales, and Family Structure

NIKIEMA Relwendé Apollinaire*

January 2024

Abstract

This study presents a novel approach to estimating resource shares, economies of scale among household members, focusing primarily on inequality between cowives in bigamous households in Burkina Faso. The findings indicate that husbands receive a larger portion of the household's total expenditures than their wives and children across household types. Next, I find that senior wives receive higher share of household total expenditure compared with junior wives. Furthermore, the results show that parents in monogamous households experience greater economies of scale than those in bigamous households. Finally, the estimated indifference scales indicate that family size affects well-being differently across individuals and living arrangements.

Keywords: Resource shares, Scale economies, Indifference scales, Collective model, Polygyny, Burkina Faso.

JEL classification: D11, D12, I39, J12, O12

---

* Researcher, Development Studies Center, Institute of Developing Economies, JETRO, 3-2-2 Wakaba, Mihama-ku, Chiba-shi, Chiba 261-8545, Japan, (Email: apollinaire96nikiema@gmail.com).

The Institute of Developing Economies (IDE) is a semigovernmental, nonpartisan, nonprofit research institute, founded in 1958. The Institute merged with the Japan External Trade Organization (JETRO) on July 1, 1998. The Institute conducts basic and comprehensive studies on economic and related affairs in all developing countries and regions, including Asia, the Middle East, Africa, Latin America, Oceania, and Eastern Europe.

INSTITUTE OF DEVELOPING ECONOMIES (IDE), JETRO
3-2-2, WAKABA, MIHAMA-KU, CHIBA-SHI
CHIBA 261-8545, JAPAN

Intrahousehold Consumption Inequality, Economies of Scale, Indifference Scales, and Family Structure*

NIKIEMA Relwendé Apollinaire

Abstract

Recent studies have made substantial efforts to identify inequalities within households, focusing on adult men and women, and children. However, our understanding of resource distribution within each category remains limited because of data constraints. This study presents a novel approach to identifying consumption inequality among household members, focusing primarily on inequality between cowives in bigamous families in Burkina Faso. The approach also allows me to estimate both economies of scale and indifference scales. The findings indicate that husbands receive a larger portion of the household's total expenditures than their wives and children across household types. Additionally, I find that senior wives receive approximately 10% more resources than junior wives. The results also show that parents in monogamous households experience greater economies of scale than those in bigamous households. Finally, the estimated indifference scales indicate that family size affects well-being differently across individuals and living arrangements.

Keywords: Resource shares, Scale economies, Indifference scales, Collective model, Polygyny, Burkina Faso.

JEL classification: D11, D12, I39, J12, O12

* This work was supported by the Japan Society for the Promotion of Science (JSPS) Grant-in-Aid for Research Activity Start-up (Grant Number ２３K１８８２０).

1 Introduction

Understanding intrahousehold resource allocation dynamics is an important economic and policy issue. First, material well-being largely depends on individual-level expenditures and consumption. That is, individuals have preferences, not households. Second, ignoring intrahousehold resource distribution may result in misclassifying poverty for certain demographic groups within households (Bargain & Donni, 2012; Dunbar et al., 2013). As a result, antipoverty programs based on traditional approaches may fail to reach many poor individuals.

Previous studies on intrahousehold consumption inequality show that women and children obtain a smaller share of household resources and are thus poorer than men (Bargain et al., 2022; Calvi, 2020; Lechene et al., 2022). Moreover, these studies help to explain certain phenomena, such as the missing women in India (Calvi, 2020), discrimination against foster children in Malawi (Penglase, 2021), and gender discrimination in Bangladesh (Brown et al., 2021). Other studies show that household size affects the material well-being of individuals in developing countries (Calvi et al., 2023).

Existing studies often focus on family size, ignoring different types of living arrangements[1]. Specifically, the allocation of household resources between cowives and other members of polygamous households has received little attention in the literature. Furthermore, the question of how much income a given member of a polygynous family would need to achieve the same standard of living as a member of a monogamous family remains unanswered. Understanding the dynamics of intrahousehold resource allocation in complex household structures is crucial in efficiently targeting vulnerable individuals in sub-Saharan Africa, where more than 35% of individuals live in nonnuclear families (Pew Research Center, 2019). In this study, I address the following three questions: How does family structure impact intrahousehold resource allocation? Do individuals in a larger family benefit from joint consumption? How do different living arrangements affect individuals' well-being?

Determining consumption inequality among cowives is challenging because consumption data are typically collected at the household-level. Furthermore, the well-known assignable good, namely clothing, often used in the literature to identify individual resource shares, is not associated with a specific wife in a polygamous household and therefore is only partially assignable. In this study, I develop a new methodology using the collective household

[1] Most of the previous studies excluded polygamous households from the analysis (Calvi et al., 2023; Penglase, 2020; Bargain et al., 2021; Bargain and Donni, 2014; Lechene et al., 2022).

framework to identify consumption inequality among cowives, husbands, and children. In addition, the model helps to identify economies of scale in households (i.e., the cost savings associated with joint consumption). I apply this method to both monogamous and bigamous households in Burkina Faso.

This study makes the following contributions to the literature: First, research on intrahousehold consumption inequality does not adequately cover sub-Saharan Africa. Second, with the exception of Bargain and Donni (2014), the literature does not account for joint consumption in analyzing poverty. In the context of sub-Saharan Africa, where people often live extended households, there is a potential for economies of scale due to sharing and joint consumption. Furthermore, in this study, I allow the benefits of joint consumption to vary across categories of individuals within a single household. Third, I identify consumption inequality between cowives in bigamous households, in contrast to previous studies that assume equality between senior and junior wives.

This study resembles Calvi et al. (2023) and Penglase (2021) in some respects but differs in several ways. First, in contrast to Calvi et al. (2023) I identify resource shares and economies of scale for senior and junior wives separately. For example, in Calvi et al. (2023), total wives' resources are equally allocated among cowives. In polygamous unions, wives may be allocated resources according to their seniority, the number of children they have, or other factors that increase their bargaining position relative to their cowives (Rossi, 2019). Furthermore, I allow the benefit of joint consumption to vary across each category of individuals, which is more consistent with the theoretical framework than assuming the same economies of scale apply to all individuals. The difference between this study and the approach in Penglase (2021) is that I extend the model to identify economies of scale. Furthermore, I focus on intrahousehold inequality between cowives instead of foster and non-foster children.

The remainder of this study is organized as follows. Section 2 presents the collective household model. Section 3 discusses the identification strategy, which is then applied to monogamous and bigamous households in Burkina Faso in Section 4. Section 5 presents a poverty analysis using the structural results, and Section 6 concludes. Additional analyses and proofs are provided in the online Appendix.

2 Collective Model of the Household

2.1 Model settings

The approach used in this study is built on the collective model (Browning & Chiappori, 1998; Chiappori, 1992), which characterizes households as a collection of individuals who aim to maximize their utilities and collectively reach the Pareto frontier. The type of household in this study is composed of four distinct types of individuals: husband (m), senior wife (s), junior wives (j), and children (c). I define household types based on the number of wives and children in the household, denoted with the subscript τ.

The model assumes households consume K types of goods at the log of market prices $\boldsymbol{p} = (p^1, \dots, p)'$. Let $\boldsymbol{z}_\tau = (z_\tau^1, \dots, z_\tau^K)$ be the K-vector of observed quantities purchased by households of type τ. The vector of unobserved quantities consumed by individuals within the household is denoted by $\boldsymbol{x}_t = (x_t^1, \dots, x_t^K)$. Household-level quantities are converted into private good equivalents $\boldsymbol{x}_t$ using a linear consumption technique as follows:

$\boldsymbol{z}_\tau = \boldsymbol{A}(\boldsymbol{x}_m + \boldsymbol{x}_s + n_j\boldsymbol{x}_j + n_c\boldsymbol{x}_c)$,

where $\boldsymbol{A}$ is a $\boldsymbol{K} \times \boldsymbol{K}$ matrix that accounts for economies of scale in consumption, and n_t denotes the number of each type of individual within the household. If good $\boldsymbol{x}^k$ is not shared, household purchases of that good equal the sum of what each individual consumes, the element in the kth row of the kth column of matrix $\boldsymbol{A}$ takes a value of one and all off-diagonal elements in that row and column are equal to zero. Nonzero off-diagonal elements occur when the amount of a good that is shared depends on the consumption of other goods. The diagonal elements of $\boldsymbol{A}$ are called Barten scales and indicate the extent to which the sum of private good equivalents of good k exceeds the purchased quantity z_τ^k.

Let $U_t(\boldsymbol{x}_t)$ be the consumption utility of an individual of type t. Utility functions among individuals of the same category are required to be stable. This consumption utility function is assumed to be separable from leisure, savings, or any other elements not included in the goods bundle (Browning et al., 2013). Hence, this function does not quantify welfare; rather, it quantifies material well-being. Individuals have their own caring preferences, with each person's total consumption utility being weakly separable over the sub-utility functions for goods (Penglase, 2021, Calvi et al., 2023). For example, the husband's total utility would be given by $\bar{U}_m = \bar{U}_m(U_m(\boldsymbol{x}_m), \dots, U_c(\boldsymbol{x}_c))$. Each household maximizes the Bergson–Samuelson social welfare function, $\widetilde{U}$:

$$\widetilde{U}\big(U_m, U_s, U_j, U_c, \boldsymbol{p}/y\big) = \sum_{t \in \{m,s,j,c\}} \mu_t(\boldsymbol{p}/y)U_t$$

where $\mu_t(\boldsymbol{p}/y)$ are the Pareto weights and y is household expenditure. The household then solves the following maximization problem:

$\max_{x^m,x^s,x^j,x^c} \tilde{U}\left(U_m, U_s, U_j, U_c, \boldsymbol{p}/y\right)$ such that:

$$\boldsymbol{z}_\tau = \boldsymbol{A}(\boldsymbol{x}_m + \boldsymbol{x}_s + \ n_j\boldsymbol{x}_j + n_c\boldsymbol{x}_c) \text{ and,}$$

$$y = z_\tau'\boldsymbol{p} \qquad (1)$$

This solution results in bundles of private good equivalents. If these goods are included within the household's prices $\boldsymbol{A}'\ \boldsymbol{p}$, I obtain the ***resource share*** η_{ts}, defined as the fraction of total household resources allocated to each individual of type t. Resource shares for men, senior wives, junior wives, and children sum to one.

Under the assumption of Pareto efficiency, the maximization problem shown in Eq.1 can be restated as a two-stage process by applying the second welfare theorem (Chiappori, 1992). During the initial stage, resources are efficiently distributed among household members; in the second stage, every member chooses $\boldsymbol{x}_t$ to maximize his or her own utility function U_t subject to the shadow budget constraint $\sum_k A_k p^k x_t^k = \eta_\tau^t y$. The household problem represented by Equation (1) can subsequently be reduced to the selection of optimal resource shares, with all shares summing to one, by applying standard duality theory. The selection of the optimal resource shares accounts for altruism because the model accommodates caring preferences.

2.2 Demand for Private Assignable Goods

I define an assignable good as one that is consumed by an individual of known type t, and a private good as one that is not shared across types. Examples of private goods include food and clothing; if a mother drinks a glass of milk, a child cannot consume that same glass of milk. Unfortunately, food cannot be assigned to a specific individual because the data only contain details about the overall quantity of food consumed by a household, not who consumed it. However, clothing is considered a private good that can be attributed to either wives, children, or husbands. Let $W_\tau^t(y,p)$ be the share of household expenditures y spent on individual type t's private assignable good in a household of type s. Browning et al. (2013) derive household demand functions for private assignable goods, which can be written as follows:

$$W_\tau^t(y,p) = n_t\eta_\tau^t w_\tau^t(A'\boldsymbol{p}, \eta_\tau^t y)$$

Furthermore, let $\alpha_\tau = (\alpha_\tau^1, \dots, \alpha_\tau^K)$ be the vector of the log values of the diagonal elements of $A'\boldsymbol{p}$ a K-vector of prices faced by the household, and x is the log of total household expenditures y. Then, the household-level budget share demand function for private assignable

good k in Browning et al. (2013) shows that household-level budget shares take the following form:

$$W_\tau^{kt}(p, x, \alpha_\tau) = n_t \eta_\tau^t(p, x, \alpha_\tau) w_\tau^t(p + \alpha_\tau, x + \ln\eta_\tau^t(p, x, \alpha_\tau)) \quad (2)$$

where w_τ^t is the amount of the private assignable good that an individual of type t living in a household of type τ would hypothetically demand if he or she lived alone with a shadow budget income of $x + \ln\eta_\tau^t$ facing a shadow price vector of $p + \alpha_\tau$.

2.3 Indifference Scales.

The objective of this study is to examine the relationship between family structure and individual well-being. I consider not only family size but also the type of living arrangements in the household. More specifically, I aim to compare the well-being of individuals of type t living in small versus large families, in monogamous versus bigamous households. This is particularly relevant in the context of sub-Saharan Africa, as individuals in larger households benefit more from economies of scale in consumption but resources are allocated in smaller proportions, and in sub-Saharan Africa large families are often associated with polygamy. In this type of household, sharing and joint consumption may be undermined by weak cooperation and coordination issues. To better quantify this tradeoff, I consider indifference scales (Browning et al., 2013; Calvi et al., 2023; Pendakur, 2018), i.e., the income adjustment that would allow a person living in a household of a particular type to be just as well off as if he or she lived in a household of a different type. Note that Browning et al. (2013) introduces indifference scales to compare the welfare of an individual living alone versus that of a couple. Calvi et al. (2023) and Pendakur (2018) expand this definition to conduct more general welfare comparisons. As I seek to compare individuals' material well-being across different types of households, I rely on the definition in Calvi et al. (2023).

Specifically, suppose a household of type τ has Barten scales given by α_τ, and each individual in that household has a resource share given by η_τ^t . We define V_t to be the indirect utility function that describes the preferences of an individual of type t. Then, the indifference scales for an individual of type t in a household of type s relative to a household of type τ' are obtained by solving the following:

$$V_t\left(\alpha_{\tau'} + p, x + ln\eta_{\tau'}^t - lnI_{\tau,\tau'}^t\right) = V_t(\alpha_\tau + p, x + ln\eta_\tau^t) \quad (3)$$

If an individual in category t living in a household of type τ' were to receive an income equal to $\eta_{\tau'}^t e^x / I_{\tau,\tau'}^t$, she would be able to buy a bundle of goods that lies on the same indifference curve as the bundle of goods she consumes as a member of a household of type τ

with total expenditure e^x and resource share η_τ^t. This accounts for both the intrahousehold allocation of resources and economies of scale in household consumption. If these indifference scales equal 1, the individual would be indifferent between living in household τ or household τ' and no income adjustment would be necessary. In contrast, if the indifference scales are below (above) 1, household income e^x for an individual in household τ' would need to be scaled up (down) to be as well off as if she were living in household τ with household income e^x.This definition assumes that individuals' preferences, and hence indifference curves, are independent of household type (Browning et al., 2013; Calvi et al., 2023; Lewbel & Pendakur, 2008; Pendakur, 2018).

3 Identification Strategy

My goal is to identify resource shares, economies of scale, and indifference scales. To achieve this, I based my approach on Calvi et al. (2023) and Penglase (2021). First, based on Penglase (2021) I expand the Dunbar, Lewbel and Pendakur (2013) framework to consider the fact that clothing expenditures are partially assignable to cowives. Next, I exploit the identification assumptions in Calvi et al. (2023) to identify resource shares in both monogamous and polygamous households. Furthermore, to identify economies of scale, I make an assumption about how economies of scale enter the demand function for the partially assignable good (i.e., clothing). Finally, I recover the indifference scales by directly applying Lemma 1 from Calvi et al. (2023). In the following section I specify the common assumptions used to achieve identification.

3.1 Assumptions for identification

Assumption 1: Resource shares are independent of x, so that $\eta_\tau^t(p, x, \alpha_\tau) = \eta_\tau^t(p, \alpha_\tau)$. This assumption is only needed for low levels of household expenditure (Dunbar et al., 2013). Several studies empirically confirm this assumption holds in the context of developing countries (Bargain et al., 2022; Botosaru & Muris, 2020).

Assumption 2: There exists a scalar-valued, differentiable function $s_\tau^t(\alpha_\tau + p)$ such that the following equality holds: $V_t(\alpha_\tau + p, x) = V_t(\alpha_\tau + p, x - s_\tau^t(\alpha_\tau + p))$ (4)

Applying Roy's identity to Equation (4), an individual-level budget share function for clothing is given by:

$$w_\tau^t(\alpha_\tau + p, x) = \lambda_\tau^t + w_\tau^t(p, x - lns_\tau^t(\alpha_\tau + p)) \quad (5)$$

Where $\lambda_\tau^{kt} = \frac{\partial lns_\tau^t(\alpha_\tau + p)}{\partial p^k}$

Blundell et al. (1998) and Lewbel and Pendakur (2008) refer to Assumption 2 as the independence of the base assumption. The function $s_\tau^t(\alpha_\tau + p)$ can be interpreted as a measure of the cost savings due to the economies of scale individual t experiences when living with a family instead of by herself. Specifically, we expect $1/s_\tau^t$ to increase as economies of scale in consumption increase. Note that $s_\tau^t(\alpha_\tau + p)$ is independent of x, so economies of scale are assumed to be independent of the expenditure for which they are evaluated. If there are economies of scale in consumption, i.e., $s_\tau^t(\alpha_\tau + p) < 1$ and $lns_\tau^t(\alpha_\tau + p) < 0$, and all goods are private, then $s_\tau^t(\alpha_\tau + p) = 1$ and $lns_\tau^t(\alpha_\tau + p) = 0$. This study compares economies of scale across household types. For this purpose, I choose a reference household and normalize the economies of scale in the reference household to equal one.

In what follows, I make two additional assumptions and show that resource shares and economies of scale are identified. Once these two parameters are identified, I apply Lemma 1 from Calvi et al. (2023) to recover the indifference scales.

Assumption 3.i: $\nabla_x w_\tau^t = \nabla_x w_\tau^{t'}$ and $\nabla_x^2 w_\tau^t = \nabla_x^2 w_\tau^{t'}$. I impose the constraint that individuals have similar (but not identical) preferences across household types, namely the Similar Across Types (SAT) assumption. That is, the first and second derivatives of demand functions of the private assignable goods are the same for all types of households. It is worth noting that while it is reasonable to assume that senior wives and wives in monogamous households have similar preferences, the preferences of junior and senior wives in polygamous households must differ to achieve identification.

Assumption 3.ii: I also assume Similarity Across People (SAP): $\nabla_x^2 w_\tau^t = \nabla_x^2 w_\tau^{t'}$. This implies that only the second derivative is the same for all categories of individuals.

Assumptions 3i and **3ii** allow for some degree of heterogeneity across individuals because they only require that the first and second derivatives of the Engle curves be the same, not their entire distributions. Moreover, only the curvatures of the Engel curves are required to be the same across categories of individuals; their slopes are allowed to vary freely across those categories.

Assumption 3.iii: I impose a certain degree of nonlinearity in the demand functions of the private assignable goods, as in Lewbel and Pendakur (2008), Bargain and Donni (2012), Browning et al. (2013), and Calvi et al. (2023): $\nabla_x^2 w_\tau^t \neq 0$. This assumption is crucial for identification because it allows for a sufficient number of equations to identify the structural parameters without relying on data for specific individuals.

Assumption 4: The budget share functions at the individual-level for the private partially assignable goods in Equation (5) are polynomial functions of second degree or higher. In my empirical application, I use the Quadratic Almost Ideal Demand System (QUAIDS)[2] proposed in Banks et al., (1997) to show that identification holds under the given assumptions:

$$W_\tau^{kt}(p, x, \alpha_\tau) = n_t \eta_\tau^t [\lambda_\tau^t + b_\tau^t (x + \ln\eta_\tau^t - \ln s_\tau^t) + c_\tau^t (x + \ln\eta_\tau^t - \ln s_\tau^t)^2] \quad (6)$$

where b_τ^t and c_τ^t are preference parameters. The parameters of interest are resource shares and economies of scale, which are not observable; therefore, to identify the system requires additional assumptions (i.e., for each equation there are four unknown functions).

3.2 Identification with Private Partially Assignable Goods

If clothing expenditures were separately recorded for senior and junior wives, clothing would be exclusively assignable. Under Assumption A3.i, this would result in the Engel curves for the system of clothing given below:

$$\begin{cases} W_\tau^s = \eta_\tau^s [\lambda_\tau^s + b^s (x + \ln\eta_\tau^s - \ln s_\tau^s) + c^s (x + \ln\eta_\tau^s - \ln s_\tau^s)^2] \\ W_\tau^j = \eta_\tau^j [\lambda_\tau^j + b^j \left(x + \ln\eta_\tau^j - \ln s_\tau^j\right) + c^j \left(x + \ln\eta_\tau^j - \ln s_\tau^j\right)^2] \\ W_\tau^c = n_c \eta_\tau^c [\lambda_\tau^c + b^c (x + \ln\eta_\tau^c - \ln s_\tau^c) + c^c (x + \ln\eta_\tau^c - \ln s_\tau^c)^2] \\ W_\tau^m = \eta_\tau^m [\lambda_\tau^m + b^s (x + \ln\eta_\tau^m - \ln s_\tau^m) + c^m (x + \ln\eta_\tau^m - \ln s_\tau^m)^2] \end{cases} \quad (7)$$

For each type of household, we have $4 \times 4 - 1 = 15$ unknown parameters. Moreover, by assuming some similarity in preferences across different individuals allows for some degree of heterogeneity in their preferences over their private assignable goods.

Under the SAT assumption, the second derivatives of Equation (6) with respect to x for $t = m, s, j, c$ identify resource shares and the preference parameters for the private assignable goods b^t and c^t, while the first derivatives identify the economies of scale parameters s_τ^t. With s_τ^t and η_τ^t identified for all household types and categories of individuals, I can identify indifference scales by directly applying Lemma 1 from Calvi et al. (2023). Note that this identification strategy[3] requires us to normalize $s_1^t = 1$, where s_1^t is the economies of scale for the reference household. Here, I define the reference household as a monogamous couple with one child.

Unfortunately, clothing for senior and junior wives is only partially assignable in the sense of Penglase (2021). That is, I do not observe the budget shares for senior and junior wives'

[2] For now, I omit the number of persons in each category n_t . An additional assumption is that resource shares are independent of the level of expenditure (Browning et al. 2013).

[3] Note that if the individual-level budget share functions for the private assignable goods in Eq. (2) are polynomial functions of second (or higher) degree, SAP is not required for the identification (Corollary 1 in Calvi et al. (2023)).

clothing W_τ^s and W_τ^j separately, but rather their sum $W_\tau^f = W_\tau^s + W_\tau^j$, where W_τ^f is the budget share for wives' clothing. Therefore, I rewrite the Engel curves for senior wives' and junior wives' clothing in system (3) as a single Engel curve for all wives' clothing. I begin by imposing the SAP and SAT restrictions (Assumptions 3i and 3ii). This gives the following system:

$$\begin{cases} W_\tau^f = \eta_\tau^s[\lambda_\tau^s + b^s(x + \ln\eta_\tau^s - \ln s_\tau^s) + c(x + \ln\eta_\tau^s - \ln s_\tau^s)^2] + \\ \quad \eta_\tau^j[\lambda_\tau^j + b^j\left(x + \ln\eta_\tau^j - \ln s_\tau^j\right) + c\left(x + \ln\eta_\tau^j - \ln s_\tau^j\right)^2] \\ W_\tau^c = n_c\eta_\tau^c[\lambda_s^c + b^c(x + \ln\eta_\tau^c - \ln s_\tau^c) + c(x + \ln\eta_\tau^c - \ln s_\tau^c)^2] \\ W_\tau^m = \eta_\tau^m[\lambda_\tau^m + b^s(x + \ln\eta_\tau^m - \ln s_\tau^m) + c(x + \ln\eta_\tau^m - \ln s_\tau^m)^2] \end{cases} \quad (8)$$

and the second derivatives of Equation (7) are:

$$\begin{cases} \nabla_x^2 W_\tau^f = \eta_\tau^s c + \eta_\tau^j c \\ \nabla_x^2 W_\tau^c = n_c\eta_\tau^c c \\ \nabla_x^2 W_\tau^m = \eta_\tau^m c \end{cases} \quad (9)$$

We now have five unknowns and four equations (including $\eta_\tau^s + n_c\eta_\tau^c + \eta_\tau^m = 1$).

Case of monogamous households

For monogamous households (including the reference household) $\eta_\tau^j = 0$, I obtain the following:

$$\begin{cases} \nabla_x^2 W_\tau^f = \eta_\tau^f c \\ \nabla_x^2 W_\tau^c = n_c\eta_\tau^c c \\ \nabla_x^2 W_\tau^m = \eta_\tau^m c \end{cases}$$

We now have four unknowns and four equations (including $\eta_\tau^s + n_c\eta_\tau^c + \eta_\tau^m = 1$) for each household type τ. Therefore, we can identify η_τ^t and c for monogamous households, including the reference household.

Given that c^t does not vary across household types, c^t for the reference household is identified. Plugging η_τ^t and c^t into first derivative of the reference household ($\ln s_\tau^t = 0$, because we normalized $s_\tau^t = 1$), I obtain the following:

$$\begin{cases} \nabla_x W_\tau^f = \eta_\tau^s\left[b^f + c(x + \ln\eta_\tau^f)\right] \\ \nabla_x W_\tau^c = n_c\eta_\tau^c[\, b^c + c(x + \ln\eta_\tau^c)] \\ \nabla_x W_\tau^m = \eta_\tau^m[\, b^m + c(x + \ln\eta_\tau^m)] \end{cases} \quad (10)$$

Therefore, we can identify b^t using each first derivative.

As b^t does not vary across τ, I can use them in the first derivatives of the nonreference monogamous households and identify such that I obtain that:

$$\begin{cases} \nabla_x W_\tau^f = \eta_\tau^s\left[\, b^f + c(x + \ln\eta_\tau^f - \ln s_\tau^f)\right] \\ \nabla_x W_\tau^c = n_c\eta_\tau^c[\, b^c + c(x + \ln\eta_\tau^c - \ln s_\tau^c)] \\ \nabla_x W_\tau^m = \eta_\tau^m[\, b^m + c(x + \ln\eta_\tau^m - \ln s_\tau^m)] \end{cases}$$

The only unknow is s_τ^t which is therefore identified using each first derivative.

Case of bigamous households

Now, let us move to the bigamous[4] households $\eta_\tau^j \neq 0$. To identify bigamous households, I assume that men's and children's preferences for clothing are similar across household types (SAT). In addition, I impose SAP on the Engel curves for partially assignable goods. Therefore, the preferences parameters for children and men identified from monogamous households can be used for children and men in bigamous households. Moreover, c is known to be the same for both monogamous and bigamous households. Applying this assumption to the second derivatives shown in Equation 9, I obtain the following:

$$\begin{cases} \nabla_x^2 W_\tau^f = \eta_\tau^s c + \eta_\tau^j c \\ \nabla_x^2 W_\tau^c = n_c\eta_\tau^c c \\ \nabla_x^2 W_\tau^m = \eta_\tau^m c \end{cases} \tag{11}$$

Thus, we are left with four unknowns and four equations (including $\eta_\tau^s + n_c\eta_\tau^c + \eta_\tau^m = 1$) and can therefore identify η_τ^t for each bigamous household. Plugging the identified parameters η_τ^t and c into the first derivatives produces the following:

$$\begin{cases} \nabla_x W_\tau^f = \eta_\tau^s[\, b^s + c(x + \ln\eta_\tau^s - \ln s_\tau^s)] + \\ \qquad \eta_\tau^j\left[\, b^j + c(x + \ln\eta_\tau^j - \ln s_\tau^j)\right] \\ \nabla_x W_\tau^c = n_c\eta_\tau^c[\, b^c + c(x + \ln\eta_\tau^c - \ln s_\tau^c)] \\ \nabla_x W_\tau^m = \eta_\tau^m[\, b^m + c(x + \ln\eta_\tau^m - \ln s_\tau^m)] \end{cases} \tag{12}$$

For husbands and children, only economies of scale s_τ^c, and s_τ^m remain unknowns and are identified by solving the last two components of Equation (12). However, b^s , b^j, s_τ^s, and s_τ^j remain unidentified, leaving us with four unknowns and one equation. To achieve identification, I make an additional assumption about how scale economies enter the budget share function of partially assignable goods.

Assumption 5: I assume that as household size increases, scale economies increase at the same rate for all adult individuals in bigamous households. This implies that:

[4] In this study, I show the identification in bigamous unions, which represents a large share of living arrangement in the data used in the empirical application. The identification still holds in polygamous with n cowives if objective is to estimate the consumption inequality between senior wife and junior wives. In this case, we assume equality among junior wives and include the number of junior wives in Equation (7).

$\frac{s^t_{p,n+1}}{s^t_{p,n}} = \frac{s^m_{p,n+1}}{s^m_{p,n}}$, for $t = s, j.$ (13)

where n is the number of children. Given that the right-side term is identified, I can write that $\frac{s^s_{p,n+1}}{s^s_{p,n}} = \frac{s^j_{p,n+1}}{s^j_{p,n}} = k_n$, with $k_n = \frac{s^m_{p,n+1}}{s^m_{p,n}}$.

and then, $s^t_{p,n+1} = k_n s^t_{p,n}$.

It follows that all $s^s_{p,n+1} = s^s_{p,1}$ and $s^j_{p,n+1} = s^j_{p,1}$. Therefore, with at least four types of bigamous households, I have enough equations to identify $s^s_{p,1}, s^j_{p,1}$, b^s, b^j, and then $s^s_{p,n}$ and $s^j_{p,n}$. For example, with four types of bigamous households ($n = 1,2,3,4$), we express $s^t_{p,n+1}$ in function of $s^t_{p,1}$; we then have four unknowns ($s^s_{p,1}, s^j_{p,1}$, b^s, b^j) and four equations. Moreover, if I assume that wives in monogamous households and senior wives in bigamous households have the same preferences with respect to the private assignable good, I need only observe three types of bigamous households to identify, b^j, s^s_τ, and s^j_τ. Penglase (2021) identifies resource shares for foster and non-foster children by imposing assumptions on how resource shares decline as household size increases. Assumption 5 mimics this approach in spirit and specifies that economies of scale increase consistently as household size increases. While identifying resource shares does not rely on Assumption 4, it is crucial in identifying economies of scale as it satisfies the rank condition. This restriction is tested in an empirical application.

Finally, directly applying Lemma 1 in Calvi et al. (2023) allows me to recover indifference scales for both monogamous and bigamous households. The Lemma states that given Assumptions 1 and 2, indifference scales[5] can be obtained as follows:

$$I^t_{\tau,\tau'}(p, \alpha_\tau) = \frac{\eta^t_{\tau'}(p,\alpha_{\tau'})\, s^t_\tau(p,\alpha_\tau)}{\eta^t_\tau(p,\alpha_\tau)\, s^t_{\tau'}(p,\alpha_{\tau'})} \quad (14)$$

4 Empirical Application

4.1 Background and Data

This study examines intrahousehold inequality and joint consumption across monogamous and bigamous households in Burkina Faso. This analysis is particularly relevant to Burkina Faso for a number of reasons. First, the country is among the poorest in the world, ranking 184th out of 191 countries in the 2021–2022 HDI report published by the United Nations Development Programme (UNDP, 2022). More than 40% of its people live on less than USD 1.90 per day

[5] Lemma 1 of Calvi et al. (2023) is provided in the appendix.

(INSD, 2020). Agriculture contributes approximately 30% of GDP, and more than 80% of the country's population relies on agriculture for their livelihoods. Second, polygamous unions are very common in Burkina Faso. The country is ranked first in sub-Saharan Africa in terms of polygamous households—according to a Pew Research Center report from 2019, 36% of living arrangements in Burkina Faso are polygamous and the country's 2019 national census states that up to 22% of men and 37.4% of women are in a polygamous union (INSD, 2020). The prevalence of polygamous unions is highest among those who practice folk religions, with over 45% of those individuals engaging in such relationships. Muslims followed closely behind with a polygamy rate of 40%, while 24% of Christians in the country were in polygamous households (Pew Research Center, 2019)

I use the Burkina Faso "Living Standard Measurement Survey-Integrated Survey in Agriculture" (LSMS-SA) and "Enquête Harmonisée sur les Conditions de Vie des Menages" (EHCVM) as data sources. The data in these reports were collected by Burkina Faso's Institut National des Statistiques et de la Démographie (INSD) with the support of the World Bank. LSMS-SA and EHCVM are nationally representative household surveys and contain detailed information on individual education, employment, migration, health, and other demographic characteristics, as well as data on household-level expenditures. The LSMS-SA covers 10,411 households surveyed in 2014, while the EHCVM covers 7,010 households surveyed in 2018-2019. I rely primarily on the expenditure module in estimating the structural model. Identifying resource shares requires expenditure data for partially assignable clothing. In both surveys, households are asked about their expenditures on different categories (shirts, shoes, pants, etc.) of men's, women's, and children's clothing, which I use to construct the corresponding budget shares. Children are defined as individuals under 15 years of age.

To ensure comparability across household types, I select a sample of 4,397 households from the initial group of 17,421 households. The selected sample included 3,439 monogamous and 958 polygamous unions (21.78% of the selected sample). I selected the sample as follows: I exclude households with no children, those with female adults who were not wives, male adults who were not husbands; and those with more than two wives. I also exclude monogamous households with more than five children and polygamous households with more than ten children. Next, I exclude households with husbands who are less than 18 years old. Similarly, households with wives younger than 17 years old or older than 70 years old are excluded. To eliminate outliers, I exclude any households in the top or bottom one percent of total household expenditures. Finally, households for which data is missing on any of the household characteristics or relevant expenditures needed for the model are excluded from the

sample. Table 1 presents summary statistics for the estimation sample. Average expenditures are USD 2,193 and USD 2,438.5 for monogamous and polygamous households, respectively. Households allocate more than half of the total budget to food (52.23% for monogamous households and 54.78% for polygamous households), which is consistent with the consumption patterns of poor people.

[Table 1 here]

4.2 Empirical model

As noted above, our empirical application uses the Quadratic Almost Ideal Demand System from Banks et al. (1997). As discussed in Section 3.2, under the QUAIDS approach budget share functions are quadratic in log total expenditures (x). By adding error terms, the system of Engel curves for the private partially assignable good (clothing) includes the 3 equations as follows:

$$\begin{cases} W_{i,\tau}^{f} = \eta_{\tau}^{s}\left[\lambda_{\tau}^{s} + b^{s}\left(x_{i,\tau} + \ln\eta_{\tau}^{s} - \ln s_{\tau}^{s}\right) + c^{s}\left(x_{i,\tau} + \ln\eta_{\tau}^{s} - \ln s_{\tau}^{s}\right)^{2}\right] + \\ \eta_{\tau}^{j}\left[\lambda_{\tau}^{j} + b^{j}\left(x_{i,\tau} + \ln\eta_{\tau}^{j} - \ln s_{\tau}^{j}\right) + c^{j}\left(x_{i,\tau} + \ln\eta_{\tau}^{j} - \ln s_{\tau}^{j}\right)^{2}\right] + \varepsilon_{i,\tau}^{f} \\ W_{i,\tau}^{c} = n_{i,c}\eta_{\tau}^{c}[\lambda_{s}^{c} + b^{c}\left(x_{i,\tau} + \ln\eta_{\tau}^{c} - \ln s_{\tau}^{c}\right) + c^{c}\left(x_{i,\tau} + \ln\eta_{\tau}^{c} - \ln s_{\tau}^{c}\right)^{2}] + \varepsilon_{i,\tau}^{c} \\ W_{i,\tau}^{m} = \eta_{\tau}^{m}[\lambda_{\tau}^{m} + b^{s}\left(x_{i,\tau} + \ln\eta_{\tau}^{m} - \ln s_{\tau}^{m}\right) + c^{m}\left(x_{i,\tau} + \ln\eta_{\tau}^{m} - \ln s_{\tau}^{m}\right)^{2}] + \varepsilon_{i,\tau}^{m} \end{cases}$$

(15)

where W_{τ}^{t} is the household demand for assignable clothing for individuals in category t in household i of type τ.

I model η_{τ}^{t} and s_{τ}^{t} as a linear function of the wives' characteristics (age, education, work), and other household characteristics (husband's age and education, average age and number of children, religion, dummies for place of residence and agro-ecological zone,[6] and survey year) as presented in Table 1. More specifically, this is how wives' characteristics enter the resource sharing functions for bigamous households. η_{τ}^{s} is a linear function of age, education, and work status of the senior wife, while η_{τ}^{j} is a linear function of the same variable for the junior wife. In addition, I include the age gap between cowives in both resource shares. For the husband's and children's resource shares, I include the average value of the wives' characteristics. Finally, I include the polygamy indicator variable for household types in the parameterization of the resource share and economies of scale functions.

[6] Agro-ecological zones include West, Sahel, Est (Center being the base category).

The terms $b^t, \lambda_\tau^t,$ and c^t are linear functions of household characteristics, with the exception of household composition variables such as the polygamy dummy, number of children, and proportion of female children. Consistent with Assumption 3, the preference parameters b^t do not vary across household type, $c^t = c$, and λ_τ^t can vary freely.

Because the error terms of the Engel curves are likely correlated across equations, the system is estimated using the Nonlinear Seemingly Unrelated Regression (NLSUR)[7] technique. Given that household expenditures may suffer from measurement errors, I follow previous studies and instrument for expenditures using the log value of total household assets (Penglase 2021, Dunbar et al., 2013; Bargain and Donni, 2014; Calvi et al., 2023). Therefore, I augment Eq. (15) by including Wu–Hausman residuals and its squares.

As discussed in Section 2, my approach assumes that the collective model holds for both monogamous and bigamous households. First, the collective model has been extensively used in previous studies to analyze intrahousehold inequality in the sub-Saharan context (Bargain and Donni, 2014; Penglase, 2021). Furthermore, relevant to my study Kazianga and Wahhaj (2017) show that households with stronger familial ties (nuclear family households) achieve near Pareto- efficient allocation of productive resources and Pareto efficient allocation of consumption, whereas households with "weaker" familial ties (extended family households) do not. This motivated me to restrict the study sample to households with family ties. Moreover, Rangel and Thomas (2019) use the 2014 LSMS-SA data, which is a subsample of this study, to show that Pareto efficiency is achieved by both monogamous and polygamous households in Burkina. Furthermore, Lewbel and Pendakur (2022) argue that objections to applying the collective model to developing countries can be overcome by considering what they call the "cooperation factor"[8] in collective behavior. This allows for inefficiency while maintaining the modeling advantages of efficient collectives. Another debatable issue is whether or not clothing is a private assignable good. Previous studies also rely on clothing to identify intrahousehold inequality. A recent study by Bargain et al. (2022) showed that clothing expenditures perform

[7] NLSUR is iterated until the estimated parameters and the covariance matrix settle. Iterated-SUR with multivariate normal errors is equivalent to maximum-likelihood estimation.

[8] According to Lewbel and Pendakur (2022), a cooperation factor is any variable that can: induce inefficiency in consumption by reducing cooperation and sharing; affect resource shares like a distribution factor; and/or directly affect the utility of household members (additively separably from consumption). The implication of their model is that households are conditionally efficient, conditioning on the value of the cooperation factor. Therefore, a collective household model with possible inefficiency driven by cooperation factors can be used to identify intrahousehold inequality (Lewbel and Pendakur, 2021).

well in predicting individual resource shares compared with expenditures on food. In this study, similar to Penglase (2021), I rely on clothing for my identification strategy.

4.3 Results and Discussion

One of the key assumptions for identification is that Engel curves for private assignable goods are nonlinear. More specifically, Engel curves for clothing have nonzero second derivatives with respect to household expenditures (or log household expenditures 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 (Calvi et al., 2023).

[Table 2 here]

I test this assumption directly using the NLSUR estimation. Table A1 shows that β^t and c^t are significantly different from zero. This implies that the Engel curves for clothing have significant slopes and thus the nonlinearity assumption holds for this sample. Finally, the determinants of resources and scale economies obtained from the NLSUR estimation of Equation (15) are presented in Tables A2 and A3 of the Appendix. The results suggest that the wives' characteristics, such as age, education level, and employment status, significantly predict the level of resource shares. Empirical distributions of estimated resource shares and scale economies are shown in Figures A2, A3, and A4.

Intrahousehold consumption inequality

Panel A of Table 2 presents summary statistics for the predicted resource shares, conditional on the set of observable variables shown in Panels B and C of Table 1. The results in columns (2) and (6) of Table 2 suggest that, on average, a larger share of household resources is allocated to husbands relative to the resource shares allocated to wives and children. In monogamous households, the husbands' resource share is 0.43, whereas women and children receive only 0.292 and 0.141, respectively. In bigamous households, the husband's resource share is 0.337, the senior wife receives 0.235, and junior wives and children receive on average 0.211 and 0.05, respectively. In other words, intrahousehold consumption is unequal between husbands and wives in both types of families. Furthermore, this result suggests that intrahousehold inequality between spouses does not vary much across living arrangements, as wives in monogamous households receive 68% of the husband's resources share, while in bigamous households each wife receives 62%–70% of the husband's resources share, on average. Additionally, the results show that in bigamous households the husband's resource share

decreases with household size, while wives' resource shares are unchanged as household size increases in both monogamous and bigamous households (Figure 1).

[Figure 1 here]

[Figure 2 here]

[Figure 3 here]

These findings are consistent with previous studies of sub-Saharan Africa. For example, Dunbar et al. (2013) and Penglase (2021) show that in Malawi wives receive 67%–82% of their husbands' resource share. However, Bargain and Donni (2014) find that in Cote d'Ivoire men's and women's shares of total household expenditures are roughly the same in monogamous households. Their model differs from mine in that it relies on a single individuals data source and restricts children's economies of scale to one. Furthermore, consistent with Calvi (2020) I find that wives' share of total expenditures rises during their reproductive years (17–45 years old) then decreases (Figure 1A).

Examining consumption inequality between cowives in bigamous households, Column (6) in Table 1 shows that on average, junior wives receive approximately 90% of what senior wives receive. This suggests that there is consumption inequality between cowives in bigamous households, although the difference is small. Furthermore, consumption inequality between senior and junior wives does not differ as the size of the household increases (Figure 1). However, inequality between cowives is significantly associated with their age difference (Figure 2). More specifically, the younger the junior wives, the more resources allocated to her, although the resource share of the senior wife remains higher. However, the senior wife is likely to have more children than a junior wife, which may be a reason for senior wives to claim more resources (Rossi, 2019). Unfortunately, due to data limitations I cannot directly test for this mechanism;[9] instead, I compare the predicted resource shares for households in which senior wives are 60 years[10] old (assuming fertility ends at 45 years old, and the wife's oldest child is still in the household at age 14) or older and junior wives are 45 years old or younger. Figure 3 shows that even after menopause, the senior wife in a bigamous household still has a higher resource share, indicating that seniority or rank matters. Furthermore, childless senior resource share is still higher than childbearing junior wife (right quadrant of Figure 3), though the difference is not meaningful. This indicates that for junior wives, childbearing does not

[9] This would be easy to test if the number of children per cowife was available.

[10] Due to the restriction imposed on sample requiring the presence of a child in the household aged 14 or younger, even if the senior wife gave birth to her last child at age 45, she is likely to be free from child-rearing by 60. One drawback is requirement that the subsample of households with senior wife who is 60 years of older is small (n = 24).

lead to a higher resource share compared with senior wives. This is highly consistent with some anthropological views on polygamy practices in West Africa that indicate the first wife, usually the oldest, enjoys undisputed authority over her cowives (Merand, 1977; Nnaemeka, 2005; Nwoye, 2007). The first wife usually has the authority to assign and distribute domestic chores to her cowives, and the existence of cowives helps enhance her status (Hayase & Liaw, 1997).

Scale of economies and differences

As household goods may have a large public component, inequality at the individual shares level does not necessarily imply a large difference in individual well-being. Therefore, it is important to consider the benefits obtained from joint consumption. A crucial restriction in identifying scale economies in bigamous households is that they consistently increase as household size increases. To check whether this restriction holds for the sample of bigamous households in this study, I test the equality coefficients of the number of children in the economies of scale functions.[11] The results shown at the bottom of Table A5 fail to reject the equality of the ratio of economies of scale.

Economies of scale for non-reference households are represented by deflators s_τ^t, whose estimates are shown in Panel B of Table 2. Recall that reference households are monogamous couples with one child. One of this study's key contributions is that it estimates scale economies for each category of individual. This is more consistent with the theoretical framework than the single economies of scale assumption computed at the household-level in previous studies. The results suggest that individuals in non-reference households experience cost savings relative to individuals reference households. Recall that a smaller deflator implies larger scale economies. For example, when focusing on the benefit of joint consumption by children I find that relative to a monogamous household with one child, total household expenditures in non-reference monogamous families is scaled up by approximately 58% (1/0.63). This suggests that the incremental cost of having an additional child in the average nonreference monogamous household is 42% of that of a monogamous household with one child (Column (6), Panel B in Table 2). This result agrees with the findings of Bargain and Donni (2014) for Côte d'Ivoire, but is higher than findings outside of sub-Saharan Africa. For example, Calvi et al. (2023) find that individuals in non-nuclear households face 98% and 91% of the living costs experienced by nuclear households with one child in Bangladesh and Mexico,

[11] The number of children enters the economies of scale as a continuous variable. Since the type of household is defined by the number of children, the coefficient of the number of children can be interpreted as the variation in economies of scale when households have an additional child. If ratio equality holds, the effect of an additional child on economies of scale for adult members of a household should not differ significantly.

respectively. One potential explanation for this difference is that the average household size in sub-Saharan Africa is larger than in other regions of the world, creating more opportunities for joint consumption.

Furthermore, and perhaps surprisingly, the results here indicate that economies of scale in monogamous households are slightly larger than in bigamous households across all categories of individuals. For example, the husband's income deflator is 0.72 in monogamous households versus 0.82 in bigamous households. One potential explanation for this is that although bigamous households are typically larger than monogamous households, sharing and joint consumption of goods among the individuals in bigamous households is often low. This is because each wife, along with her children, often forms a separate entity within a polygamous household, occupying separate rooms or houses in the compound (Nanama and Frongillo, 2012). It is worth noting that sharing and joint consumption of goods requires cooperation and coordination among household members, which is more complicated in large households. Each household may be Pareto efficient with respect to its own consumption; however, due to lower cooperation and greater coordination issues a consumption approach may be inefficient compared to another household with a different composition (Barr et al., 2019; Lewbel & Pendakur, 2022).

Lastly, Panel C in Table 2 shows summary statistics for the estimated indifference scales, which consider the tradeoff between smaller resource shares and economies of scale. Here, the scale economies in one child monogamous households (reference households) are equal to one by construction ($\hat{s}_1^t = 1$). Therefore, following Calvi et al. (2023), I compute indifference scales as follows:

$$\hat{I}_{1,\tau'}^t = \frac{\hat{\eta}_{\tau'}^t \times 1}{E[\,\hat{\eta}_1^t] \times \hat{s}_{\tau'}^t},$$

where $E[\,\hat{\eta}_1^t]$ is the mean resource share for each individual of type t in the reference household. Note that $\hat{I}_{1,\tau'}^t$ lower (greater) than one implies income in nonreference households should be scaled up (down) to make those individuals as well off as they would be if they lived in a reference household.

On average, I estimate indifference scales below one for children in bigamous households, whereas parents' indifference scales are above one in monogamous households. The results suggest that being part of a larger family is associated with lower material well-being for children in both types of living arrangement. For example, the average income in a nonreference households would have to scale up by 78% (1/0.56) for a child to achieve the same living standard as if he or she were in a one child monogamous household. This required

income adjustment is much higher for children in bigamous households. Although sharing and joint consumption are advantageous for children in large families, as family size increases the resulting smaller resource shares outweigh the impact of economies of scale on children's consumption levels (Figure 4). The indifference scales for parents are greater than one in monogamous households, which suggests that parents' material well-being increases with household size.

Bargain and Donni (2014) posit that children income deflator is indifferent to family size. However, my findings suggest that children experience a substantial loss of material welfare as family size increases. In other words, the benefit from joint consumption that they enjoy is outweighed by the smaller resource share allocated to them. Therefore, it is important to consider the effect of economies of scale on children's welfare when modeling intrahousehold inequality, as welfare transfers from parents to children may not be straightforward. Moreover, compared to the findings in Bargain and Donni (2014) that suggest couples in Côte d'Ivoire experience a loss of well-being compared to single adults, I find that parents have higher material well-being in larger families.[12]

Robustness check and limitations

As a robustness check, I estimate the NLSUR model for monogamous (Tables A4 and A6) and bigamous households (Tables A5 and A7) separately. The results are, on average, very similar to the main results. Next, I re-estimate Equation (15), augmenting it with an inverse Mills ratio (IMR) to address selection into polygamy. More specifically, I obtain the IMR from a probit selection equation that uses an indicator of bigamous households as a dependent variable and a region dummy variable as a measure of the prevalence of polygamy as an excluded instrument. These results are also in line with the baseline results (Table A8 and A9).

These results should be interpreted with the following caveats. First, the results indicate a correlation, but not causality, between family size and type and intrahousehold household inequality. Potential sources of endogeneity arise from the choice of living arrangements, although the robustness of the results is consistent using the IMR. Most of the variables that affect a husband's or junior wife's choice of polygamy are not observable by the researcher and are therefore omitted. Ideally, one would like to instrument the living arrangement; however, finding such an instrument is quite challenging. Modeling the selection of living arrangement type is beyond the scope of this study. The available literature identifies religion,

[12] Note that in Bargain and Donni (2014), the scale of economies enjoyed by children was restricted to one.

education, and ethnicity as key determinants of polygamy in sub-Saharan Africa (Falen, 2008; Fenske, 2015; Hayase & Liaw, 1997; Kudo, 2014). From an economic perspective, the prevalence of polygamy has been attributed to women's central role in agricultural labor in the region (Bergstrom, 1994; Boserup, 1970; Jacoby, 1995). Early anthropology studies of sub-Saharan Africa distinguish between two forms of polygamy based on motive (Nwoye, 2007). In the first form, which is characterized by affluence, individuals engage in many marriages due to a desire for social status and economic success (Nnaemeka, 2005). The second form, interventive polygamy, occurs in response to familial stress (Anozie, 1999; Burke, 1987; Ogho, 2005). For example, in this form polygamy may be driven by the first wife's infertility or because she produces only female offspring (Ogho, 2005). Finally, the mechanism underlying resource allocation among cowives remains under investigated. Data on the fertility and children of each co-spouse would be important in studying this.

[Figure 4 here]

[Table 3 here]

5 Poverty Analysis

There are several approaches to measuring poverty at the household and individual levels. The first uses income per capita, as is done by the World Bank (2015). An alternative is to adjust household expenditures across household compositions using equivalence scales. Here, I use the OECD equivalence scale, which equals 1 for the first adult household member and adds 0.7 for each additional adult and 0.5 for each child. A major limitation of both per capita and equivalence-based poverty measures is that they ignore intrahousehold inequality. (Chiappori, 2016; Pendakur, 2018).

Moreover, the equivalence-based poverty measure is based on ad hoc assumptions (Chiappori, 2016; Pendakur, 2018). A third approach overcomes these weaknesses by obtaining individual-level expenditures by adjusting household expenditures for each category of individuals' resource shares (Brown et al., 2021; Calvi, 2020; Dunbar et al., 2013; Penglase, 2021; Sokullu & Valente, 2022; Tommasi, 2019). However, individual-level consumption and poverty are determined by both resource shares and scaling factors. Therefore, a fourth approach consists of obtaining individual-level consumption with economies of scale (Calvi et al., 2023; Bargain and Donni, 2014). This not only considers intrahousehold inequality but also economies of scale. Unlike Calvi et al. (2023), I measure economies of scale at the individual-level.

For comparison purposes, following Calvi et al. (2023) I compute poverty rates using these four approaches. I classify an adult individual in the reference household as poor if household per capita expenditures are less than 533.23 CFA per day, the definition of poverty is used in the EHCVM 2018–2019 survey. It is worth noting that I analyze poverty relative to the reference household because I assume that economies of scale equal to one for a one child monogamous household. As discussed in Calvi (2023), this assumption is quite arbitrary—even when relying on a standard threshold for poverty, one cannot easily test the assumption that this is the relevant poverty line for a nuclear family with one child (Calvi et al., 2023). Moreover, following Calvi et al. (2023) and Brown et al. (2021) I fix the poverty line at 426.60 CFA (0.8×533.23) for individuals 45 years and older. In addition, to account for differences in caloric needs between children, I follow Penglase (2021) and adjust the poverty line for children across different groups by assuming calorie consumption ranges from 1,000 per day to 2,300 per day, with 2,400 being the daily caloric intake for an adult.

Table 3 shows poverty rates across different types of households measured by its size and the type of union among parents. Only the subsample of households surveyed in 2018-2019 survey is included in Table 3. First, the results show that poverty varies not only within a household but also across households and when measured using different approaches. Consistent with Calvi et al. (2023), the likelihood of being poor increases with the size of households. Therefore, not surprisingly, poverty rates are higher among bigamous households. Children, junior wives, and senior wives are the poorest groups. Lastly, considering economies of scale has a significant impact on poverty measures. For example, Panel D suggests that husbands in both monogamous and bigamous households are non-poor when individual-level expenditure is deflated by economies of scale. This is not surprising because not only do husbands receive higher shares of household expenditure in a context where the scale of economies within households does not differ much in magnitude.[13]

Furthermore, consistent with previous studies the conventional measurement approaches lead to poverty misclassifications. The results indicate the per capita-based measure overestimates poverty for adults and children, and the OECD equivalence scale-based measure underestimates poverty for both adults and children. For example, on average, a policy based on the OECD equivalence poverty measure would have reached only 25% (6.31/25.24) and 21% (18/84.57) of poor children living in monogamous and bigamous households, respectively.

[13] Table 2 shows that husbands enjoy only 3% more cost savings than wives in monogamous households.

One caveat of this analysis, which is common to previous studies, is that I analyze poverty relative to a reference household instead of in absolute terms. For the latter, one would have to identify absolute scale of economies, which is beyond the scope of this study as the required data are rare in this context; not only do children always live with their parents, social and cultural norms mean that unmarried females who live alone are rare.[14]

6 Conclusion

The existing literature often assumes that adults of the same gender have equal access to household resources, likely due to the limited data on assignable goods. In this study, I suggest a method of estimating intrahousehold consumption inequality between cowives in polygamous households that also allows me to recover scale economies under more flexible assumptions. Based on this approach, I compute individual indifference scales relative to monogamous households with one child. The main findings of this research are summarized as follows.

First, consistent with previous studies the results here indicate that husbands in both monogamous and bigamous households in Burkina Faso command the largest share of a households' resources compared to both wives and children. I also find evidence of consumption inequality between cowives, although the difference is small. However, younger junior wives receive a higher share of household total expenditures than senior wives. I argue that a potential explanation for this is that resource allocation between bigamous cowives is based on their seniority and rather than their needs as a function of their childbearing.

Second, I find larger economies of scale than in previous studies. This implies that larger families experience cost savings relative to a nuclear household with one child. Surprisingly, I find that individuals in monogamous households experience larger economies of scale than those in bigamous households. This suggests less efficient consumption in large households due to less cooperation and greater coordination issues. Furthermore, indifference scales suggest that the effect of family size on material well-being varies across types of individuals and households. More specifically, larger family sizes are associated with a decrease in children's well-being in both monogamous and polygamous households, whereas parents in monogamous households enjoy a higher standard of living with larger families.

[14] In rural areas of Burkina Faso, a single male can live alone but female adults always live in a family. In urban areas, single females living alone can be found but are rare. In general, female adults living alone are not well perceived.

Lastly, I find that considering both intrahousehold inequality and economies of scale in poverty measures has substantial implications in terms of targeting poor people within a household. In this study, traditional approaches to measuring poverty such as the OECD equivalence scale-based measure, lead to large misclassifications. This finding implies that it is not only important to account for intrahousehold inequality in a poverty analysis but also economies of scale, particularly in the sub-Saharan African context where a large share of the population lives in large households. To my knowledge, this study is the first attempt to model consumption inequality between cowives based on partially assignable goods. Future work with purely assignable goods may help improve identification.

References

Anozie, M. (1999). *Childless marriage in Igbo Christianity: Description of, and reflections concerning solution in a pastoral problem*.

Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic Engel Curves and Consumer Demand. *Review of Economics and Statistics*, *79*(4), 527–539. https://doi.org/10.1162/003465397557015

Bargain, O., & Donni, O. (2012). Expenditure on children: A Rothbarth-type method consistent with scale economies and parents' bargaining. *European Economic Review*, *56*(4), 792–813. https://doi.org/10.1016/j.euroecorev.2012.02.003

Bargain, O., Donni, O., & Kwenda, P. (2014). Intrahousehold distribution and poverty: Evidence from Côte d'Ivoire. *Journal of Development Economics*, *107*, 262–276. https://doi.org/10.1016/j.jdeveco.2013.12.008

Bargain, O., Lacroix, G., & Tiberti, L. (2022). Intrahousehold Resource Allocation and Individual Poverty: Assessing Collective Model Predictions using Direct Evidence on Sharing. *Economic Journal*, *132*(643), 865–905. https://doi.org/10.1093/ej/ueab085

Barr, A., Dekker, M., Janssens, W., Kebede, B., & Kramer, B. (2019). Cooperation in Polygynous Households. *American Economic Journal: Applied Economics*, *11*(2), 266–283. https://doi.org/10.1257/app.20170438

Bergstrom, T. C. (1994). *On the Economics of Polygyny*.

Blundell, R., Duncan, A., & Pendakur, K. (1998). Semi-parametric estimation and consumer demand. *Journal of Applied Econometrics*, *13*(5), 435–461.

Boserup, E. (1970). *Woman's Role in Economic Development*. Martin's Press. https://doi.org/10.4324/9781315065892

Botosaru, I., & Muris, C. (2020). Intertemporal Collective Household Models: Identification in Short Panels with Unobserved Heterogeneity in Resource Shares. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3642893

Brown, C., Calvi, R., & Penglase, J. (2021). Sharing the pie: An analysis of undernutrition and individual consumption in Bangladesh. *Journal of Public Economics*, *200*. https://doi.org/10.1016/j.jpubeco.2021.104460

Browning, M., & Chiappori, P. A. (1998). Efficient Intra-Household Allocations: A General Characterization and Empirical Tests. *Econometrica*, *66*(6), 1241. https://doi.org/10.2307/2999616

Browning, M., Chiappori, P. A., & Lewbel, A. (2013). Estimating consumption economies of scale, adult equivalence scales, and household bargaining power. *Review of Economic Studies*, *80*(4), 1267–1303. https://doi.org/10.1093/restud/rdt019

Burke, C. (1987). Marriage and the Family in Africa: Traditional African Approaches in the light of National Values and Modern Secular Attitude. *Catholic Position Papers*, *147*, 1–18.

Calvi, R. (2020). *Why Are Older Women Missing in India? The Age Profile of Bargaining Power and Poverty*.

Calvi, R., Penglase, J., Tommasi, D., & Wolf, A. (2023). The more the poorer? Resource sharing and scale economies in large families. *Journal of Development Economics*, *160*. https://doi.org/10.1016/j.jdeveco.2022.102986

Chiappori, P. A. (2016). Equivalence versus Indifference Scales. *Economic Journal*, *126*(592), 523–545. https://doi.org/10.1111/ecoj.12371

Chiappori, P.-A. (1992). Collective Labor Supply and Welfare. *Journal of Political Economy*, *100*(3), 437–467. https://doi.org/10.1086/261825

Dunbar, G. R., Lewbel, A., & Pendakur, K. (2013). Children's resources in collective households: Identification, estimation, and an application to child poverty in Malawi. *American Economic Review*, *103*(1), 438–471. https://doi.org/10.1257/aer.103.1.438

Falen, D. J. (2008). Polygyny and Christian Marriage in Africa: The Case of Benin. *African Studies Review*, *51*(2), 51–74. https://doi.org/10.1353/arw.0.0082

Fenske, J. (2015). African polygamy: Past and present. *Journal of Development Economics*, *117*, 58–73. https://doi.org/10.1016/j.jdeveco.2015.06.005

Hayase, Y., & Liaw, K. (1997). Factors On Polygamy in Sub-Saharan Africa: Findings Based On The Demographic And Health Surveys. *The Developing Economies*, *35*(3), 293–327. https://doi.org/10.1111/j.1746-1049.1997.tb00849.x

INSD. (2020). *Enquête Harmonisée sur les Conditions de Vie des Ménages de 2018 (EHCVM-2018) Diagnostic de la pauvreté*.

Jacoby, H. G. (1995). The Economics of Polygyny in Sub-Saharan Africa: Female Productivity and the Demand for Wives in Côte d'Ivoire. *Journal of Political Economy*, *103*(5), 938–971. https://doi.org/10.1086/262009

Kazianga, H., & Wahhaj, Z. (2017). Intra-household resource allocation and familial ties. *Journal of Development Economics*, *127*, 109–132. https://doi.org/10.1016/j.jdeveco.2017.03.002

Kudo, Y. (2014). Religion and polygamy: evidence from the Livingstonia Mission in Malawi. *IDE Discussion Paper*, *No 477*.

Lechene, V., Pendakur, K., & Wolf, A. (2022). Ordinary Least Squares Estimation of the Intrahousehold Distribution of Expenditure. *Journal of Political Economy*, *130*(3), 681–731. https://doi.org/10.1086/717892

Lewbel, A., & Pendakur, K. (2008). Estimation of collective household models with Engel curves. *Journal of Econometrics*, *147*(2), 350–358. https://doi.org/10.1016/j.jeconom.2008.09.012

Lewbel, A., & Pendakur, K. (2021). *Estimating A Model of Inefficient Cooperation and Consumption in Collective Households*. https://www2.bc.edu/arthur-lewbel/.

Lewbel, A., & Pendakur, K. (2022). Inefficient Collective Households: Cooperation And Consumption. *Economic Journal*, *132*(645), 1882–1893. https://doi.org/10.1093/ej/ueab099

Merand, P. (1977). La vie quotidienne en Afrique Noire à travers la littérature africaine. *Paris, L'Harmattan*.

Nnaemeka, O. (2005). *The politics of (M) othering: Womanhood, identity and resistance in African literature. Routledge.* (O. Nnaemeka, Ed.). Routledge.

Nwoye, A. (2007). The practice of interventive polygamy in two regions of Africa: Background, theory and techniques. *Dialectical Anthropology*, *31*(4), 383–421. https://doi.org/10.1007/s10624-008-9036-y

Ogho, A. P. (2005). *dentify and Change in African Culture. The Case of African Women*.

Pendakur, K. (2018). *Welfare analysis when people are different*.

Penglase, J. (2021). Consumption Inequality Among Children: Evidence from Child Fostering In Malawi. *Economic Journal*, *131*(634), 1000–1025. https://doi.org/10.1093/ej/ueaa104

Pew Research Center. (2019). *Religious and Living Arrangements Around the World*.

Rangel, M., & Thomas, D. (2019). *Decision-Making in Complex Households*. https://doi.org/10.3386/w26511

Rossi, P. (2019). Strategic choices in polygamous households: Theory and evidence from Senegal. *Review of Economic Studies*, *86*(3), 1332–1370. https://doi.org/10.1093/restud/rdy052

Sokullu, S., & Valente, C. (2022). Individual consumption in collective households: Identification using repeated observations with an application to PROGRESA. *Journal of Applied Econometrics*, *37*(2), 286–304. https://doi.org/10.1002/jae.2875

Tommasi, D. (2019). Control of resources, bargaining power and the demand of food: Evidence from PROGRESA. *Journal of Economic Behavior and Organization*, *161*, 265–286. https://doi.org/10.1016/j.jebo.2019.04.008

UNDP. (2022). *Human Development Report 2021/2022*.

Tables and Graphs

Tables

Table 1: Descriptive statistics

	Monogamous Households				Bigamous Households			
	Obs.	Mean	Median	Std. Dev.	Obs.	Mean	Median	Std. Dev.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household Expenditure								
Total expenditures (USD)	3,439	2204.4	1779.5	1490.8	958	2466.8	2109.5	1424.3
Food Budget Share	3,439	52.124	51.814	12.64	958	53.67	53.48	11.82
Children's Clothing Budget Share	3,439	0.018	0.016	0.013	958	0.020	0.017	0.014
Wife's Clothing Budget Share	3,439	0.018	0.015	0.014	958	0.019	0.017	0.015
Husband's Clothing Budget Share	3,439	0.016	0.013	0.015	958	0.012	0.010	0.011
Wives Characteristics								
Senior Wife's Age	3,439	28.82	28.00	7.300	958	34.64	33.00	8.891
Junior Wife's Age		-	-	-	958	27.18	26.00	7.403
Senior Wife's Education	3,439	1.418	1.000	0.750	958	1.079	1.000	0.331
Junior Wife's Education		-	-	-	958	1.196	1.000	0.549
Senior Wife's Active (=1)	3,439	0.781	1.000	0.414	958	0.818	1.000	0.386
Junior Wife's Active (=1)		-	-	-	958	0.797	1.000	0.403
Other Household Characteristics								
Number of Children	3,439	2.614	3.000	1.230	958	5.228	5.000	2.105
Husband's Age	3,439	37.17	35.00	9.251	958	42.72	40.00	10.45
Average Age of Children	3,439	5.104	5.000	2.849	958	5.950	6.000	2.162
Husband's Education	3,439	1.986	2.000	0.812	958	1.985	2.000	0.714
Muslim household	3,439	0.653	1.000	0.476	958	0.729	1.000	0.445
Christian household	3,439	0.269	0.000	0.443	958	0.162	0.000	0.368
Traditional religion household	3,439	0.078	0.000	0.268	958	0.116	0.000	0.320
Other religions [a)]	3,439	0.003	0.000	0.056	958	0.003	0.000	0.056
Reside in Rural Area (=1)	3,439	0.574	1.000	0.495	958	0.809	1.000	0.393
Year=2014	3,439	0.535	1.000	0.499	958	0.605	1.000	0.489
Year=2018	3,439	0.465	0.000	0.499	958	0.395	0.000	0.489

Notes: Data are from the Burkina Faso EHCVM 2018/2019 and LSMS-ISA 2014.

a) Includes households of other religions and households without a religion.

Education ranges from 1 to 4. The exchange rate USD/XOF is 587.608 as of January 1, 2019.

Table 2: Estimated resource shares, Scale economies, and Indifference scales

	Monogamous Households				Bigamous Households			
	Obs.	Mean	Median	Std. Dev.	Obs.	Mean	Median	Std. Dev.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(A) Resource Shares								
Children	3439	0.141	0.101	0.083	958	0.055	0.043	0.041
Junior	0				958	0.211	0.211	0.005
Senior	3439	0.292	0.293	0.019	958	0.235	0.232	0.014
Husband	3439	0.430	0.430	0.029	958	0.337	0.34	0.022
(B) Scale Economies								
Children	2660	0.629	0.631	0.026	958	0.747	0.748	0.028
Junior	0				958	0.986	0.998	0.044
Senior	2660	0.803	0.881	0.139	958	0.852	0.887	0.112
Husband	2660	0.720	0.717	0.046	958	0.824	0.822	0.050
(C) Indifference Scales								
Children	2660	0.558	0.515	0.191	958	0.305	0.234	0.234
Junior	0				958	0.725	0.72	0.041
Senior	2660	1.279	1.131	0.305	958	0.957	0.884	0.192
Husband	2660	1.439	1.436	0.132	958	1.086	1.084	0.099

Notes: Estimates are conditional on wives' and household characteristics as presented in Table 1. The resource shares in this table are per child. Indifference scales are computed as: $\hat{I}^t_{1,r} = \hat{\eta}^t_{\tau'} \times 1/E[\,\hat{\eta}^t_1] \times \hat{s}^t_{\tau'}$. The means resource shares for reference households (consisting of a husband, one wife, and one child) are 0.438 for husbands, 0.286 wives, and 0.275 for children.

Table 3: Poverty rates (%) by household size

Household size	Monogamous households						Bigamous households					
	All	3	4	5	6	7	All	4 - 5	6 - 7	8 - 9	10 -11	12- 13
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(A) Per-capita Expenditure												
Household	25.63	08.59	18.29	28.40	42.57	64.41	53.98	38.89	42.61	53.91	67.44	83.33
(B) Equivalent Expenditure $(\boldsymbol{y} \,/\, n_{eq})$												
Household	06.31	0.000	03.24	08.64	11.24	20.34	17.99	13.89	06.96	20.31	22.09	50.00
(C) Individual Expenditure $(\hat{\eta}_{\tau}^{t} \times \boldsymbol{y})$												
Children	46.81	00.25	18.29	44.69	68.07	88.31	84.57	32.31	64.88	86.40	95.85	98.65
Junior	-						13.88	27.78	13.91	13.28	09.30	12.50
Senior	09.06	08.59	10.65	09.88	06.83	06.78	07.71	19.44	07.83	06.25	04.65	08.33
Husband	00.69	01.52	00.46	00.25	00.4	00.85	00.77	02.78	00.00	00.00	01.16	04.17
(D) Individual Consumption $(\hat{\eta}_{\tau}^{t} \times \boldsymbol{y}/\hat{s}_{r}^{t})$												
Children	25.24	00.25	03.13	17.12	39.66	66.78	66.49	12.31	32.93	66.29	84.66	93.69
Junior	-						13.88	27.78	13.91	13.28	09.30	12.50
Senior	05.44	08.59	04.86	04.94	03.21	03.39	04.88	13.89	06.09	03.13	01.16	08.33
Husband	00.38	01.52	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00

Notes: This table presents poverty rates by household size, computed using four approaches: household per capita expenditures, household expenditures adjusted using the OECD equivalence scale, model-based individual expenditures and model-based individual consumption. Per capita expenditures are obtained by dividing total household expenditures by the number of individuals in the household. Equivalent expenditures are calculated by dividing total household expenditure by $n_{eq} = 1 + 0.7 * (n_m + n_w - 1) + 0.5 \times n_c$ where n_t gives the number of men, women, and children for $t = m, w, and\ c$. Individual expenditures are obtained by multiplying total annual household expenditures by individual resource shares. Individual consumption is obtained by dividing individual expenditures by scale economies (Calvi et al, 2023). Poverty lines correspond to the 533.34 CFA/day poverty line. In Panels C and D, the child poverty line as a function of age-based daily calorie intake. Similarly, the poverty line for individuals aged 46 years and older is scaled by 0.80.

Figures

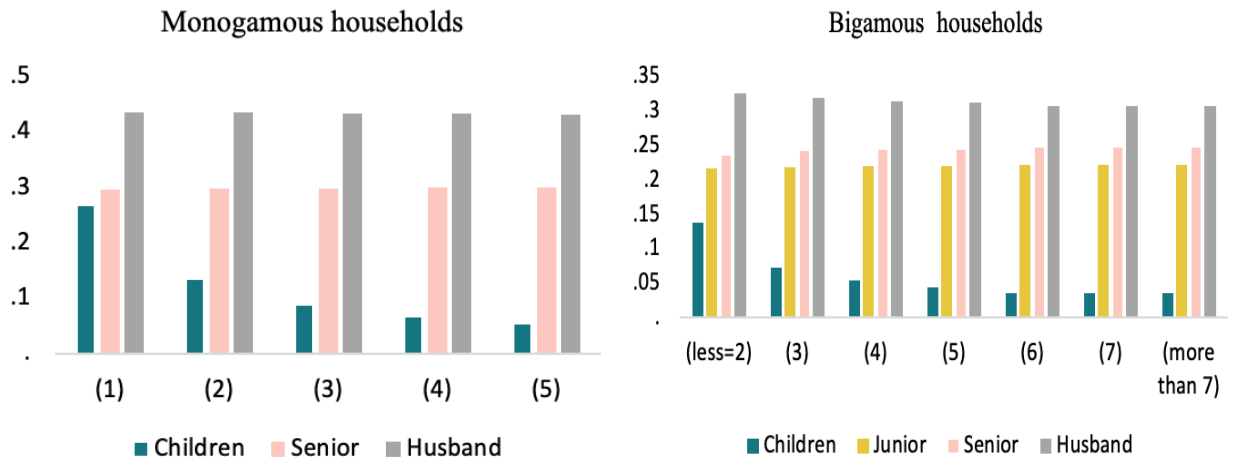

Figure 1:Resource shares by household size

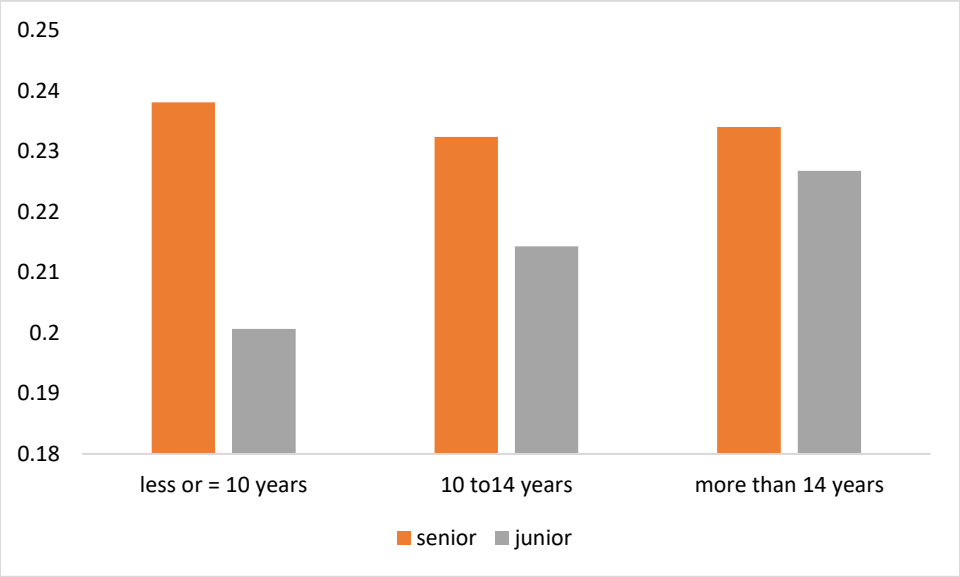

Figure 2: Mean of predicted resource shares between co-wives in different age groups. Figure 2 compares the mean resource shares between co-wives with age difference is less than 10 years, between 10 and 14 years, and more than 14 during their childbearing (18-45 years old).

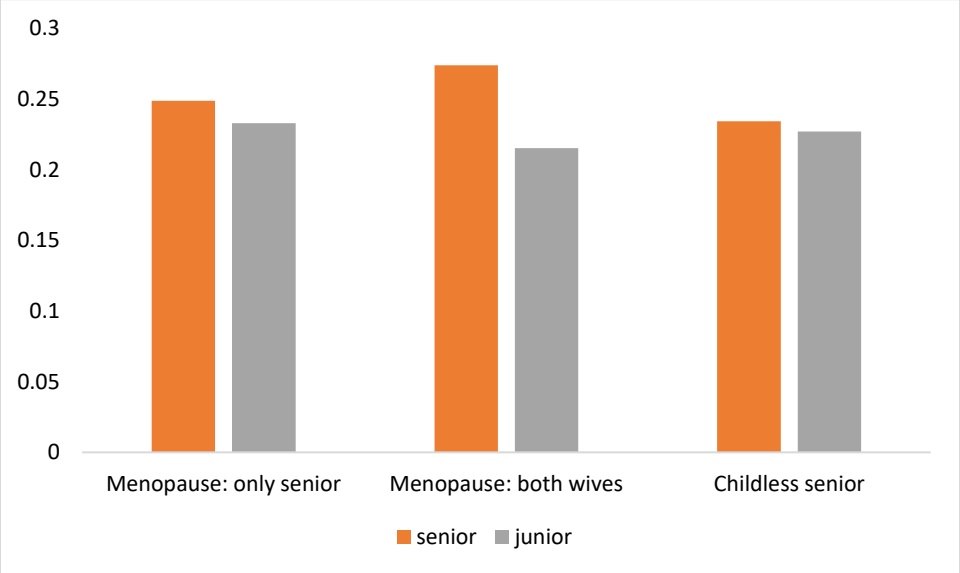

Figure 3: Mean of predicted resource shares among co-wives in different phase of reproductive cycle age groups. This figure compares resource shares between cowives when only senior wife is menopaused (46 or older), when both co-wives are menopaused, and when senior wife is childless (aged 60 or older).

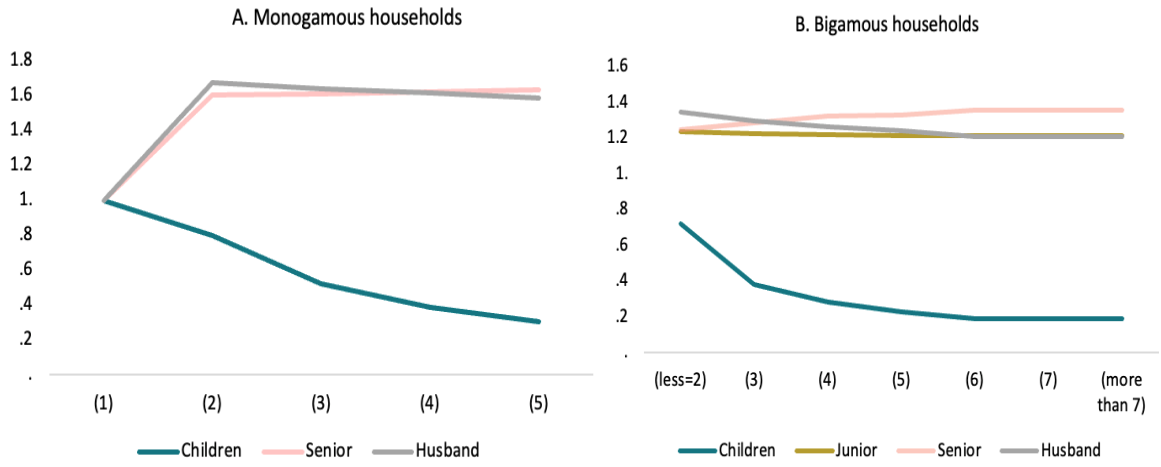

Figure 4: Indifference scales by household size

Appendix

Proof of LEMMA 1 (Calvi et al, 2023)

From the definition of indifference scales equation (3) is given in the main text.

$$V_t\left(\alpha_{\tau'} + p, x + ln\eta^t_{\tau'} - lnI^t_{\tau,\tau'}\right) = V_t(\alpha_\tau + p, x + ln\eta^t_\tau) \quad \text{Eq. (A.1)}$$

Assumption 2 provides equation (4):

$$V_t(\alpha_\tau + p, x) = V_t(\alpha_\tau + p, x - s^t_\tau(\alpha_\tau + p)) \text{ (Family versus in single).} \quad \text{Eq. (A.2)}$$

It follows that (family type τ' versus τ):

$$V_t\left(\alpha_{\tau'} + p, x + ln\eta^t_{\tau'} - lns^t_\tau + lns^t_{\tau'}\right) = V_t(\alpha_\tau + p, x + ln\eta^t_\tau) \quad \text{Eq. (A.3)}$$

Right side of (1) equals right side of (3):

$$V_t\left(\alpha_{\tau'} + p, x + ln\eta^t_{\tau'} - lnI^t_{\tau,\tau'}\right) = V_t\left(\alpha_{\tau'} + p, x + ln\eta^t_{\tau'} - lns^t_\tau + lns^t_{\tau'}\right)$$

This holds if only:

$$ln\eta^t_{\tau'} - lnI^t_{\tau,\tau'} = ln\eta^t_{\tau'} - lns^t_\tau + lns^t_{\tau'} \ ,$$

$$lnI^t_{\tau,\tau'} = \frac{\eta^t_{\tau'}(p,\alpha_{\tau'})\, s^t_\tau(p,\alpha_\tau)}{\eta^t_\tau(p,\alpha_\tau)\, s^t_{\tau'}(p,\alpha_{\tau'})} \quad \text{Eq. (A.4)}$$

Table A 1: Test of nonlinearity of Engel curve

	Estimated	Standard error Er.
Slope: Children's clothing budget share function (β^c)	0.0167***	0.0014
Slope: Junior wife's clothing budget share function (β^j)	0.0178***	0.0022
Slope: Senior wife's clothing budget share function (β^s)	0.0206***	0.0034
Slope: Husband clothing budget share function (β^m)	0.0317***	0.0016
Curvature (c)	-0.005***	0.0001

Note: Slope and curvature parameters are obtained from the NLSUR estimation of equation (15) with the full sample. These parameters are estimated conditional on individual characteristic variables but not on household composition variables. Following Assumption 3, curvature is the same across categories of individuals and household types. *** denotes statistical significance at p<0.001.

Table A 2: Determinants of resource shares (Full sample)

Variables	Senior wife	Junior wife	Children
Wife's age	0.0155***	0.0300***	0.0227***
	(0.002)	(0.0001)	(0.0014)
Wife's education	0.0293***	0.0031	0.0372***
	(0.0038)	(0.0037)	(0.0019)
Wife is working	0.0217***	0.0094	0.0101***
	(0.0023)	(0.0037)	(0.0010)
Number of children	0.087***	0.0107***	0.0724***
	(0.0011)	(0.0024)	(0.0004)
Husband's Age	0.0048***	0.0218***	-0.0056***
	(0.0013)	(0.0033)	(0.0005)
Average age of children	0.0067**	0.0209*	0.0091***
	(0.0029)	(0.0119)	(0.0011)
Education of Husband	0.0046***	-0.0016	0.0080***
	(0.0002)	(0.0016)	(0.0007)
Muslim household	0.0356***	0.0199*	0.0145***
	(0.0029)	(0.0110)	(0.0016)
Christian household	0.0303***	0.0311**	0.0174***
	(0.0049)	(0.0156)	(0.0021)
Rural	-0.0199***	0.0410*	0.0067***
	(0.0025)	(0.0220)	(0.0010)
West	0.01300***	0.0501**	0.0244***
	(0.0060)	(0.020)	(0.0075)
East	0.0160****	0.007	0.0061
	(0.0070)	(0.0135)	(0.0049)
Sahel	0.0004	0.0042	-0.0021
	(0.0020)	(0.0124)	(0.0030)
Year 2018	0.0903***	-0.0123**	0.0060***
	(0.0052)	(0.0064)	(0.0021)

Notes: NLSUR estimates. [a)] Junior wives' resources functions based on age difference instead of a polygamy dummy variable. Coefficients for agro-ecological dummy variables West, Sahel, Est (with Center as the base category) are not shown for the sake of conciseness. Sample size is 4,397 households. Resource shares are constrained to sum to one. Age variables are divided by 10 for easy computation. Robust standard errors are in brackets. *** denotes statistical significance at $p<0.001$.

Table A 3: Determinants of economies of scale (full sample)

Variables	Senior wife	Junior wife	Children	Husband
Wife's age	0.0468**	0.0323	0.0532***	0.0527***
	(0.0200)	(0.0340)	(0.00457)	(0.0053)
Wife's education	0.0001	-0.0834	0.01356***	0.0152***
	(0.0001)	(0.0758)	(0.00199)	(0.0040)
Wife is working	0.126***	0.1647***	0.0447***	0.0217**
	(0.0328)	(0.0121)	(0.0061)	(0.0089)
Number of children	0.0437***	0.0517**	0.0146***	0.0278***
	(0.0043)	(0.0397)	(0.0012)	(0.0033)
Husband's Age	0.0024	-0.0066	0.0194***	0.0087***
	(0.0027)	(0.0085)	(0.0017)	(0.0026)
Average age of children	0.0551	-0.3872***	0.0623***	0.0707***
	(0.0345)	(0.1456)	(0.0091)	(0.0126)
Education of Husband	0.1132***	0.1168**	0.0406***	0.0511***
	(0.0292)	(0.0464)	(0.0036)	(0.0066)
Muslim household	0.0224	0.0300	0.0181***	0.0093
	(0.0162)	(0.0349)	(0.0032)	(0.0101)
Christian household	0.0201	0.0020	0.0165***	0.0055
	(0.0140)	(0.0020)	(0.0036)	(0.0045)
Rural	0.0041	0.0137	0.0218***	0.0149
	(0.0030)	(0.0359)	(0.0032)	(0.0153)
West	-0.0227	-0.0010	0.0075	0.0075
	(0.0402)	(0.0205)	(0.0093)	(0.0093)
East	-0.0030	0.0341	0.0012	0.0012
	(0.0128)	(0.0898)	(0.0031)	(0.0031)
Sahel	-0.0030	-0.0425	0.0016	0.0016
	(0.0687)	(0.0862)	(0.0042)	(0.0042)
Year 2018	0.0297**	-0.0372	0.0752***	0.0621
	(0.0130)	(0.0516)	(0.0075)	(0.0151)

Notes: NLSUR estimates. Sample size is 4,397. The average wife's characteristics are used for the resource share functions of children and husbands. Resource shares are constrained to sum to one. Age variables are divided by 10 for easy computation. Robust standard errors are in brackets. *** denotes statistical significance at p<0.001.

Table A 4: Determinants of resource shares for the subsample of monogamous households

	Resource shares		Economies of scale		
Variables	Wife	children	Wife	children	Husband
Wife's age	0.039***	0.01047**	0.0514***	0.0057***	0.0022***
	(0.0044)	(0.0040)	(0.0149)	(0.0012)	(0.0004)
Wife's education	0.0464***	0.0025	-0.1227***	0.0181***	0.0166***
	(0.0169)	(0.00307)	(0.0313)	(0.0021)	(0.0015)
Wife is working	0.0065	0.00273	0.0719	0.0205***	0.0042***
	(0.0057)	(0.00408)	(0.02932)	(0.0037)	(0.0004)
Number of children	0.01738***	0.0192***	0.0108***	0.0246***	0.0159***
	(0.0062)	(0.00396)	(0.0065)	(0.0054)	(0.0091)
Husband's Age	0.0064	-0.00104	-0.0117***	0.0011***	0.0473***
	(0.0042)	(0.00101)	(0.0058)	(0.0002)	(0.0036)
Average age of children	-0.0013	0.02540*	-0.0003	0.0579	0.0067***
	(0.0027)	(0.01397)	(0.0006)	(0.0052)	(0.0007)
Education of Husband	0.0060	0.0168***	0.1921***	0.0606***	0.0674***
	(0.0057)	(0.00483)	(0.0345)	(0.0063)	(0.0020)
Muslim household	0.1283***	0.00507	-0.0050	0.00039	0.00009
	(0.0410)	(0.00548)	(0.0165)	(0.0011)	(0.0001)
Christian household	0.1293***	0.0203**	0.0151	-0.0055	0.00003
	(0.0423)	(0.00957)	(0.06944)	(0.01374)	(0.02354)
Rural	-0.0034	0.009	-0.0092	0.02348	0.0242
	(0.0059)	(0.0074)	(0.0256)	(0.3940)	(0.01369)
West	0.0003	0.0123***	-0.00016	0.0282***	0.0282***
	0.0000	0.0014	0.0002	0.0055	0.0055
East	0.0112	0.0044***	0.0402*	0.0212***	0.0212***
	0.0128	0.0008	0.0243	0.0041	0.0041
Sahel	-0.00005	-0.0005	-0.0013	0.0130***	0.0130***
	0.00004	0.0004	0.0004	0.0027	0.0027
Year 2018	0.0064	0.0501***	0.08625	0.00191	0.01896
	(0.0074)	(0.01721)	(0.12098)	(0.04336)	(0.01336)

Notes: NLSUR estimates. Sample size is 3,439. The average wife's characteristics for resource shares and economies of scale functions of children and husbands. Resource shares are constrained to sum to one. Age variables are divided by 10 for easy computation. Robust standard errors are in brackets. *** denotes statistical significance at p<0.001.

Table A 5: Determinants of resource shares for the subsample of bigamous households

	Resource shares			Economies of scale			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	Senior	junior	children	Senior	junior	children	Husband
Wife's age	0.0098***	0.0067	0.0106***	0.0055***	-0.0129	0.0495***	0.0275***
	(0.00273)	(0.00771)	(0.0021)	(0.0014)	(0.0183)	(0.0069)	(0.0056)
Wife's education	0.0435***	0.0170***	0.0340***	0.0324**	0.0750***	0.0529***	0.0327***
	(0.01197)	(0.00547)	(0.00450	(0.0114)	(0.0187)	(0.0121)	(0.0082)
Wife is working	0.0115	0.00005	0.0143***	0.2670**	0.0219***	0.0789***	0.0365***
	(0.0082)	(0.00007)	(0.0037)	(0.1173)	(0.0044)	(0.0165)	(0.0096)
Number of children	0.0097***	0.0093***	0.0236***	0.0259***	0.0101***	0.0030***	0.0161***
	(0.00130)	(0.00175)	(0.0015)	(0.0170)	(0.0040)	(0.0009)	(0.0028)
Husband's Age	0.0068***	0.0144***	-0.0082***	0.0088	-0.0001	0.0189***	0.0361***
	(0.0025)	(0.00246)	(0.00127)	(0.0123)	(0.0002)	(0.0045)	(0.0037)
Average age of children	0.0122**	0.0138***	0.0094***	-0.175*	-0.0044	0.0471***	0.0449***
	(0.0049)	(0.00530)	(0.0021)	(0.1045)	(0.0326)	(0.0162)	(0.01175)
Education of Husband	0.0097*	0.0076*	0.0106***	0.0273	0.0973**	0.0737***	0.0450***
	(0.00541)	(0.0039)	(0.0013)	(0.0349)	(0.0539)	(0.0113)	(0.0070)
Muslim household	0.0064*	0.01914	0.0090**	0.0037	0.01862	0.00203	0.00401
	(0.0035)	(0.0128)	(0.0037)	(0.0224)	(0.0174)	(0.01013)	(0.0073)
Christian household	-0.00027	0.01156	0.0129***	-0.00012	0.08288	-0.03013	0.03398
	(0.0062)	(0.0082)	(0.0047)	(0.0140)	(0.0405)	(0.03587)	(0.0292)
Rural	-0.0372***	-0.00703	0.0068**	0.1919**	-0.0099	0.0034**	0.0185***
	(0.01216)	(0.00445)	(0.0027)	(0.1074)	(0.0499)	(0.0011)	(0.0050)
West	0.0000	-0.00486	0.0454***	-0.1558	-0.04263	0.045479	-0.00004
	(0.00006)	(0.0074)	(0.0175)	(0.281)	(0.04244)	(0.0175)	(0.00003)
East	0.0060***	0.0310***	-0.0000	-0.202	-0.03938	0.000	0.000033
	(0.0010)	(0.015)	(0.00006)	(0.350)	(0.0405)	(0.000)	(0.00004)
Sahel	0.0000	0.0049	-0.00291	0.086	-0.0116	-0.0029	0.0054
	(0.00005)	(0.0091)	(0.0067)	(0.232)	(0.0241)	(0.0067)	(0.0180)
Year 2018	0.1026***	0.0060***	0.0094***	-0.2703**	0.0088	0.0379***	0.0410***
	(0.01206)	(0.0019)	(0.00235)	(0.1233)	(0.0435)	(0.0079)	(0.0069)
Test for ratio equality [a)]				-0.0075 (0.1241)	-0.0082 (0.0310)	0.2375 (0.5670)	-

Notes: NLSUR estimates. Sample size is 958. The average wife's characteristics are used for resource shares and economies of scale functions for children and husbands. Age variables are divided by 10 for easy computation.

[a)] The null hypothesis: Equality of the coefficients of the number of children across parents 'economies of scale functions. The test shows the difference in coefficients from the nlcom post-estimation command from NLSUR in Stata 17. Robust standard errors are in parentheses. *** denotes statistical significance at p<0.001.

Table A 6: Estimated structural parameters and difference of scales with the subsample of monogamous households.

Number of children	(All)	(1)	(2)	(3)	(4)	(5)
Resources shares						
Children	0.143	0.285	0.141	0.094	0.070	0.056
Senior	0.292	0.288	0.290	0.293	0.294	0.297
Husband	0.424	0.427	0.425	0.423	0.423	0.420
Economies of scale						
Children	0.788	1.00	0.717	0.728	0.732	1.741
Senior	0.649	1.00	0.548	0.547	0.546	0.542
Husband	0.778	1.00	0.701	0.713	0.722	0.731
Indifference of the scale						
Children	0.609	1.00	0.696	0.457	0.339	0.267
Senior	1.668	1.00	1.844	1.863	1.877	1.908
Husband	1.308	1.00	1.431	1.394	1.374	1.351

The estimates are conditional on the wives and household characteristics presented in Table 1. Sample size is 958. The resource shares in this table are not necessary because the resource shares shown here are per child. Indifference scales are computed as follows: $\hat{I}_{1,r}^{t} = \hat{\eta}_{\tau'}^{t} \times 1/E[\,\hat{\eta}_{1}^{t}] \times \hat{s}_{\tau'}^{t}$. The mean resource shares for reference households (a husband, one wife, one child) are 0.427 for husbands, 0.288 for wives, and 0.285 for children.

Table A 7: Estimated structural parameters and difference of scales with the subsample of bigamous households.

Number of children	All	Less or equal 2	3	4	5	6	7	More than 7
Resource shares								
Children	0.0589	0.1466	0.0781	0.0588	0.0474	0.0397	0.0397	0.0397
Junior	0.2148	0.2073	0.2112	0.2135	0.2148	0.2168	0.2168	0.2168
Senior	0.2322	0.2225	0.2303	0.2315	0.2314	0.2346	0.2346	0.2346
Husband	0.3165	0.3382	0.3243	0.3199	0.3169	0.3102	0.3102	0.3102
Economies of scale								
Children	0.8135	0.8066	0.8037	0.8105	0.806	0.8112	0.8112	0.8112
Junior	0.644	0.5977	0.6213	0.6313	0.638	0.6538	0.6538	0.6538
Senior	0.6741	0.6632	0.6733	0.6741	0.6729	0.6742	0.6742	0.6742
Husband	0.8743	0.8596	0.8619	0.8698	0.8719	0.8731	0.8731	0.8731
Indifference sales								
Children	0.258	0.6487	0.3449	0.2572	0.2076	0.1731	0.1731	0.1731
Junior	1.1646	1.2147	1.1871	1.1797	1.1736	1.1556	1.1556	1.1556
Senior	1.2091	1.1859	1.2048	1.2074	1.2044	1.2214	1.2214	1.2214
Husband	0.8538	0.9338	0.8899	0.8684	0.8549	0.8361	0.8361	0.8361

The estimates are conditional on the wives' and household characteristics presented in Table 1. Sample size is 958. The resource shown here are per child. Indifference scales are computed as follows: $\hat{I}^t_{1,r} = \hat{\eta}^t_{\tau'} \times 1/E[\,\hat{\eta}^t_1] \times \hat{s}^t_{\tau'}$. The means resource shares for reference households (a husband, one wife, one child) are 0.438 for husbands, 0.286 wives, and 0.275 for children (see Table A6).

Table A 8: Estimated structural parameters and indifferences scale in monogamous households: **Selection model.**

Number of children	(All)	(1)	(2)	(3)	(4)	(5)
Resource shares						
Children	0.138	0.271	0.137	0.092	0.070	0.056
wife	0.283	0.283	0.283	0.284	0.284	0.285
Husband	0.439	0.445	0.442	0.437	0.435	0.431
Economies of scale						
Children	0.808	1.00	0.728	0.752	0.773	0.790
wife	0.796	1.00	0.722	0.736	0.748	0.758
Husband	0.853	1.00	0.779	0.811	0.836	0.855
Indifference of scales						
Children	0.609	1.00	0.698	0.456	0.336	0.265
wife	1.284	1.00	1.391	1.368	1.346	1.331
Husband	1.172	1.00	1.284	1.218	1.172	1.135

NLSUR Estimation of Equation (15), augmenting it with an inverse Mills ratio (IMR) to address selection into polygamy. Estimates are conditional on the wives' and household characteristics presented in Table 1. Sample size is 4,397. Resource shares in this table are not necessary because the resource shares shown here are per child. Indifference scales are computed as follows: $\hat{I}_{1,r}^{t} = \hat{\eta}_{\tau}^{t\prime} \times 1/E[\,\hat{\eta}_{1}^{t}] \times \hat{s}_{\tau}^{t\prime}$. The means resource shares for reference households (a husband, one wife, one child) are 0.445 for husbands, 0.283 for wives, and 0.271 for children.

Table A 9: Estimated structural parameters and indifferences scale in bigamous households: **Selection model.**

Number of children	All	Less or equal 2	3	4	5	6	7	More than 7
Resource shares								
Children	0.057	0.140	0.075	0.057	0.046	0.039	0.039	0.039
Junior	0.236	0.218	0.226	0.230	0.235	0.240	0.240	0.240
Senior	0.234	0.223	0.230	0.232	0.233	0.237	0.237	0.237
Husband	0.297	0.337	0.317	0.307	0.298	0.287	0.287	0.286
Economies of scale								
Children	0.829	0.814	0.811	0.822	0.823	0.830	0.830	0.830
Junior	0.697	0.659	0.670	0.685	0.692	0.706	0.706	0.706
Senior	0.779	0.779	0.774	0.776	0.772	0.776	0.776	0.776
Husband	0.856	0.830	0.834	0.846	0.850	0.859	0.859	0.859
Indifference of scales								
Children	0.259	0.640	0.346	0.258	0.209	0.175	0.175	0.175
Junior	1.198	1.177	1.196	1.191	1.203	1.205	1.205	1.205
Senior	1.067	1.023	1.058	1.065	1.073	1.084	1.084	1.084
Husband	0.785	0.926	0.863	0.821	0.790	0.752	0.752	0.752

NLSUR Estimation of Equation (15), augmenting it with an inverse Mills ratio (IMR) to address selection into polygamy. Estimates are conditional on the wives' and household characteristics presented in Table 1. Sample size is 4,397. The resource shares in this table are not necessary because the resource shares shown here are per child. Indifference scales are computed following: $\hat{I}_{1,r}^{t} = \hat{\eta}_{\tau'}^{t} \times 1/E[\,\hat{\eta}_{1}^{t}] \times \hat{s}_{\tau'}^{t}$. The means resource shares for reference household (one husband-one wife-one child) are 0.445 for husbands, 0.283 for wives, and 0.271 for children (Table A8).

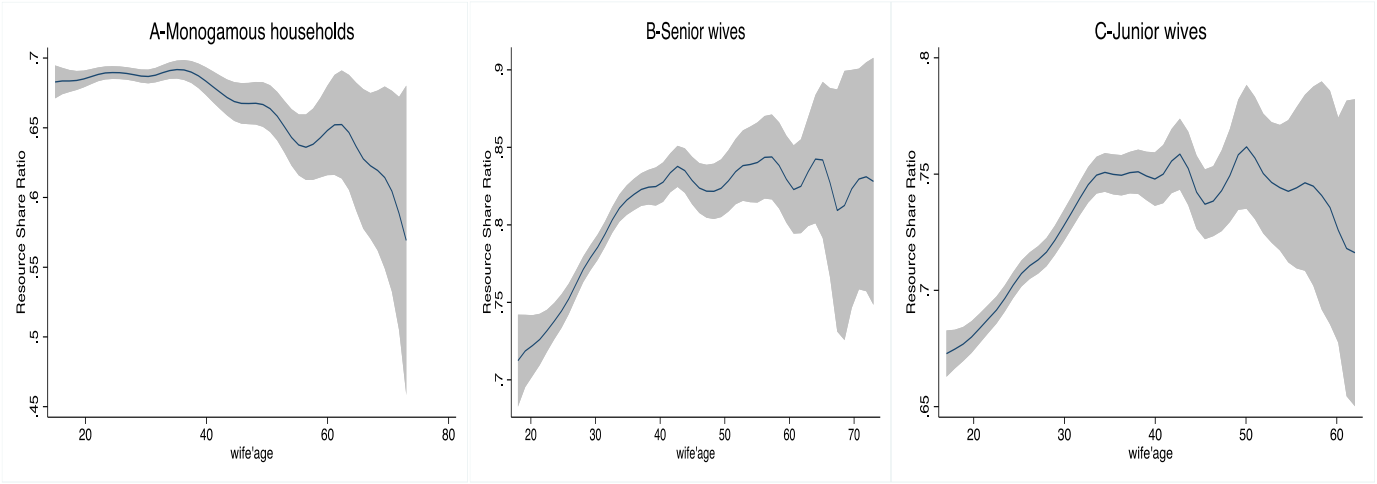

Figure A 1: Consumption inequality between wives and husbands

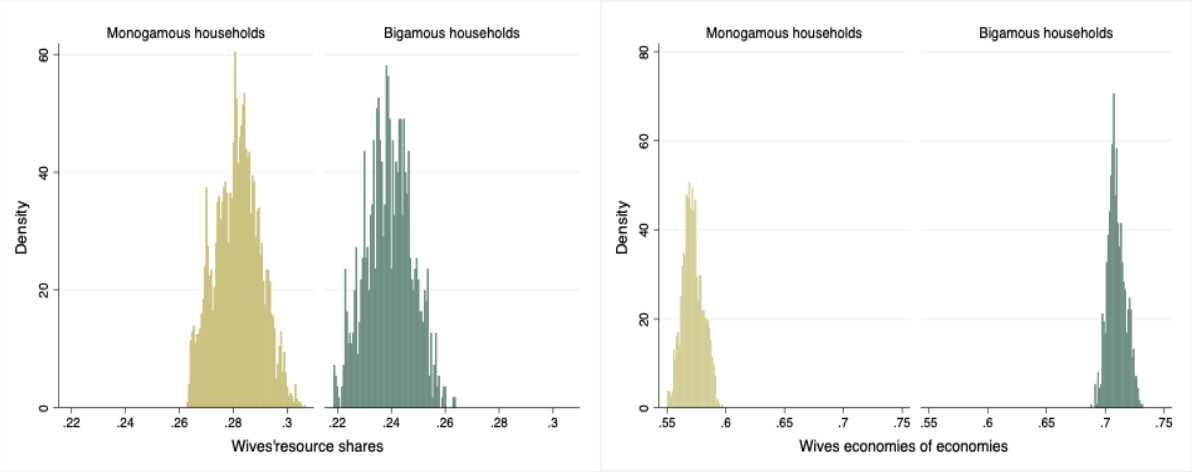

Figure A 2: Distributions of wives' resource shares and economies of scale (full sample)

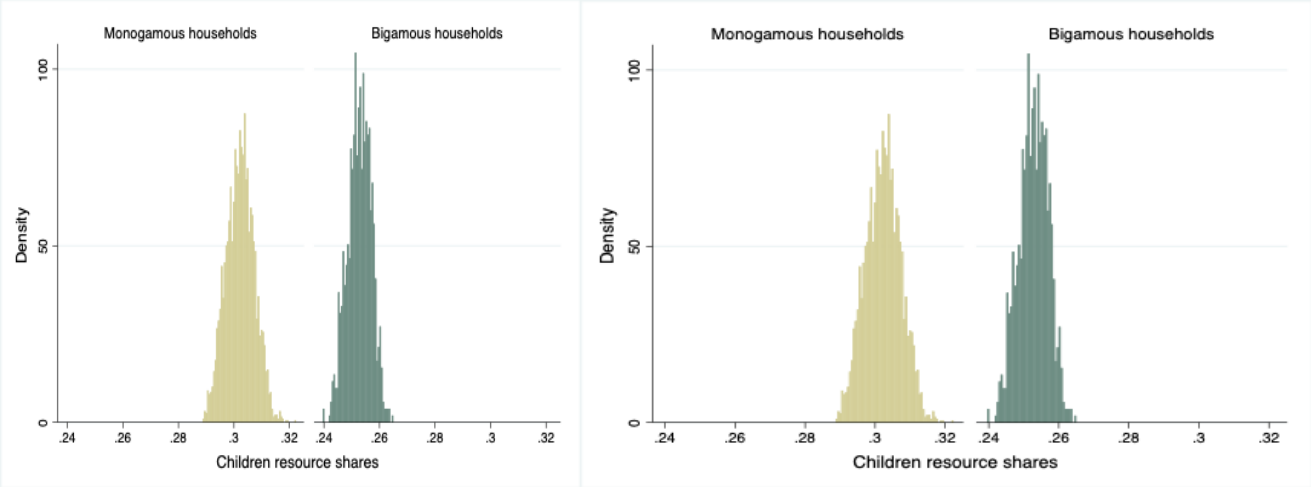

Figure A 3: Distribution of children's resource share and economies of scale (full sample)

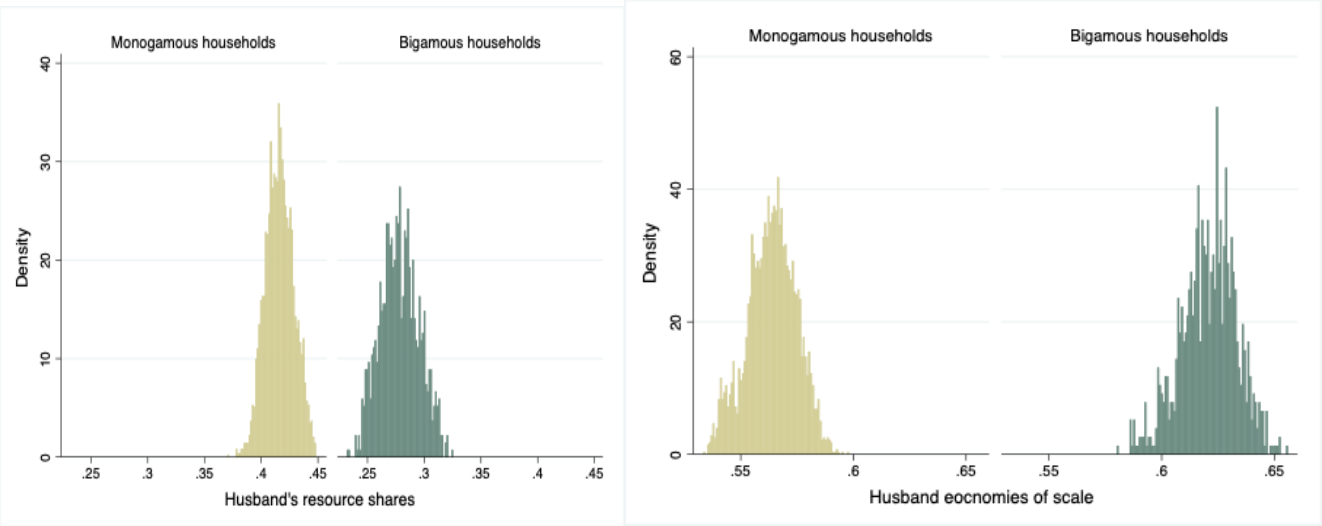

Figure A 4: Distribution of husbands' resource shares and economies of scale (full sample)