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Essays on Women's (Dis)advantage in Access to Resources

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Contents

List of Figures

List of Tables

Introduction

The economic literature provides abundant evidence of the unequal distribution of resources across genders in both developing and developed countries (Ponthieux & Meurs, 2015, D'Souza & Tandon, 2019, Brown et al., 2021). Across numerous dimensions, women face more obstacles in accessing resources compared to men, leading to poorer economic and health outcomes. For instance, in 2022, women's labor income worldwide accounted for approximately half of men's (51%), with their participation in the labor force at 61.4%, in contrast to men at 90.6% (ILO, 2023). In Sub-Saharan Africa, legal land rights are granted to less than 20% of women in most countries (FAO, 2018). Furthermore, in poor countries, women are more vulnerable to nutritional deficiencies during periods of food scarcity, as priority often goes to men's nutrition (D'Souza & Tandon, 2019; Brown et al., 2021).

The first two chapters of this thesis focus on the intrahousehold allocation of resources in developing countries, while the third investigates gender inequality in deprivation in the United States. The collective model provides insight into the economic rationale behind intrahousehold inequality in resource allocation, attributing it to differences in bargaining power (Chiappori, 1992; Browning & Chiappori, 1998). In many Sub-Saharan African contexts, strong patriarchal norms grant men authority over resource allocation, resulting in their disproportionate control over resources. In such a context, despite their high level of contribution to household production, women typically have a low level of access to resources. Beyond this issue of "intra-household fairness," there is substantial empirical evidence indicating that resources within households are inefficiently allocated, resulting in potential surplus losses (Udry, 1996; Dercon & Krishnan, 2000; Guirkinger et al.,

2015; Kazianga & Wahhaj, 2017). This suggests the existence of alternative resource allocation patterns that could improve outcomes for all household members.

Several explanations have been proposed in the literature to elucidate contextual reasons for intrahousehold inefficiencies. The first commonly cited reason is power imbalances (Baland & Ziparo, 2018). In households with extreme inequality in bargaining power, marginalized members may adopt non-cooperative behaviors since the benefits of cooperation are mainly retained by the most powerful member. This phenomenon is particularly prevalent in strongly patriarchal societies where women often have limited control over resource allocation and few exit options. Additionally, household structure may hinder efficiency. The prevalence of complex household structures such as extended and polygamous households complicates the bargaining process due to the presence of multiple decision-makers with varying levels of bargaining power (Duflo, 2003, Delpierre et al., 2019) living room to social norms to govern most of the allocation of resources within households.

In the first two chapters of this thesis, I examine the issues of fairness and efficiency in intrahousehold resource allocation in developing countries through two main avenues. First, I analyze gender inequality in household members' participation in the production process, along with the subsequent disparities in the allocation of resulting resources. Second, in the context of very low levels of women's agency, I investigate whether enhancing women's bargaining power leads to greater household efficiency. Additionally, I investigate whether marginalized women with very low agency can undertake collective actions to enhance their access to resources, even if it means challenging men's interests.

More specifically, **the first chapter** titled "*Gender Inequality in Workload and Nutrition in Agricultural Households - New Insights from Activity Tracker Data in Rural Burkina Faso*," co-authored with Catherine Guirkinger, investigates the correlation between intra-household gender inequality in nutrition and workload. For this purpose, we use continuous movement data recorded over a six-month agricultural season in Burkina Faso to measure the activity levels of household members. Additionally, we measure the weight and height of household members each month to capture their nutritional status. Four main conclusions

emerge from the analysis.

First, contrary to conventional wisdom, women, on average, dedicate more time to intensive activities compared to men and have more vulnerable nutritional outcomes. Second, the household structure matters: in extended households, women not only spend more time in intense activities but also experience lower and more vulnerable nutrition outcomes compared to men. Conversely, in nuclear households, minimal gender differences are observed in both nutrition and workload. Third, women with low bargaining power work more than men and exhibit poorer nutritional outcomes. Finally and alarmingly, hard-working women also face greater nutritional vulnerability during periods of food scarcity. We posit that women's lower bargaining power restricts their access to nutritional resources and limits their ability to negotiate reduced workloads. These findings imply that women with limited bargaining power should be prioritized in development programs, as they face greater vulnerability in nutrition. This vulnerability could lead to nutritional poverty traps, particularly since these women are the primary producers in households.

The second chapter, titled *"Cooperation in Polygamous Households. Experimental Evidence from Northern Benin*," co-authored with Catherine Guirkinger, explores the effect of empowering wives in polygamous households on cooperation and efficiency. Furthermore, we investigate whether wives cooperate (even at the expense of the husband) when mutual interests are at stake, particularly in a context where women have limited agency. To address these inquiries, we invited monogamous and polygamous couples from rural Benin to participate in lab-in-the-field games to elicit their levels of cooperation under various circumstances.

Our findings indicate that co-wives with low levels of agency are more inclined to cooperate with each other than with their husbands when mutual interests are at stake. Moreover, they are more likely to unite to safeguard their mutual interests, even if it comes at the expense of their husbands' interests. Furthermore, increasing wives' participation in decision-making leads to a greater willingness to cooperate and improves household efficiency. These results challenge the belief that rivalry and competition among wives are the main barriers to cooperation in polygamous households. Instead, they suggest that the low agency of

women in such households is a key factor limiting cooperation. Interventions aimed at fostering mutual interests among co-wives and promoting a participatory approach to managing collective resources in polygamous households are likely to enhance the overall welfare of these households.

The third chapter, titled *"Are American Women More Deprived than Men?"* explores gender inequalities in deprivation at a more aggregate level, focusing on the United States. In this country, women have lower wages than men and experience higher rates of income poverty. The trend towards singlehood among women has significantly contributed to the persistence of female poverty despite the country's enduring economic performance (Hoynes et al., 2006; Snipp & Cheung, 2016). At the same time, women experience lower mortality rates than men living approximately five years longer (Arias & Xu, 2020).

Studies on poverty and mortality in the US have evolved independently, often overlooking the fact that premature mortality can be considered as an extreme form of deprivation. This oversight can lead to what is known as "the mortality paradox," wherein higher mortality rates artificially decrease poverty rates among living populations as the poor are more likely to die prematurely (Lefebvre et al., 2013). The effect of poverty masking mortality becomes more concerning when one group is better off in one dimension and worse off in another as is the case of gender differences in the US.

Given the divergent outcomes for women compared to men regarding the two dimensions of deprivation (poverty and mortality) in the United States, the subsequent question arises: which gender group is the most deprived when we consider both poverty and mortality? To answer this question, I combine mortality and poverty data as components of total deprivation using the Generated Deprivation Index, newly proposed by Baland et al. (2021), and assess deprivation across genders. This index helps to provide a comprehensive picture of deprivation, enabling accurate comparisons over time and across groups and facilitating a better evaluation of development objectives such as the Sustainable Development Goals. While investigating the causes of these observed facts is crucial for decision-makers, my focus in this chapter remains on the gross gender differences in outcomes rather than on their underlying causes.

The findings indicate that since the 1990s, men and women have experienced similar total deprivation rates in the United States, whereas before this period, men were more deprived. The large decline in mortality rates among men, coupled with stagnant progress in poverty rates among women, has resulted in comparable total deprivation rates across genders. However, this general picture hides important racial differences. In minority groups (Blacks and Hispanics), women face higher levels of deprivation compared to men, despite their mortality advantage. Conversely, among the majority group (non-Hispanic whites), women exhibit a relative advantage in total deprivation compared to men. The analyses also suggest that women in minority groups accumulate race and gender penalties in a non-additive manner. Hence, development programs should prioritize women in minority groups who experience high deprivation rates across multiple dimensions.

Chapter 1

Gender Inequality in Workload and Nutrition in Agricultural Households - New Insights from Activity Tracker Data in Rural Burkina Faso

Joint with Catherine Guirkinger[0]

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Abstract

This study explores intrahousehold gender inequality in effort and its link with nutritional disparities in rural North Burkina Faso. Using six months of continuous activity tracker data, we objectively measured the effort level of 159 individuals, and complemented this data with monthly anthropometric measures and surveys. Four key findings emerge from the analysis of this data. First and contrary to conventional wisdom, activity tracker records reveal that women work more intensively than men: not only do they dedicate more hours to physical activities but the intensity of effort is higher. Second, household structure matters; in nuclear households, there is less gender disparity in effort and nutrition (and in their fluctuation over the season) than in extended households. Furthermore, there is a negative correlation between the household female to male effort ratio and the household female to male BMI ratio (and it is especially strong in extended households). This finding is consistent with a simple model of intrahousehold allocation of effort and nutrition, where household members with lower bargaining power tend to work relatively more and consume relatively less, resulting in lower nutritional outcomes. Finally and worryingly, women are at a stronger disadvantage in nutritional status, in particular in periods of food scarcity and in households where they bear a larger share of physical work.

1.1 Introduction

The investigation of the relationship between women's labor share in agriculture and the pattern of resource allocation across gender has a long history in social sciences in general (Boserup, 1970; Goody & Buckley, 1973) and in economics in particular (A. Sen, 1987; Pitt et al., 1990). For example, women's (lack of) productive role in agriculture has been shown to have left enduring impacts on gender norms and values. In a very influential paper, Alesina et al. (2013) test Boserup's hypothesis regarding the lesser equal gender norms in groups that adopted the plough and find strong support even among migrants from these groups in the USA.[1] Turning to the allocation of resources within household, the first explanation for gender inequality in access to food relies on a "*life-boat logic*" whereby men receive priority in access to food because they exert more physical work (Stiglitz, 1976, Pitt et al., 1990; see also Chapter 8 in Ray, 1998). An alternative explanation is based on a bargaining power mechanism: those with lower bargaining power in collective decisions receive a lower share of collective resources (such as food).

In this paper, we investigate the allocation of workload and nutrition across men and women in farming households, making use of exceptional data on physical labor. Our context is that of hoe agriculture, where women play a prominent role in production. We explore whether women being in charge of an important workload is associated with better access to nutrition, as would be expected if priority is given to the more active workers or if, within subsistence households, a more important share of physical labor helps secure a larger share of collective resources. The opposite would occur if bearing a disproportionate share of the workload reflects a lower bargaining position which also translates into a lower access to resources.

Our data on labor effort is based on the measurement of activity

[1] The stated rationale is that plow farming requires more upper body strength than hoe farming, for which men have a larger comparative advantage. In addition, the use of the plough decreases the need for weeding (a woman's task). As a result, men specialized in working outside of the house while women stayed inside the house and today, values and norms in these groups reflect less equal gender attitudes and behavior. In contrast in groups practicing hoe farming, which is the case in most of sub-Saharan Africa, the productive role of women outside the house is larger, translating into a more favorable position in their societies.

by fitness trackers. In particular, we collected exceptional effort levels using activity trackers for 159 men and women continuously throughout an agricultural season (6 months), among rural households living in a malnutrition-prone area of Burkina Faso. In addition, we conducted monthly surveys to measure nutritional status (weights and heights) and collect more traditional recall information on labor applications of household members. These households were randomly selected from a larger sample for which we collected objective measures of nutritional status five times over the course of the three years preceding the activity trackers' data collection. This data helps to address a major limitation of the existing literature which is the measurement of labor efforts. Indeed, recall information on labor is fraught with biases (Arthi et al., 2018; Beegle et al., 2012), and gender norms may lead to gender-specific biases, rendering the comparison of patterns for men and women, particularly problematic.

We confirm that women are very active to the point that they exert more physical effort than men, throughout the agricultural season. Surprisingly, this is the case even when we focus on very intensive levels of effort (contradicting the conventional wisdom that men specialize in vigorous tasks that require more physical power). The contrast between women's and men's effort load is particularly striking in extended households. Furthermore, the ratio of women to men's effort load is negatively correlated with the ratio of women to men's nutritional status (measured by body mass index), both across households and within households across months (in particular in the case of extended households). We show that this negative correlation between effort ratios and nutrition ratios is compatible with a bargaining framework where high effort and low nutrition both result from a relatively low bargaining position of women. More worryingly, we find that women are at a stronger disadvantage in nutritional status in times of food shortage, in particular when they carry a high workload relative to men.

We contribute to several strands of the literature. First, we contribute to the literature on the relationships between women's contribution to household labor and their access to vital resources (here nutrition). While there is a large literature investigating the impacts of maternal labor implication on child nutrition, there are few systematic

investigations of the relationship between women's labor and their own health and nutrition (Schultz, 2001; Higgins & Alderman, 1997; Komatsu et al., 2019; Picchioni et al., 2020, Rao & Raju, 2020). We find results that are consistent with Higgins & Alderman (1997)'s evidence from Ghana, Komatsu et al. (2019) from Tanzania, and Rao & Raju (2020) for India to the extent that, individuals who work more are more exposed to nutritional deficiencies compared to others (more in years of large negative shocks like drought).

More broadly we contribute to a large literature on the determinants of intra-household inequalities in access to resources. Based on individual data on nutrition and food consumption from Bangladesh and the structural estimation of a collective household model, Brown et al. (2021) show a substantial level of intra-household inequalities in the consumption of food, with women being systematically more likely to be undernourished. With the same data, D'Souza & Tandon (2019) explore the determinants of intrahousehold inequality in access to food. They conclude that gender inequality cannot be explained by higher energy requirements for men or "a return to brawn" but that, instead, women's empowerment plays a decisive role.

Finally, we contribute to a small but growing literature that makes use of activity trackers in rural areas of developing countries to answer economic questions. Picchioni et al. (2020) analysis of activity trackers data in India and Nepal, reveals that women have higher physical activity levels than men, yet, in contrast to us, they find that differences are not statistically significant, and they find that the higher activity level is the result of "long hours spent in habitual light / moderate intensity tasks as opposed to short bursts of intense physical activity". This stands in stark contrast with our finding that women spend more time in intense physical activities than men all along the agricultural cycle. Using data from the same project as Picchioni et al. (2020), Srinivasan et al. (2020) investigate whether the substitution of less intense for more intense activities (drudgery reduction) can improve the nutrition of men and women. They conclude that women would disproportionally benefit from drudgery reduction. Consistent with our simple model, Friedman et al. (2023) found that, in Malawi, within households, the difference in effort is positively correlated with intra-household differences in bar-

gaining power, proxied by husband-wife gaps in age and land ownership. The originality of our study is that we equipped participants with an activity tracker continuously for several months (existing studies never cover more than one or two weeks at a time, and never continuously, including when in contact with water), allowing a deeper investigation of the differences in seasonal patterns of labour across genders.

The remainder of this paper is organized as follows. In Section 1.2, we discuss the measurement of labour in the literature and present our data. In Section 1.3, we describe the gendered patterns of physical labour and nutrition across the agricultural season. In Section 1.4, we investigate the intrahousehold allocation of labour and nutrition, staring with a simple bargaining model and turning then to empirical correlations. Section 1.5 concludes.

1.2 Measures, Data and Descriptive Statistics

1.2.1 The measurement of physical labour and it intensity in the literature

Several studies have been conducted to measure labour and its intensity. Three groups can be distinguished: the first relies on reported data from household surveys, the second uses sophisticated objective measures to capture energy expenditure, and the third uses movement data. In the first approach, individuals are asked to recall detailed information on the type and duration of activity they have performed in the recent past. A certain number of studies have questioned the quality of recall data, especially in agriculture. In the early seventies, Sudman & Bradburn (1974) showed in a literature review exercise that reported information is often subject to recall bias, which is influenced by the nature of the event, and the timing between the event and reporting. More recently, Conway et al. (2002) and Arthi et al. (2018) provided empirical evidence supporting recall bias in reporting the duration and intensity of labor in agriculture. Collectively, these studies underscore the imperative of using objective measures of labor to enhance accuracy and reliability.

In the biological literature, Dufour & Piperata (2008) listed 26 studies from 1965 to 2007 that used objective measures to capture physical

activity levels (PAL)[2] in farming populations of developing countries. The determination of PAL requires information on energy expenditure estimated with costly and time-consuming protocols on small samples of highly selected individuals.[3]

In the economic literature, much simpler technologies have started to be used to capture energy expenditure on relatively large samples. Srinivasan et al. (2020) and Zanello et al. (2020) used wearable accelerometry devices to record movement data which were converted into energy expenditure. The simplicity of this accelerometer-based approach allows it to be a real alternative to the gold standard method (Doubly Labeled Water). While there is no doubt about the ability of accelerometers to capture movement, recent findings in the medical literature suggest serious bias in algorithms used to convert movement data into energy expenditure. For instance, Gastin et al. (2018) showed that these algorithms (ActiGraph GT3X+ and BodyMedia SWA) provide invalid estimates when the intensity of movement is high or intermittent.[4] In addition, O'Driscoll et al. (2020) proved that the accuracy of estimates of energy expenditure from wearable devices dependent largely on the type of activity performed.[5]

[2]The physical activity level corrects the total energy expenditure for body sizes and can then be used for comparison

[3]For example, the Doubly Labeled Water (DLW), which is viewed as the most reliable method, is an isotope dilution technique where people receive an oral administration of isotopes of oxygen and hydrogen whose elimination is regularly tracked by the analysis of urine samples (during 12-14 days). Other techniques include the Heart Rate Monitoring (HRM) method which estimates energy expenditure from one-day heart rate records and oxygen consumption. The factorial method (Fact) exploits information on energy cost measured by respiratory exchange and activity diary (record of type and duration of activities performed) to measure energy expenditure.

[4]This study compared energy expenditure derived from the actigraph algorithm and that from calorimetry. The results indicate that the energy expenditure of free-living tasks like walking is over-estimated whilst that of high intensive activities (running, etc) is underestimated

[5]The implication of this finding for gender comparisons is that since men and women typically engage in different activities, gender-specific biases should be expected when converting movement data into energy expenditure.

1.2.2 Data: effort and nutrition

The data were collected from a representative sample of households in 14 villages in northern Burkina Faso. These households were initially part of a larger panel survey conducted between 2011 and 2013 to evaluate the impact of a food security intervention (Gross et al., 2020). Sixty-four households were selected randomly to be part of the monthly survey and the continuous collection of activity data from May to October 2016. These months concentrate agricultural on activities in rural northern Burkina Faso. The agricultural activities associated with the main products (Rice, Maize, Sorghum, Millet, Maize, Yam, and Cassava) in the region are the following (FEWSnet, 2010): (1) Land preparation in April and May, (2) sowing in June and July, (3) crop maintenance in August and September, and (4) harvesting in October and November.

In each household, the household head, his wife, and one randomly selected adult were invited to be part of the activity-track sub-sample.[6] In total 159 individuals participated in the activity tracking sample. In addition to wearing the activity tracker, they answered a monthly survey and were, on this occasion, weighted and measured following WHO standards. In the survey, individuals self-reported the duration and intensity of tasks they performed, including domestic chores, agricultural activities, and work outside the household. Specifically, respondents were asked to indicate the strenuousness of the activities they engaged in over the last seven days and the duration of each activity (see more details in Section 1.B in the appendix). In total, we have 672 individual-month observations[7] of activity tracking, time use, and anthropometric measures.

To record physical activity we used a fitness tracker device ("Moov Now") that is worn on the wrist. We identified this tracker as the most appropriate for our research because (1) it is very robust and waterproof (designed for boxing and swimming); (2) it includes a battery that holds for continuous use over a two-month period; (3) it does not include a

[6] For details about selection, see Section 1.C in appendix. Individuals included in the sample are similar to other individuals on a large number of observed characteristics (Figure 1.C.1 in appendix). In addition, we do not observe specific reported effort or nutrition behaviors in the activity track subsample. This allows us to rule out potential experimental psychological effects.

[7] For details about sampling, see Section 1.C in the appendix.

display or any switch; (4) reviews that compared this tracker to other commercial devices were excellent; (5) it was relatively cheap. We contacted the firm who designed the device and they agreed to develop a specific application for us to be able to download the data during our monthly visit, without relying on the internet (that was not available in the survey area).

An activity tracker like Moov Now measures acceleration which relates to the change in velocity of the wrist. It is an indicator of the intensity of a physical activity with higher acceleration being associated with more vigorous activities. Because the device measures acceleration several times per minute, it also estimates the duration of the activity (Zanello et al., 2020). We obtained a measure of activity intensity every 20 seconds on a scale from 0 to 121. Using bins of 10, we aggregate this data into an average number of hours per day spent in each of 13 possible levels of activity by each individual over the 30 days preceding the survey.

What does the intensity of activity (not) measure?

1.2.2.0.1 Energy expenditure? The intensity and length of a physical activity positively correlate with energy expenditure. Yet total energy expenditure also depends on individual characteristics such as gender, age, or body mass index. The algorithms used by commercial activity trackers to convert activity into calories are proprietary and have been shown to be only moderately reliable when compared to accurate measurements of energy expenditure (Gastin et al., 2018). In any case, we did not obtain the conversion of activity in caloric expenditure using the Moov Now algorithm.[8]

1.2.2.0.2 All physical activities? A key question is whether an activity tracker adequately measures the intensity of activities typically performed by manual farmers. Activity trackers are accurate at measuring the intensity of activities that require accelerations (Hills et al.,

[8]Researchers have used standard formulas to convert acceleration into energy expenditure, with BMI as the only other input, yet such formula cannot be readily applied using the aggregated data we retrieved from our device. Furthermore, the accuracy of the formula is debatable (Zanello et al., 2020).

2014), which is the case of manual agriculture or most household chores. Activities less adequately measured include slow activities that require strength (Hills et al., 2014) - such as carrying water on one's head. Because women are typically in charge of carrying water and other heavy loads, we believe that the device may underestimate the intensity of women's activity more than that of men.

1.2.2.0.3 Labour? If we are to compare intensities of activity across individuals to infer something about the intrahousehold allocation of labour, a natural question is whether when two people perform a task with the same intensity, they reach the same outcome in terms of labour. Let's take the example of hoeing a field. By measuring acceleration, the tracker provides an adequate measure of the intensity of effort applied by an individual (Hills et al., 2014). Yet the result of this acceleration on hoeing may differ across individuals, in particular, because the force applied by the hoe on the ground is a product of acceleration and mass (as stated by the second law of Newton). Because men are at an advantage in terms of mass, the force they apply for a given acceleration is typically larger. In fact, the advantage of men in terms of physical strength is a classic argument for labour specialization and the reason why we typically expect men to perform the most vigorous activities. In short, trackers inform us about the intensity of activities, yet the outcome in terms of labour performed may vary across individuals (with men being most likely at an advantage for physical tasks where strength is important).

1.2.3 Descriptive statistics

Table 1.1 presents the main time-invariant characteristics of the sample by gender (panel 1) or household structure (Panels 2 and 3). In terms of household structure, we distinguish between nuclear and extended households where extended households refer to households hosting more than one married man.[9] Moreover, a household is classified as polygamous if the head has at least two wives. Our definition of household

[9]Married men may be from different generations, typically a father and a son (vertically extended households) or from the same generation, typically two brothers (horizontally extended households).

extension implies that men of both nuclear and extended households may be polygamous (in fact the share of polygamous men is very high at 59% and not significantly different by household structure). In an extended household, the structure of power is typically more vertical than in nuclear households where there are more bilateral discussions (M. Sen et al., 2006, Jayaraman & Khan, 2023, Mookerjee, 2019).[10]

In our sample we have 60% (95) of women, two-thirds of them being the wife of the household and 15% daughters-in-law. Fifty-eight percent of men are household heads and 34% are sons of the head. Mechanically, a larger share of men are household heads and a larger share of women are wives of the head in nuclear households than in extended ones. This implies that individuals from nuclear families likely engage more in bilateral bargaining than those from extended families. Sampled men and women have similar age and education levels, with more than 72% of individuals having not attended formal school.

The characteristics of nuclear and extended households are remarkably similar in terms of ethnicity, religion, type of marriage, or size of the collective field. One notable difference is that the size of extended households is larger than that of the nuclear, with 6 more members on average. Thinking about labour allocation, it is not clear a priori whether women from extended households would be more or less active than women from nuclear households. On the one hand, economies of scale may work in their favor (in a context where land cultivated per capita is similar across household structures and chores may be shared). On the other hand, they may have less bargaining power due to the more vertical structure of authority, making it hard to negotiate lower workloads.

[10]In extended households, decision-making involves a multitude of individuals, leading to a more complex bargaining process. Consequently, these households often rely on established social norms to guide intra-household behaviors. In contrast, nuclear households offer a simpler structure, facilitating bilateral bargaining between spouses for the allocation of resources.

Table 1.1: Sample Characteristics and Family Structure

INDIVIDUAL CHARACTERISTICS BY GENDER	**All**	**Women**	**Men**	**Difference**
=1 if Male	0.40			
Age (years)	38.80	37.40	40.87	-3.47
=1 if went to school	0.28	0.23	0.34	-0.11
Number of Individuals	159	95	64	31.00
HOUSEHOLD CHARACTERISTICS BY TYPE		**Nuclear Household**	**Extended Household**	
=1 if Extended Household	0.39			
=1 if polygamous Household	0.59	0.56	0.64	-0.08
Household Size	11.33	9.05	14.88	-5.83***
=1 if Mossi	0.80	0.82	0.76	0.06
=1 if Muslim	0.86	0.87	0.84	0.03
Size of collective field (hectare per capita)	0.30	0.29	0.32	-0.02
=1 if marriage arranged by parents	0.82	0.87	0.74	0.13
INDIVIDUAL CHARACTERISTICS BY TYPE		**Nuclear Household**	**Extended Household**	
Number of Women	95	55	40	
Relation to the head				
Head	0.03	0.05	0.00	
Wife	0.67	0.80	0.50	
Daughter	0.09	0.11	0.07	
Daughter in Law	0.15	0.00	0.35	
Others	0.05	0.04	0.07	
Number of men	64	40	24	
Relation to the heead				
Head	0.58	0.68	0.42	
Son	0.34	0.28	0.46	
Others	0.08	0.05	0.13	
Number of households	64	39	25	
Number of months in the sample		4.26	4.17	

Note: This table presents the main sample characteristics by gender and household structure. Extended households refers to households hosting more than one married man. Otherwise, the household is considered as nuclear. The fourth column displays the difference in means. */**/*** means that the difference is statistically significant at 10%/5%/1%

1.3 Gendered patterns of physical labour and nutrition across an agricultural season

1.3.1 Descriptive Statistics

Table 1.2 presents, on the one hand, the number of measured daily effort hours by the activity tracker and the nutrition parameters of individuals on the other hand. In parallel, Figure 1.1 introduces the gender differences in daily hours spent at each intensity level, whereas Figure 1.2 highlights the cumulative distribution of exertion parameters. We begin by commenting on the general pattern of effort and nutrition indicators and then explore the gender difference.

Regarding nutrition, the average Body Mass Index is one unit lower than the national average (22kg/m2),[11] and 16% of adults are under-

[11] https://iris.who.int/bitstream/handle/10665/148114/9789241564854_eng.pdf

Table 1.2: Effort (Daily Hours) and Nutrition Indicators

Variable	All	Means		Difference
		Women	Men	Women-Men
	(1)	(2)	(3)	(4)
Activity Tracker				
Daily mean (intensity level)	3.58	3.64	3.49	0.16***
Sleep	8.70	8.51	9.00	-0.49
Not Intense	4.83	4.42	5.44	-1.02***
Moderate Intense	3.03	3.10	2.93	0.17*
Intense	4.07	4.42	3.54	0.88***
Very Intense	3.33	3.49	3.09	0.41***
Intense and Very Intense	7.40	7.91	6.63	1.29***
Reported hours				
Strenuous and very strenuous	2.35	2.72	1.80	0.92***
Sleep	7.54	7.63	7.41	0.22***
Reported Activity				
Agriculture	1.09	1.04	1.17	-0.13
Domestic	1.16	1.70	0.35	1.35***
Livestock	0.23	0.09	0.44	-0.35***
Nutrition				
BMI	20.84	20.88	20.77	0.10
=1 if undernourished	0.16	0.16	0.17	-0.02
Weight (KG)	56.88	53.67	61.59	-7.92***
Height (CM)	164.87	160.13	171.87	-11.74***
N	672	405	267	

Note: The column (1) to (3) present the averages of nutrition and effort indicators for all individuals and by gender. The effort indicators are averages of daily hours (reported and measured) spent in each intensity level over the last 7 days prior to the survey. The variable Daily mean is the average daily intensity level (maximum 13). The column (4) presents gender differences (Women-Men) for all the variables. The significance associated to the differences results from the test of equality of men's and women's means. */**/*** means the difference is significant at 10%/5%/1%.

nourished (BMI less than 18.5). The average height is 164.9 cm, which

is 2 cm lower than the national average.[12] The descriptive analysis of effort measures reveals that respondents sleep an average of 8 hours and 40 minutes per day, and they are on the move for 15 hours and 20 minutes. They perform intense and very intense activities for half of their non-sedentary time (we clarify the definition of intensity in the next paragraph) implying that most of the work time is devoted to energy-intensive tasks.[13]

Figure 1.1 considers seven levels of intensity[14] of the activity tracker to plot the gender differences in effort. A general pattern is that men spend more hours in the lowest intensity levels (2, and 3), while women spend more hours in the highest intensity levels (4 and above). In summary, Figure 1.1 shows that women rest for a significantly shorter time and that the intensity of their effort is higher than that of men. As shown on the left panel of Figure 1.2, the distribution of effort intensity of women first-order stochastically dominates that of men. The total share of women in the highest intensity levels is always greater than that of men. For the rest of the analyses, we group hours spent in each intensity level into five categories in the following way: 2-Sleeping hours 3-Not intense, 4-Moderate, 5-Intense, and 6-13- Very intense.[15] Women's first-order stochastic dominance is even greater when focusing on hours spent in intense and very intense activities as highlighted in the right panel of Figure 1.2: the distance between the cumulative distribution of men and women becomes larger.

In the same line, Table 1.2 (columns 2 to 4) indicates that women spend 77 minutes more than men in intense and very intense activities. The gender difference is the highest in intense activities (52 minutes) compared to very intense (25 minutes). To explore the type of activities people are involved in, we rely on reported data. In general, agriculture and domestic chores are the main activities in the study area (livestock being marginal). Looking at the gender difference, while there is no

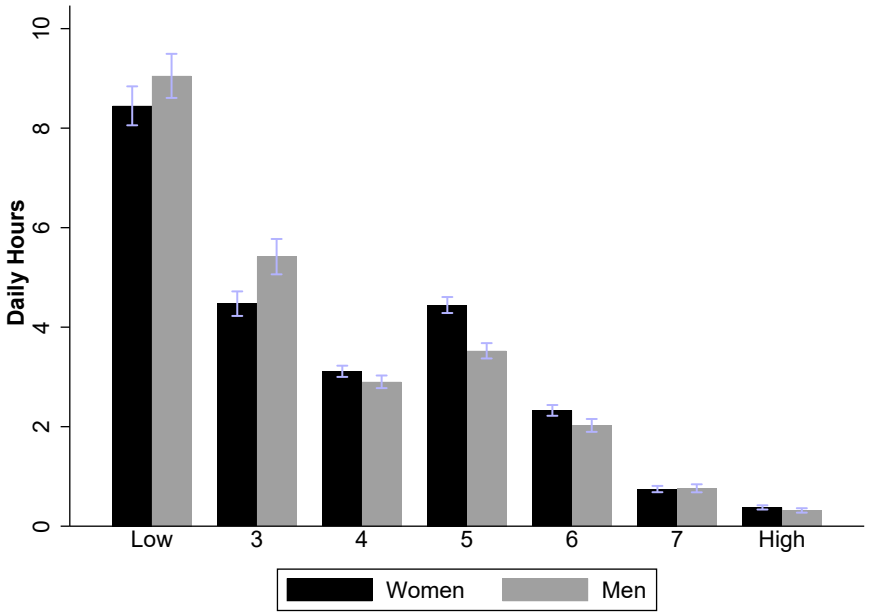
[12] https://worldpopulationreview.com/country-rankings/average-height-by-country

[13] Agricultural and domestic activities are reported to be the most time-consuming.

[14] Given the limited number of hours spent at an intensity level above 8, we aggregate the upper bound of the scale. Additionally, level 1 corresponds to complete sedentarization, which was not observed. Initially, there were 13 intensity levels.

[15] For a better understanding of this classification, intense activity corresponds to the level of physical effort a fit man exerts when playing intensive tennis for one hour

Figure 1.1: Daily effort hours by gender

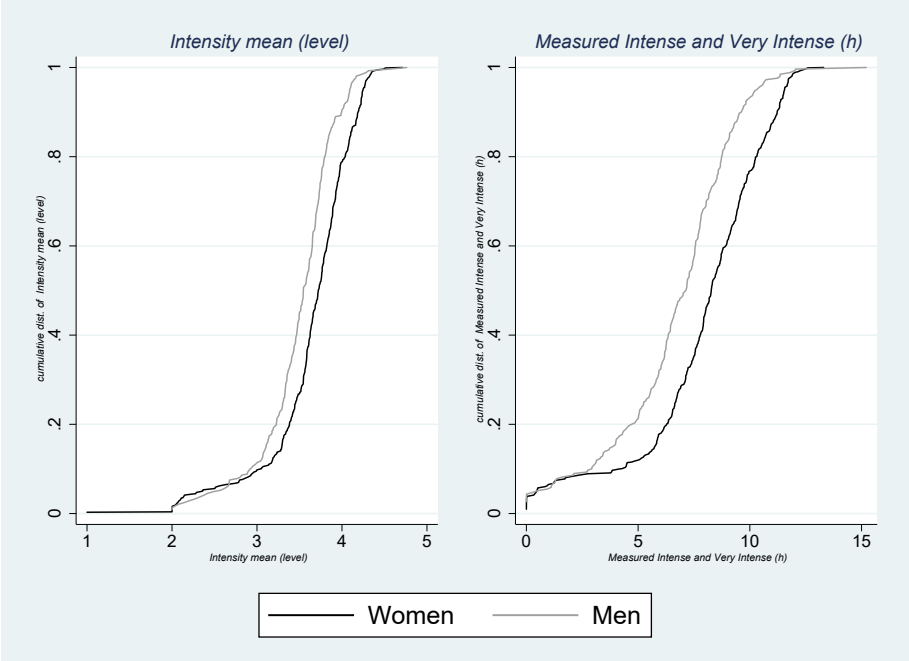


Note: This figure presents, by gender, the average number of daily hours spent in each activity tracker intensity level over the last 7 days prior to the survey. No control is included.

difference in reported working hours in agriculture, women are far more involved than men in domestic chores (in which they spend 83 minutes more than men).

Comparing reported time use and objective effort information is easiest for sleep: sleep detection is easy with the activity tracker and we asked respondents about their average daily sleep duration over the past seven days. Compared to survey responses, the activity trackers record about one additional hour of sleep for women and more than 1.5 hours for men. The discrepancy is not necessarily surprising: people rest sometimes during the day, and they may not declare it as sleep, although the tracker records no movement. Yet the two sources of information draw a different picture of gender differences: women declare sleeping significantly more than men (by about 13 min), yet the objective effort measure suggests that men rest more than women (by about 26 min), even if the difference is not statistically significant.

Figure 1.2: Cumulative distribution of effort by gender



Note: These figures present the cumulative distribution of daily effort level on one hand and the number of hours spent daily in intense and very activities on the other hand.

Reading: (all are averages on a daily basis)

Intensity mean: what is the level of intensity (out of 13) at which effort was exerted every 20 seconds?

Intense and very intense: how many hours (out of 24) were spent in intense and very intense activities ?

The detailed comparison of our reported data on time spent in a list of activities with activity tracker data is more difficult because there are many activities we do not capture in the reported data (time spent walking for example). Furthermore, it appears that we capture only a small fraction of activities with our questionnaire because the total time spent in these activities only amounts to about 2.5 hours, while time spent in intense and very intense activities according to the tracker reaches almost 7.5 hours. This could be related to the fact that our respondents simply do not keep track of time and find it hard to assess the duration of each activity. Also, we suspect that sometimes they chose to declare not having performed a given activity to avoid further questions. We regret not having used a classic time-use questionnaire

recording hour by hour every activity. It is nevertheless interesting to observe the gender pattern in the declared level of strenuous and very strenuous activities (those who reported that the performed activities were tiresome and very tiresome on the questions in Section 1.B). Men declare spending 55 fewer minutes on average in such activities and the difference across gender is statistically significant. This is in line with the measured level of activity: the distribution reported in Figure 1.1 reveals that regardless of where we would reasonably put the cut-off between moderately intense and intense activities, women would appear more active (and the difference is significant).

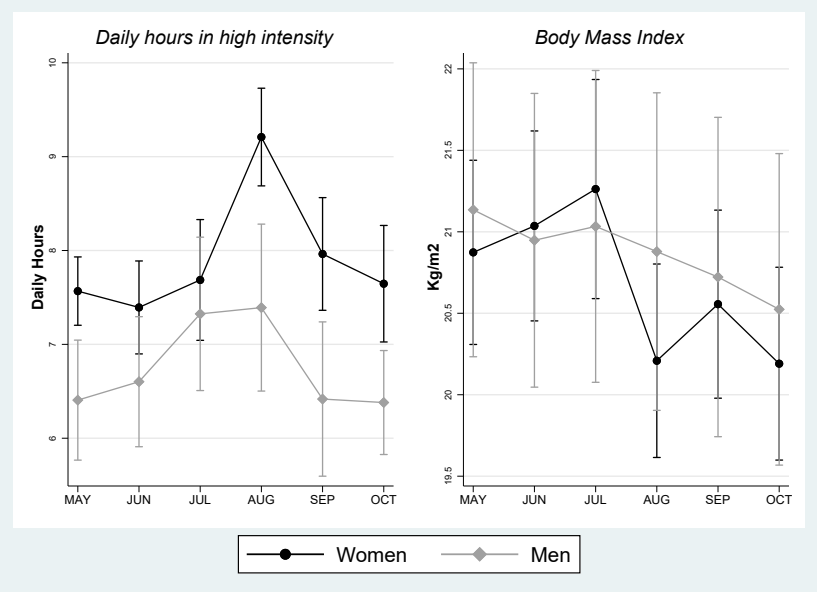
1.3.2 Seasonal pattern

Figure 1.3 displays the hours spent in high (intense and very intense) intense activities (left panel) and the levels of body mass index (right panel) month by month and separately for men and women.

It is striking that in all months, women are more active than men, with a difference in hours worked in highly intense activities of more than 2 hours in August (and never less than one hour). August coincides with the beginning of harvest for some crops and the weeding of other crops. This is in line with the traditional pattern of agricultural labour allocation where women are particularly solicited for weeding and harvesting. Furthermore, apart from consistently exerting more effort throughout the year, women seem to face more pronounced seasonal variations in labor. Specifically, women experience a 1.8-hour difference between peak and lowest activity months, while men's fluctuation is less than one hour. For a more detailed view, Figure 1.A.1 in the appendix illustrates, in the left panel, the seasonal variation in effort intensity levels categorized by gender. This figure confirms that women are more active than men throughout the agricultural season.

In addition, Figure 1.3 displays on the right panel the BMI levels for men and women over the course of the agricultural season. Levels are rather similar across genders, with a trend that is decreasing over the season (even if for women there is a slight increase initially). Yet women appear again more sensitive to seasonal variation as they experience more fluctuation in their BMI. The lowest BMI levels for women are observed in August, coinciding with the peak of physical effort. To pro-

Figure 1.3: Seasonal variation of effort (Intense and Very Intense) and nutrition (BMI)



Note: These figures report by gender the seasonal variation of daily hours spent in Intense and very intense activity; as well as the variation of the Body Mass Index. They report predicted margins of the OLS estimation of the following equation: $Y_i = \alpha * Male_i + \beta * Month_t + \delta * Month_t * Male_i + \theta * X_i + \varepsilon_i$. with Y the outcome variables (BMI and hours spent in intense and very intense activities). The vector X include controls (Age, household size, ethnic group, religion, education and relation to the head of the household). Standard errors are clustered at the household level

vide additional insights, the right panel of Figure 1.A.1 in the appendix shifts focus to weight. It is evident from this panel that women tend to lose more weight during months of increased activity, even though they start with a lower initial weight (and may therefore be expected to fluctuate less).

These seasonal patterns in women's BMI are further confirmed at a larger scale using Burkina Faso DHS surveys of 2003, 2010, and 2021. Figure 1.A.3 in the appendix presents the average women's BMI by month of survey (assuming no selection in months) and clearly shows that women's nutritional outcomes are lower during periods of intense agricultural activities (July, August, and September). Unfortunately, the DHS data lack anthropometric measurements for men, thereby pre-

venting us from making gender comparisons.

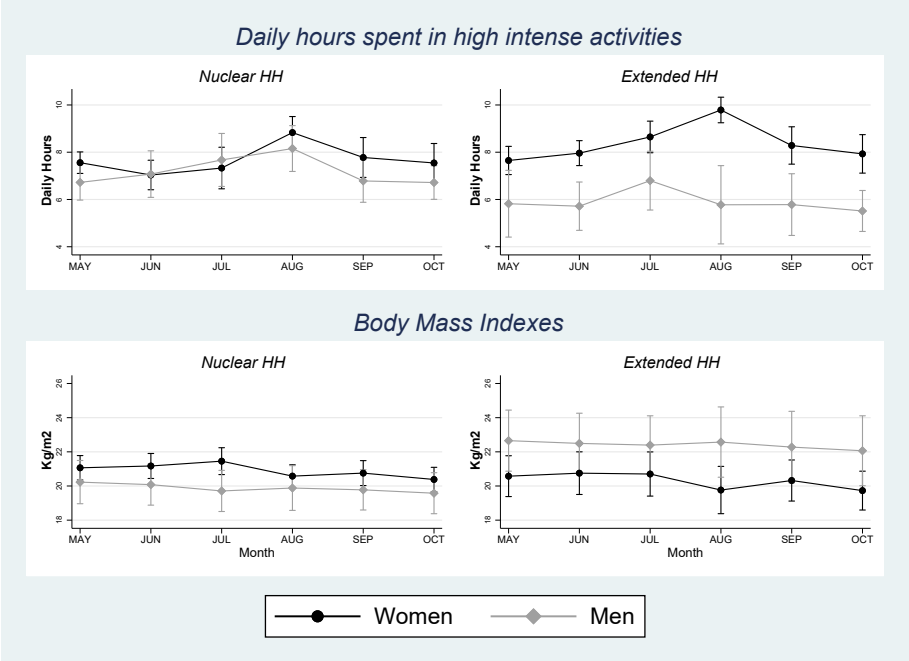
1.3.3 Household structure and gender differences

The bargaining position of women within households may affect their access to nutrition and workload allocation. Existing literature suggests that women in extended households experience a weaker bargaining position in decision-making due to the vertical power structure (M. Sen et al., 2006, Debnath, 2015). In these households, where women commonly co-reside with their in-laws, power dynamics often result in limited influence over household decisions. Consequently, bilateral bargaining between spouses regarding resource allocation and tasks is rare, as social norms—often biased against women—tend to govern intra-household decisions. Unfortunately, we did not collect data on women's bargaining power or involvement in decision making. We can however explore the correlation between household structure and women's agency using DHS data. Burkina Faso DHS data (2021) suggest a negative correlation between several indicators of women's agency and living in extended households (see Table 1.A.1 in appendix). Additionally, two other variables—polygamy and wives' education—are correlated with indicators of agency (negative correlation with polygamy and positive correlation with women's education).

Motivated by these observations, we delve into the heterogeneity regarding household structure. We start by breaking the sample between extended and non-extended households. The gendered patterns of effort and nutrition present stark differences across the two types of households. Figure 1.4 reveals that the difference between men's and women's intensity of effort is more pronounced in extended households. Although in nuclear households men's levels of effort are lower than women's, the difference is small and not statistically significant (the confidence intervals overlap). In contrast, in extended households, women spend in all months but July at least two hours more than men in intense and very intense levels of activities, and the difference reaches 4 hours in August.

Turning to the comparison of nutrition across household types, we observe no significant differences in levels of BMI across genders, yet the difference between men's and women's nutrition over the season flips sign between nuclear and extended households: women's BMI is

Figure 1.4: Nutrition, Effort and Household Structure



Note: These figures report by gender the seasonal variation of daily hours spent in Intense and very intense activity; as well as the variation of the Body Mass Index. They report predicted margins of the OLS estimation of the following equation: $Y_i = \alpha * Male_i + \beta * Month_t + \delta * Month_t * Male_i + \theta * X_i + \varepsilon_i$. with Y the outcome variables (BMI and hours spent in intense and very intense activities). The vector X include controls (Age, household size, ethnic group, religion, education and relation to the head of the household). Standard errors are clustered at the household level.

consistently higher than men's in nuclear households while the reverse is true in extended households. Furthermore, while in the most critical month in terms of effort, August, men's and women's levels of nutrition are almost identical in nuclear households, their difference is the highest in extended households. Because confidence intervals largely overlap we cannot draw any strong conclusion from these comparisons. They are nevertheless suggestive of a relationship between women's relative contribution to strenuous activities and relative nutrition, implying that there may exist a relationship between the intrahousehold allocation of effort and nutrition. We explore more systematically this possibility in the next section.

Before moving to the next section, it is important to note that the

differential influence of household characteristics on the patterns of gender inequalities in workload and nutrition is not clearly observed when considering heterogeneity with respect to polygamy and women's education (see Figures 1.A.4 and 1.A.5 in the appendix).

1.4 Intrahousehold allocation of effort and nutrition

1.4.1 Conceptual framework

Because nutrition is an important input of physical labour, the allocation of nutrition and physical effort across household members may not be independent. In fact, as detailed in the Introduction, several authors formalized the idea that maximizing household income may require giving priority to the nutrition of the most active member(s) when they are nonlinear returns to nutrition. Otherwise, a nutritional poverty trap may emerge, whereby all members are too weak to properly work and ensure the household's future (Stiglitz, 1976; Pitt et al., 1990). This situation of increasing returns is relevant in the context of important food scarcity where resources do not suffice to cover the basic needs of all household members. However, empirical evidence supporting this life-boat logic to explain intrahousehold inequality in nutrition, especially in developing countries, remains scarce. Therefore, we propose an alternative analytical framework based on intrahousehold bargaining power.

A more pragmatic reason why some household members may be favored in their access to resources is that they have higher bargaining power (due to prevailing gender norms or other reasons) and thus secure a higher share of household resources. To the extent that there is a disutility from effort, we may, in this case, expect a negative correlation between access to resources and effort: those with relatively low bargaining power will also work more. To formalize these ideas, we lay out a very simple model of intrahousehold allocation of effort and consumption.

1.4.1.1 Preferences, households, budget and production

We assume that preferences are defined over effort and consumption and are separable: $U(c,e) = u(c) - v(e)$ with $u' > 0$, $u'' < 0$ and $v' > 0$ and $v'' > 0$.

We consider a subsistence household composed of two individuals indexed 1 and 2 who produce jointly their consumption with the production function F, with $F' > 0$ and $F'' < 0$. The budget constraint thus writes $c_1 + c_2 \leq F(e_1 + e_2)$

In order to exert a given level of effort, a minimum level of consumption is needed (to capture the idea that undernourished individuals have lower physical power so that there is an increasing return to nutrition for some ranges of consumption): $c \geq d(e)$, with $d' > 0$ (and to simplify things $d'' = 0$).

1.4.1.2 Household allocation

The household maximizes: $U_1 + \alpha U_2$, where $0 < \alpha < 1$ is the relative bargaining power of individual 2, under the following constraints:

$c_1 + c_2 = F(e_1 + e_2)$
$c_1 \geq d(e_1)$
$c_2 \geq d(e_2)$

Non-binding physical power constraints

If the physical power constraints are not binding the first order conditions imply (For more details, see Subsection 1.D.0.2 in the appendix):

$$u'(c_1) = \alpha u'(c_2) \tag{1.1}$$
$$v'(e_1) = \alpha v'(e_2) \tag{1.2}$$

Since u is concave and v convex, and $\alpha < 1$, we have $c_1 > c_2$ and $e_1 < e_2$. In other words, the individual with the lower bargaining power works more and consumes less than the individual with the higher bargaining power.

Suppose that the body mass index of an individual i, BMI_i is a positive function of consumption and a negative function of effort (for example $BMI_i = B_i(c_i) - C_i(e_i)$ with $B_i' > 0$ and $C_i' > 0$). Then an increase in α would lead to an increase in BMI_2 since it would increase

the consumption and decrease the effort of individual 2. It would have the opposite effect on the BMI of individual 1.

Binding physical power constraints

The physical power constraint is always more binding for individual 2 (since she consumes less and exert more effort). When the power constraint binds, we have (more details provided in Subsection 1.D.0.2):

$$u'(c_1) > \alpha u'(c_2) \tag{1.3}$$

$$v'(e_1) > \alpha v'(e_2) \tag{1.4}$$

In other words, the binding power constraint requires that individual 2 receives a greater share of total consumption and contributes a lower share of effort than that her bargaining power alone would imply in the absence of power constraint. It is easy to show that all other things equal, the power constraint is more likely to bind for small values of α, i.e. low levels of bargaining power for individual 2 (see Subsection 1.D.0.2 in the appendix for further details). The power constraint puts a limit on the labour that individual 1 can demand from 2 without compensation in terms of increased nutrition.

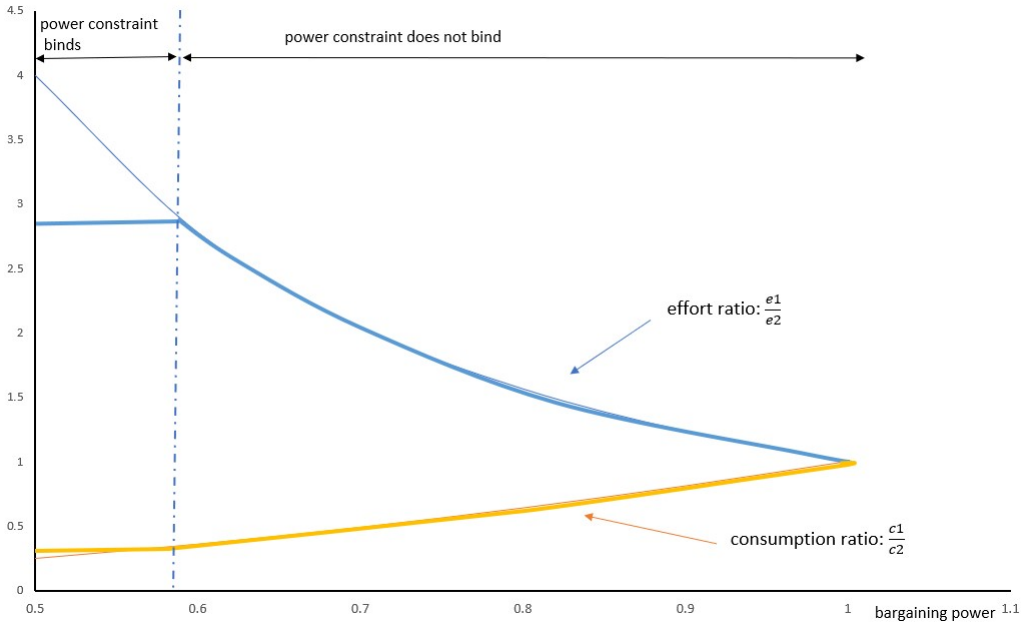
1.4.1.3 Simulation

Using specific functional forms, we solve numerically the maximization problem outlined above. We use a constant relative risk aversion function for the utility of consumption and a square root function of the disutility of effort (details are provided in Subsection 1.D.0.3 in the appendix). The graph below provides an illustration of the results obtained. It plots the ratio of effort levels and the ratio of consumption levels as a function of individual 2 relative bargaining power α. The lower the bargaining power of 2 relative to 1, the higher is the relative effort of 2 relative to 1, and the lower her relative consumption. When α falls below the level represented by the dashed line, further decreases in bargaining power do not change the ratios of consumption and effort anymore, because the power constraint binds.

This simple model illustrates the negative correlation that may exist between effort and consumption when they both result from the same

bargaining program in the household. In a household, those with low bargaining power work more and consume less. Furthermore, across households, when effort is less equally distributed, so is consumption. The fact that consumption is an input to effort when levels of nutrition are low is captured by a simple effort constraint and is shown to put a limit on the achievable level of inequality in effort and consumption.

Figure 1.5: Consumption and effort ratio as a function of bargaining power



Note: This figure is based on the numerical solving of the maximization program detailed in Subsection 1.D.0.3 in the appendix. The x-axis represents the relative bargaining power α. The thick blue (orange) curve plots the ratio of effort (consumption) across individuals. The light blue (orange) curve plots the ratio that would obtain in the absence of a power constraint

1.4.1.4 Discussion

Before turning to the empirical analysis it is important to note that we do not observe individual consumption but we observe individual BMI, which is an increasing function of food intake and a decreasing function of physical effort. Taking our model at face value, we expect the ratio of BMI to be negatively correlated with the ratio of effort both because of

the direct impact of effort on BMI and because unequal effort may reflect unequal access to other resources such as food. However, if we are in a generalized "life-boat" situation (or in a context where the work capacity constraint binds), the correlation would not be negative as those who work physically would be favored in their access to nutrition (because otherwise their work capacity decreases).

Our toy model is static yet in the context of agriculture, the workload fluctuates throughout a season. If the burden of the fluctuation is disproportionately borne by the individual with a low bargaining power, this individual may experience more variation in effort over the course of the season. The question then arises of the consequences for nutrition. If the power constraint does not bind, it is not clear that the one who bears the burden of an increased workload can negotiate enough food during months of high workload (where food is typically quite scarce) to compensate for the increased workload. In contrast, in a life-boat framework, the one who works more is given priority in terms of nutrition and may benefit from relatively favorable nutrition in months where she works hard.

Similarly, we can speculate about the consequences of food scarcity in a given year. Suppose that we consider two years. Effort in year 1 produces food for year 2, and in year 1 individuals consume a fixed budget. The correlation between effort and consumption would be obtained, as in the simple model. If, all else equal, the fixed budget would decrease (in a year of food scarcity for example), the power constraint would be more likely to be binding (first for individual 2), which, as seen above, limits the level of inequality in effort and consumption in the household. Even when the power constraint does not become binding, the FOC ($v'(c_1) = \alpha v'(c_2)$) and the concavity of the utility function implies that a decrease in total food availability would decrease the consumption of individual 1 more than that of individual 2 (in other words it would decrease the absolute consumption advantage of individual 1). Yet, if the power constraints do not bind, food scarcity should not impact the relative effort level.[16]

[16] Another way to capture food scarcity would be to make the power constraint more stringent and the same conclusion would be obtained.

1.4.2 Empirical analysis: exploring the relationship between relative nutritional outcome and relative workload

1.4.2.1 Are women exerting relatively more effort also more disadvantaged in terms of nutrition in their household?

Our simple conceptual framework illustrates how, across households, a relative effort ratio correlates with relative access to consumption when both are jointly bargained over. This correlation gets weaker if what we term "the physical power constraint" binds, that is if consumption barely covers nutritional needs to perform the required effort. This is because, in this case, more effort needs to be accompanied by greater access to food.

To investigate this correlation empirically we compute the ratio of effort for each women-men pair in each household and each month and the ratio of BMI for the same pair in each month.[17] We also have information on BMI in past survey rounds and we exploit this data to investigate the consequences of food scarcity.

We then run simple regressions of the following form (where i is a household and t a month):

$$\frac{BMI_{woman}}{BMI_{man}}_{t,\,i} = \alpha \frac{Effort_{woman}}{Effort_{men}}_{t-1,\,i} + \beta' X + \varepsilon_{i,t} \tag{1.5}$$

The vector X includes control and, depending on the specification, month or woman fixed effect. The variable $\frac{Effort_{woman}}{Effort_{men}}$ is written as lagged in the equation because the effort data was continuously recorded during the month preceding the collection of anthropometric data, mitigating the risk of reverse causality (between BMI and workload). Additionally, we control for unobserved heterogeneity that could introduce omitted variable bias by including the woman fixed effects.

Table 1.3 reports the results. We first exploit the across households variation by including month fixed effects (Column 1). As expected, we find a negative correlation between ratios of BMI and effort: when women exert relatively more effort, they have a significantly lower nutritional status relative to a man of their household. Within households,

[17] For more details about the computation of ratios, see Section 1.C in the appendix

Table 1.3: Correlations between BMI and workload ratios (woman/men)

	(1)	(2)	(3)	(4)	(5)
Effort ratio (A)	−0.007*	−0.001	0.006*	0.003	0.016***
	(0.003)	(0.001)	(0.003)	(0.002)	(0.002)
Extended HH × Effort ratio			−0.008**		
			(0.003)		
Polygamous HH × Effort ratio				−0.005**	
				(0.002)	
Wife not educated × Effort ratio					−0.018***
					(0.002)
Controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Month FE	*Yes*				
Individual FE		*Yes*	*Yes*	*Yes*	*Yes*
Coefficients A+(A × BP)			-0.002	-0.002	-0.002
Test A+(A × BP)=0 (p-val)			0.062	0.014	0.149
Mean Y	1.012	1.012	1.012	1.012	1.012
Mean Bargaining Power (BP)			0.405	0.613	0.895
Observations	213	213	213	213	213

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

Note: This table presents the correlations between ratios of BMI (woman/men) and ratios of effort across and within households (Estimation of Equation 2.1). Controls include the age, household size, whether the individual had fever in the month prior to the survey, ethnic group, religion and education. Standard errors are cluster at the household level and p-values are reported in parenthesis.

we then explore whether month by month variation in relative effort load correlates with variation in BMI, by including the woman fixed effects (Columns 2 and 3). Column 2 indicates that on average, within households, in months where women work relatively more, they do not suffer from a steeper drop in nutrition than men. Yet an interesting contrast emerges by household types: while in nuclear households those who bear the burden of a relative increase in effort benefit from a relative increase in nutrition, this is not the case in extended households, where, on the contrary, women appear to suffer from a worsening of their relative nutritional status in months where they carry more of the workload. In other words, while women in nuclear households appear somehow compensated for increased effort in some months, this is not the case in extended households, where it is as if bearing the burden of a seasonal increase in relative workload translates into a lower relative nutritional status. Similar patterns emerge when considering other proxies of women's bargaining power, such as living in polygamous households or households where the wife has no formal education.[18] These results

[18]Living in extended or polygamous households, as well as women's education levels, exhibit a negative correlation with indicators of women's agency, as illustrated in Table 1.A.1. These

are consistent with the prediction of our simple model, indicating that women with low bargaining power who allocate more time to work than men experience relatively lower nutritional outcomes.

1.4.2.2 Should we worry? Does food scarcity disproportionately affect the nutrition of women compared to men?

So far, we have shown that, within households, women who work relatively more than men tend to have lower relative nutrition outcomes. The question we take up now is whether female to male BMI ratio is affected by food scarcity. In other words, we explore whether the nutrition of women (who are more active than men) is given priority in periods of scarcity. To explore this question empirically, we rely on a measure of household-level food consumption which is the quantity of cereal prepared for meals over the past 7 days. As food diversity is extremely low and cereals are the main staple in this context, it is a good proxy for calories prepared (Gross et al., 2020). We call food scarcity the opposite of the quantity of cereals prepared per person and per day. This variable is available at the household level each month of the monthly survey in 2016 and for two survey rounds in 2011 and 2012. Harvests preceding the 2016 agricultural campaign were abundant so that most households produced enough cereals to cover their yearly needs. In contrast, 2011 was a year characterized by extreme food scarcity[19], while 2012 was relatively better.

We run two types of analysis, one exploiting the 2016 monthly survey and one where we compare the end-of-season situations in 2011, 2012, and 2016. In the former case, we can correlate both BMI and effort ratio with scarcity while in the latter case, we only have information on BMI (since we did not measure effort in 2011 and 2012). Again we run analysis with and without the woman fixed effects.

Table 1.A.2 in the appendix presents the results using the 2016 monthly survey. Columns (1) and (2) include monthly fixed effects so that the coefficient on food scarcity is identified by differences both between and within households (across months). Worryingly, the coeffi-

correlations were computed using Burkina Faso DHS Data (2021).

[19]In this year, in 72% of households, the cereal disposable per capita was not sufficient to ensure enough food for everyone throughout the year (Gross et al., 2020).

cient is strongly negative, a decrease in 0.1 kg of the quantity of cereal per person would decrease the ratio of BMI by 1.3 standard deviations.[20] This suggests that when and where less food is prepared, women tend to be more disadvantaged relative to men in terms of nutritional status. When we include the woman fixed effect, the correlation disappears, suggesting that the correlation between food scarcity and BMI ratio is driven by heterogeneity across households and not seasonal changes within households. Regarding effort ratio, the correlation is never significantly different from zero. This indicates that scarcity does not affect the allocation of effort across genders (even though women's nutrition is more negatively affected by scarcity).

Table 1.A.3 in the appendix reports the results of similar regressions when we use yearly variation in BMI and food scarcity (including a year of extreme food scarcity). Column (1) includes year fixed effects while Columns (2) to (4) include the woman fixed effects. The correlation between food scarcity and the ratio of BMI is again negative and strongly significant, even with woman fixed effects, revealing that in years of severe food shortages, women's BMI drops more than that of men. Furthermore, the effect is driven by households where, based on objective measures in 2016, the woman/man ratio of effort is above the median. This suggests that where women tend to carry more of the workload they also suffer relatively more than men from drops in BMI. This is worrying because malnutrition is high in our sample so that a loss of a couple of kilograms often means becoming malnourished (or severely malnourished) according to international standards.

1.5 Concluding remarks

On the base of exceptional measures of effort collected in agricultural households continuously over six months, we show that women work on average more than men, in particular in extended households. In these households, their effort load appears to increase also more than that of men in times of peak labour in the fields. Furthermore, their nutritional status also fluctuates more than that of men.

[20] The standard deviation in BMI ratio in the sample is 0.17, so that 0.221 translates into 1.3 standard deviations.

To properly investigate the relationship between the allocation of consumption and effort in subsistence households, we develop a simple bargaining framework. It illustrates that where women have relatively low bargaining power they may be burdened with more labour and lower consumption relative to men. To test the prediction of the model, we explore empirically the correlation between relative effort load and relative nutritional status. We find an overall negative correlation: when and where women work relatively more (compared to men) their relative nutritional status (compared to men) is worse. This correlation is even observed within woman-men pair across months in extended and polygamous households. This is consistent with the prediction of our simple model, whereby relatively lower bargaining power translates simultaneously into more workload and lower consumption.We also investigate the relationship with food scarcity and find that, worryingly, women tend to suffer relatively more from food shortages, in particular when they carry a larger share of the workload. Furthermore, effort ratios do not appear sensitive to food scarcity.

Appendix

1.A Additional Tables and Figures

Table 1.A.1: Correlation between Agency and Household characteristics (DHS, 2021)

	Health Decisions	**Purchases Decisions**	**Visits Decisions**	**Mean (1-3)**
	(1)	(2)	(3)	(4)
Extended HH	−0.02**	−0.01	−0.03***	−0.02**
	(0.01)	(0.01)	(0.01)	(0.01)
Polygamous HH	−0.06***	−0.09***	−0.09***	−0.08***
	(0.01)	(0.01)	(0.01)	(0.01)
No education	−0.31***	−0.30***	−0.20***	−0.27***
	(0.04)	(0.04)	(0.04)	(0.03)
Muslim	0.01	−0.01	0.00	−0.00
	(0.01)	(0.01)	(0.01)	(0.01)
Controls		*Yes*		
Mean Y	0.33	0.22	0.45	0.33
R-squared	0.08	0.07	0.08	0.09
Observations	12868	12868	12868	12868

Note: This table presents the correlation between Women Agency and household characteristics using Burkina Faso DHS data (2021). Decision variables in each domain (Health, large household purchase, visit) are coded as 1 if the wife reports making decisions alone or jointly with her partner in the respective domain, and 0 if she does not participate in the decision-making process. We control for Region Fixed Effect, Age, and relation to the head. Standard errors are clustered at the household level, and p-values are reported in parentheses.

Table 1.A.2: Correlation between food scarcity and BMI and effort ratios (women/men), 2016 monthly survey

	BMI Ratio	**Effort Ratio**	**BMI Ratio**	**Effort Ratio**
	(1)	(2)	(3)	(4)
Daily cereal P/C in kg(-)	−0.221***	0.099	0.013	−0.023
	(0.054)	(0.754)	(0.013)	(0.251)
Controls	*Yes*	*Yes*	*Yes*	*Yes*
Month FE	*Yes*	*Yes*		
Individual FE			*Yes*	*Yes*
Mean Y	1.012	1.440	1.012	1.440
Observations	210	210	210	210

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

Note: This table presents the results of the OLS estimation of the equation $\frac{Y_{woman}}{Y_{man}}_{t,\ i} = \alpha\ Cereal_{t,\ h} + \beta' X + \varepsilon_{i,t}$. Where Y, the outcome variables are effort and BMI. The variable *Cereal* is measured monthly at the household level and indicates the quantity in 0.1kg of daily cereals available per capita in each household. In the regression table, we report the opposite of the variable cereal (Daily cereal (-)), reflecting food scarcity. Controls include age, household size, whether the individual had fever in the month prior to the survey, ethnic group, religion and education. Standard errors are clustered at the household level and p-values are reported in parenthesis.

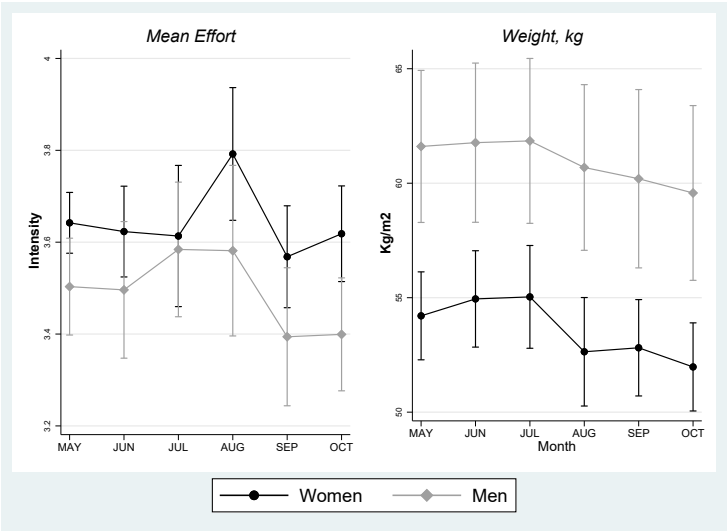
Table 1.A.3: Correlation between food scarcity and BMI ratios (women/men), end of season survey rounds 2011, 2012 and 2016

	(1)	(2)	(3)	(4)
Daily cereal P/C in Kg (-) (A)	−0.18**	−0.08***	−0.06	−0.03
	(0.09)	(0.02)	(0.04)	(0.03)
Daily cereal P/C × Effort ratio (B)			−0.01	
			(0.02)	
Daily cereal P/C × Effort above median (C)				−0.10**
				(0.04)
Controls	*Yes*	*Yes*	*Yes*	*Yes*
Year FE	*Yes*			
Individual FE		*Yes*	*Yes*	*Yes*
Coefficients A+B			-0.07	
Test A+B=0 (p-val)			0.01	
Coefficients A+C				−0.12
Test A+C=0 (p-val)				0.00
Mean Y	0.99	0.99	0.99	0.99
Observations	189	189	189	189

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

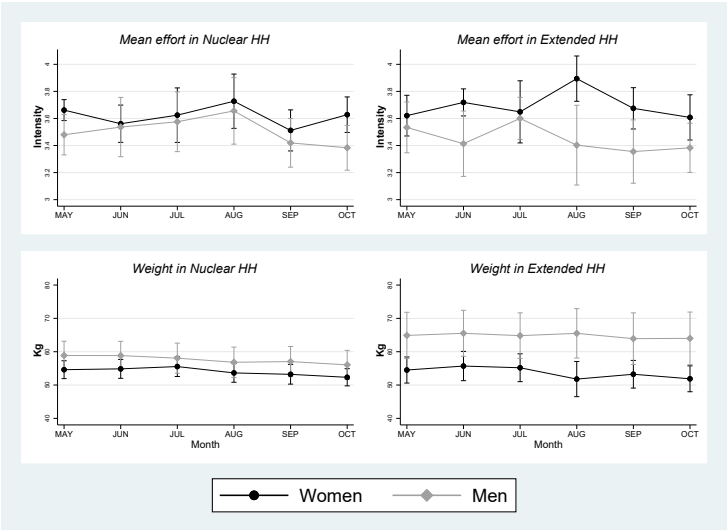
Note: This table presents the results of the OLS estimation of the equation $\frac{Y_{woman}}{Y_{man}}_{t,\ i} = \alpha\ Cereal_{t,\ h} + \beta' X + \varepsilon_{i,t}$. Where Y, the outcome variables are effort and BMI. The variable *Cereal* is measured annually at the household level and indicates the quantity in 0.1kg of daily cereals available per capita in each household. In the regression table, we report the opposite of the variable cereal (Daily cereal (-)), reflecting food scarcity. The variable "above median effort" is equal to 1 if, in 2016, the ratio of effort (man to woman) in the household is greater than the median effort ratio in the sample. Controls include age, household size, ethnic group, religion and education. Standard errors are clustered at the household level and p-values are reported in parenthesis.

Figure 1.A.1: Seasonal variation of effort and Weight



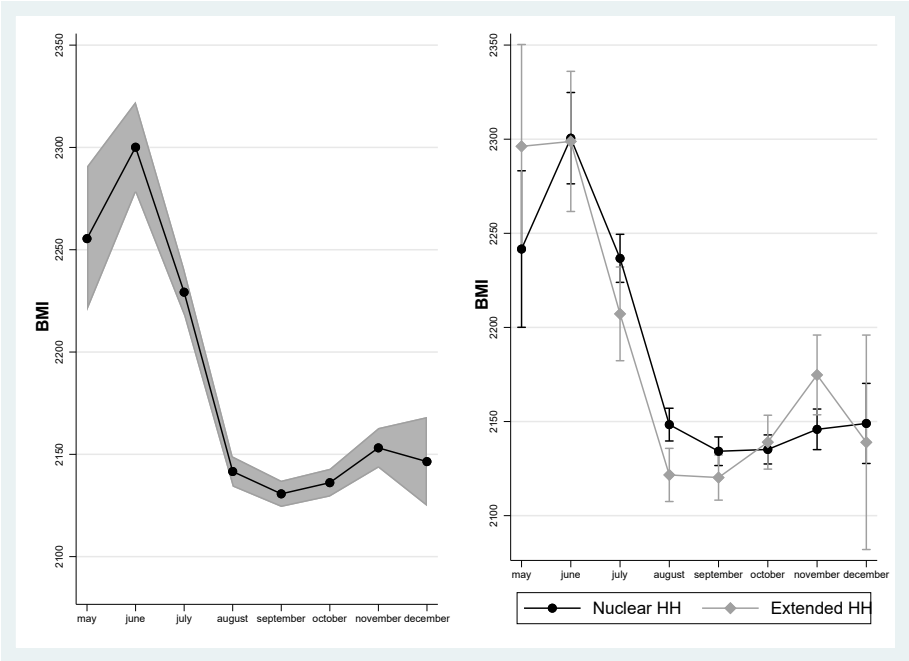
Note: These figures report by gender the seasonal variation of effort intensity level; as well as the variation of weight. They report predicted margins of the OLS regression of the following equation: $Y_i = \alpha * Male_i + \beta * Month_t + \delta * Month_t * Male_i + \theta * X_i + \varepsilon_i$. The vector X include controls (Age, household size, ethnic group, religion, education and relation to the head of the household). Standard errors are clustered at the household level

Figure 1.A.2: Effort load and Weight, by household structure



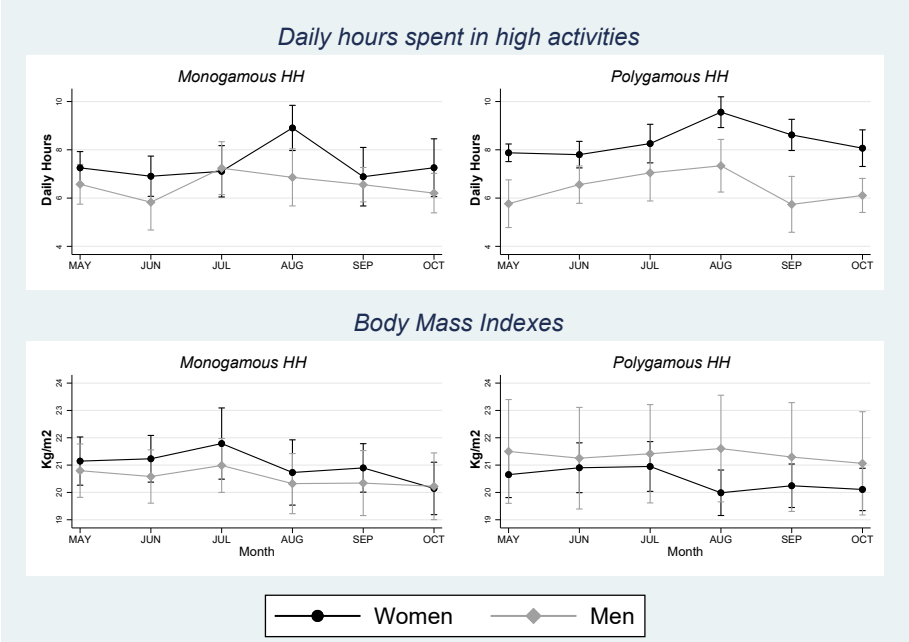
Note: These figures report by gender the seasonal variation of effort intensity level; as well as the variation of weight. They report predicted margins of the OLS regression of the following equation: $Y_i = \alpha \ * Male_i + \beta \ * Month_t + \delta \ * Month_t * Male_i + \theta \ * X_i + \varepsilon_i$. The vector X include controls (Age, household size, ethnic group, religion, education and relation to the head of the household). Standard errors are clustered at the household level

Figure 1.A.3: Women BMI by month using DHS Burkina Faso (2003, 2010 and 2021)



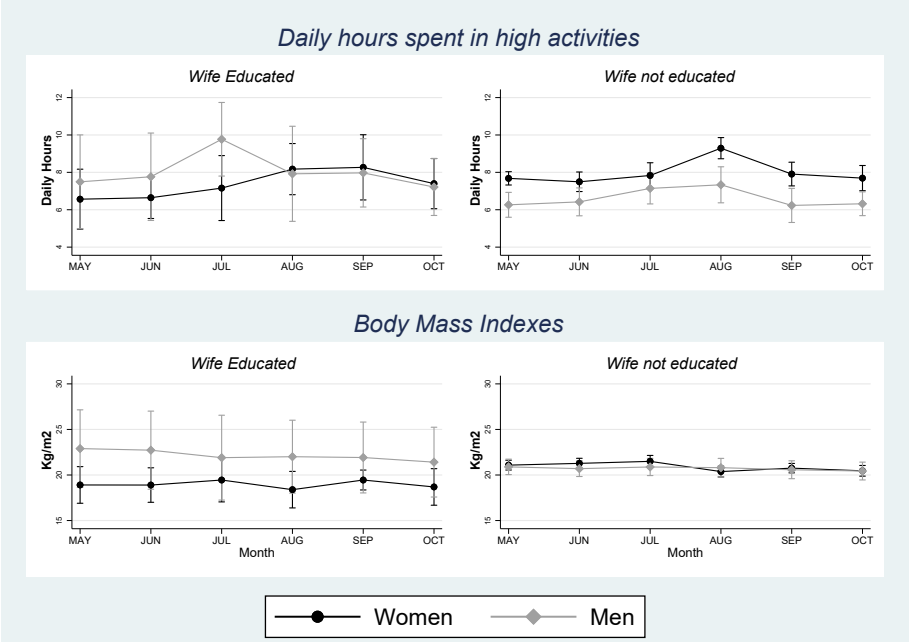
Note: These figures present the average BMI of women by the month of the DHS Survey in Burkina Faso for the years 2003, 2010, and 2021. They report predicted margins from OLS estimation of the following equation:
$BMI_i = \beta * Month_t + \delta * Month_t * Extended\_household_i + \theta * X_i + \varepsilon_i$. X denotes the vector of control variables, including Region Fixed Effect, Survey Year FE, Age, and Relation to the head.

Figure 1.A.4: Nutrition, Effort and Polygamy



Note: These figures report by gender the seasonal variation of daily hours spent in Intense and very intense activity; as well as the variation of the Body Mass Index. They report predicted margins of the OLS estimation of the following equation:
$Y_i = \alpha * Male_i + \beta * Month_t + \delta * Month_t * Male_i + \theta * X_i + \varepsilon_i$. with Y the outcome variables (BMI and hours spent in intense and very intense activities). The vector X include controls (Age, household size, ethnic group, religion, education and relation to the head of the household). Standard errors are clustered at the household level.

Figure 1.A.5: Nutrition, Effort and education of the wife of the household head



Note: These figures report by gender the seasonal variation of daily hours spent in Intense and very intense activity; as well as the variation of the Body Mass Index. They report predicted margins of the OLS estimation of the following equation:
$Y_i = \alpha * Male_i + \beta * Month_t + \delta * Month_t * Male_i + \theta * X_i + \varepsilon_i$. with Y the outcome variables (BMI and hours spent in intense and very intense activities). The vector X include controls (Age, household size, ethnic group, religion, education and relation to the head of the household). Standard errors are clustered at the household level.

1.B Survey Questions on Time Use

1. Has `[respondent]` performed `[activity]` AT LEAST ONCE SINCE OUR LAST VISIT?
   (a) No
   (b) Yes
2. **If Yes:** How many days has `[respondent]` performed this activity IN THE LAST WEEK?
3. ON THE LAST DAY `[respondent]` performed this activity, how long did this task last in total throughout the day?
   (a) Less than 30 minutes
   (b) Between 30 minutes and 1 hour
   (c) Between 1 hour and 2 hours
   (d) Less than half a day
   (e) More than half a day
   (f) The whole day
4. ON THE LAST DAY `[respondent]` performed this activity, did he find the completion of this task...?
   (a) Not tiresome at all
   (b) Slightly tiresome
   (c) Tiresome
   (d) Very tiresome

List of Activities included in the survey:

1. Meal preparation
2. Wood collection
3. Water collection
4. Cleaning the courtyard or doing laundry
5. Wild food collection
6. Going to the market
7. Livestock farming
8. Production for self-consumption (soap, weaving, etc.)
9. Agricultural activities
10. Individual field work
11. Collective field work

12. Visiting hours
13. Nap/Rest time

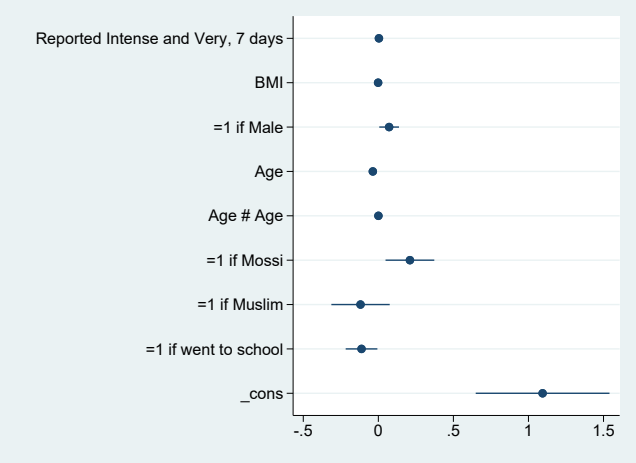
1.C Sampling

As mentioned in the main text, we had previous interactions with the households in the activity tracker subsample as they were previously involved in a broader data collection related to the impact of a nutrition intervention. We proceeded as follows to select individuals in the activity tracker sample. Initially, by default, the household head and his spouse were considered for inclusion in the activity tracking. In cases of polygamy, one wife was randomly chosen to be part of the activity tracker sample. Additionally, one adult aged 16 or older was randomly selected to participate. It is crucial to note that participation was voluntary and contingent on the individuals not traveling during the data collection period. Consequently, some individuals declined to wear the bracelet, others were excluded due to extended absences from the village, and others were excluded for health reasons. In summary, the sample comprised 159 different individuals, with 85% of them wearing the activity tracker for more than 3 months.

To explore the possible selection, we present in Figure 1.C.1 the differences in observable characteristics of adults in and out of the activity track sub-sample, controlling for the household fixed effect. Figure 1.C.1 shows that individuals in the activity track sample are not different from those out of the sample on a large number of observed characteristics (they are different in terms of age and ethnic group. We control for these variables in all the analysis). The reported daily working hours and the BMI are similar in these two sub-samples and this allows us to rule out the selection in time use; and in nutrition. We do not observe specific effort or nutrition behaviors in the activity track subsample (as suggested by coefficients of reported working hours and BMI). This allows us to rule out potential experimental psychological effects.

It is crucial to note that certain individuals were absent from the activity tracker sample during some months. By restricting the sample to individuals who were part of the study for more than 5 months (67%), Figure 1.C.2 reveals a consistent gendered pattern in effort and nutrition indicators. Specifically, women are more active and experience more pronounced seasonal variation in nutrition compared to men. Unfortunately, for certain households, only one gender group was available for some months in the activity tracker subsample, leading to a reduc-

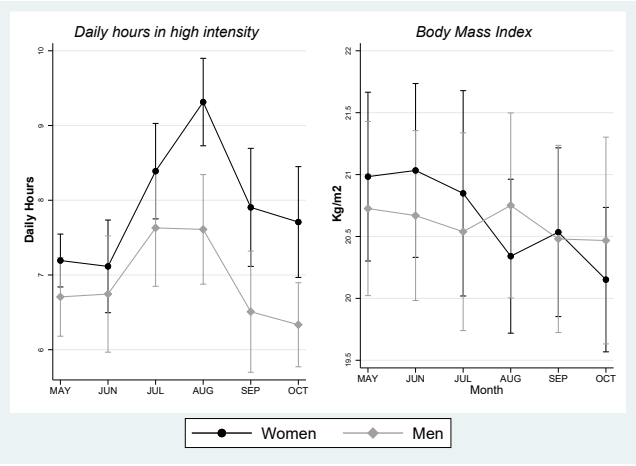
Figure 1.C.1: Probabilty of participating in the activity track sample



Note: This figure reports the coefficients of an OLS regression explaining the probability of participating in the activity track sample. The regression includes household fixed effect and standard errors are clustered at the household level

tion in observations in the empirical analysis with ratios. To calculate monthly ratios for both BMI and effort, we computed the value of women over men within each household. In households with one man and one woman, a single ratio (woman over man) was obtained. For households with two women and one man, two observations were recorded, representing the first and second woman over the man's value. In cases where there were two men and one woman, the ratio was determined as woman over the average of the two men, resulting in one observation.

Figure 1.C.2: Seasonal variation of effort and nutrition, restricted sample



Note: These figure report by gender the seasonal variation of daily hours spent in Intense and very intense activity; as well as the variation of the Body Mass Index. They report predicted margins of the OLS regression of the following equation: $Y_i = \alpha * Male_i + \beta * Month_t + \delta * Month_t * Male_i + \theta * X_i + \varepsilon_i$. with Y the outcome variables (BMI and hours spent in intense and very intense activities). The vector X include controls (Age, household size, ethnic group, religion, education and relation to the head of the household). These estimations are limited to households surveyed at least 5 times out of 6. Standard errors are clustered at the household level.

1.D Bargaining model of allocation of effort and food in subsistence farming households

1.D.0.1 Preferences, budget and production

Preferences are separable in effort and consumption: $U(c, e) = u(c) - v(e)$ with $u' > 0$, $u'' < 0$ and $v' > 0$ and $v'' > 0$.

A household is composed of two individuals indexed 1 and 2 who produce jointly their consumption with the production function F, with $F' > 0$ and $F'' < 0$. The budget constraint thus writes $c_1 + c_2 \leq F(e_1 + e_2)$

In order to exert a given level of effort, a minimum level of consumption is needed : $c \geq d(e)$, with $d' > 0$ (and to simplify things $d'' = 0$).

1.D.0.2 Household allocation

The household maximizes:

$U_1 + \alpha U_2$

where $\alpha > 0$ is the bargaining power of individual 2, under the following constraints:

$c_1 + c_2 = F(e_1 + e_2)$

$c_1 \geq d(e_1)$

$c_2 \geq d(e_2)$

The Lagrangian is:

$L = u(c_1) - v(e_1) + \alpha\left(u(c_2) - v(e_2)\right) - \lambda\left(c_1 + c_2 - F(e_1 + e_2)\right) - \nu_1\left(d(e_1) - c_1\right) - \nu_2\left(d(e_2) - c\right.$

The First Order Conditions (FOC) are:

$$\frac{\partial L}{\partial c_1} = u'(c_1) - \lambda + \nu_1 = 0 \tag{1.6}$$

$$\frac{\partial L}{\partial c_2} = \alpha u'(c_2) - \lambda + \nu_2 = 0 \tag{1.7}$$

$$\frac{\partial L}{\partial e_1} = -v'(e_1) + \lambda F'(e_1 + e_2) - \nu_1 d'(e_1) = 0 \tag{1.8}$$

$$\frac{\partial L}{\partial e_2} = -\alpha v'(e_2) + \lambda F'(e_1 + e_2) - \nu_2 d'(e_2) = 0 \tag{1.9}$$

$$0 = \lambda\left(c_1 + c_2 - F(e_1 + e_2)\right) \tag{1.10}$$

$$0 = \nu_1\left(d(e_1) - c_1\right) \tag{1.11}$$

$$0 = \nu_2\left(d(e_2) - c_2\right) \tag{1.12}$$

Non-binding physical power constraints

If the physical power constraints are not binding, $\nu_1 = \nu_2 = 0$, and the FOC imply:

$$u'(c_1) = \alpha u'(c_2) \tag{1.13}$$

$$v'(e_1) = \alpha v'(e_2) \tag{1.14}$$

Since u is concave and v convex, if $\alpha < 1$, we have $c_1 > c_2$ and $e_1 < e_2$. In other words, the individual with the lower bargaining power works more and consumes less than the individual with the higher bargaining power.

Suppose that both individuals have the same nutritional production function that determines their body mass index (BMI) and that the BMI

is a positive function of their consumption and a negative function of their effort (for example $BMI = B(c) - C(e)$ with $B' > 0$ and $C' > 0$). Then $\alpha < 1$ implies that $BMI_2 < BMI_1$, and an increase in α would decrease the difference in BMI (if $\alpha = 1$, both individuals would exert the same effort, consume the same amount of food and have the same BMI).

Even if BMI production function differ across gender, so that with $\alpha = 1$, BMI would differ, a decrease in $\alpha \leq 1$ will still result in a decrease in c_2 and an increase in c_1. Women have a more efficient metabolism whereby, for the same BMI, their basal metabolism is lower (Zhao et al., 2020; Tarnopolsky, 2000). This suggests that with the same level of c and e, they would have a higher BMI. If men and women have the same preferences over c and e, a woman would then have a higher BMI than man even with $\alpha = 1$.

Binding physical power constraints

The physical power constraint binds first for the individual with the lower bargaining power (since he consumes less and exert more effort), that is individual 2 if $\alpha < 1$.

If $c_2 = d(e_2)$, the FOC become:

$$\frac{\partial L}{\partial c_1} = u'(c_1) - \lambda = 0 \tag{1.15}$$

$$\frac{\partial L}{\partial c_2} = \alpha u'(c_2) - \lambda + \nu_2 = 0 \tag{1.16}$$

$$\frac{\partial L}{\partial e_1} = -v'(e_1) + \lambda F'(e_1 + e_2) = 0 \tag{1.17}$$

$$\frac{\partial L}{\partial e_2} = -\alpha v'(e_2) + \lambda F'(e_1 + e_2) - \nu_2 d'(e_2) = 0 \tag{1.18}$$

$$0 = c_1 + c_2 - F(e_1 + e_2) \tag{1.19}$$

$$c_2 = d(e_2) \tag{1.20}$$

When the power constraint is binding, it seems to be difficult to reach an explicit analytical solution with FOC expressions. It is as if 2 at this point would be willing to work more and eat less (given her low bargaining power); and 1 would benefit from her doing so; but she is forbidden to work more (without increase in her ration) by her

biological function. Therefore, to go further we simulate these functions; and explore numerically what happens for ranges of parameters.

1.D.0.3 Simulations

Suppose $U(c,e) = \frac{c^{1-\sigma}}{1-\sigma} - \frac{c^{1+\nu}}{1+\nu}$, $F(e) = A\sqrt{e}$

Then $u' = c^{-\sigma}$ and $v' = e^{\nu}$

if power constraints are not binding we have $c_1^{-\sigma} = \alpha c_2^{-\sigma}$ ($c_1 = \alpha^{-\frac{1}{\sigma}} c_2$) and for effort: $e_1^{\nu} = \alpha e_2^{\nu}$ ($e_1 = \alpha^{\frac{1}{\nu}} e_2$).

For a given c_1, we can find c_2 and then $e_1 + e_2 = (1/A^2)(c_1 + c_2)^2$. Using $e_1 = \alpha^{\frac{1}{\nu}} e_2$, we have $e_2(1 + \alpha^{\frac{1}{\nu}}) = (1/A^2)(c_1 + c_2)^2$, which gives a value for e_2 and then e_1. Thus for a given c_1 (and with set parameters), all other variables can be defined and we can compute U_1, U_2 and the household objective. We can then look for the optimum for set values. We solved it for different values of α. Results are presented in Figure 1.5.

Chapter 2

Cooperation in Polygamous Households. Experimental Evidence from Northern Benin

Joint with Catherine Guirkinger[0]

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Abstract

In the literature, polygamy is frequently associated with intra-household inefficiencies, commonly attributed to a lack of cooperation between co-wives. In this paper, we challenge this claim by investigating the extent to which wives are inclined to cooperate when mutual gains are at stake. Additionally, we examine whether the lack of voice in intra-household decision-making contributes to explaining commonly observed inefficiencies. Using public good games in north Benin, we find that co-wives are not more prone to cooperate with their husband than with each other. Moreover, when they share mutual interests, they tend to coalesce and play against their husband's interests. These findings are particularly strong in the case of women with low levels of agency. We argue that co-wives with low agency have more incentive to unite to collectively improve their access to household resources since, individually, they are marginalized. Finally, the comparison of monogamous and polygamous households reveals that efficiency levels and the determinants of cooperative behavior are similar in both types of households (when household members themselves set the rules regarding the allocation of the public good).

2.1 Introduction

Polygamy is widespread in Western Africa with, for example, 40% of married women living in polygamous marriages in Benin according to the 2018 Demographic and Health Survey. Polygamy has been shown to be an obstacle to development in the macro (Tertilt, 2005) and microeconomic literature (Munro, 2023 for a survey). In the latter, polygamy is typically associated with intra-household inefficiencies. Co-wives lack of cooperation is typically seen as responsible for these inefficiencies as they fail to contribute to household public goods (Barr et al., 2019; Munro, 2023 for a survey), compete in fertility (Rossi, 2019), or engage in destructive rivalries.

Yet ethnographic literature documented cases of cooperation among co-wives in Sub Saran Africa (Madhavan, 2002; Jankowiak et al., 2005). And while in some dimensions like inheritance and fertility, conflicts of interest between wives are evident (see discussion by Rossi, 2019 in Senegal), they may also share a common interest in cooperating with each other, possibly to jointly gain better access to collective resources. This may be the case in particular when they have individually low levels of bargaining power because in that case they may cooperate little with the husband to start with and may thus have little to lose to coalesce with the co-wife at his expense. Baland & Ziparo (2018) discuss how a very unbalanced distribution of bargaining power hinders cooperation between husband and wife because the gains from cooperation are reaped almost entirely by just one spouse. In that case, if there is any cost associated with bargaining or cooperating (time cost, potential tension, etc. . .), the low-empowered partners may forgo cooperation together. We posit here that, in polygamous households, a very low level of bargaining power for women may decrease their incentive to cooperate to household public goods, yet may foster cooperation with the co-wife who has similarly low power (especially if they have mutual interest). We thus see inefficiencies in polygamous households as the result of the very low agency of women in these marriages, rather than fierce competition between them.

To test these ideas, we conducted lab-in-the-field games with monogamous and polygamous couples in Benin with three main objectives. The first is to investigate cooperative behavior in polygamous households and

co-wives' willingness to unite (possibly at the expense of the husband). The second is to explore whether the extent of cooperation among co-wives is higher when women have limited agency in the household. The third is to compare overall efficiency and cooperative behavior across monogamous and polygamous households.

In practice, we conducted multiple rounds of public good games, where each participant received an initial endowment and could privately contribute to a common pot. The funds in the common pot were then multiplied by 1.5 and distributed among players. The household efficient outcome is that all invest the full amount while keeping all to oneself is the non-cooperative equilibrium. In the first set of games, the common pot is equally shared among players, while in the second set of games, players set the sharing rule. In one game, mirroring daily life in Benin, husbands privately determined the sharing rules. In a second game, all spouses jointly decided on the rules, while in a third game, wives decided on the sharing rule (jointly in polygamous households) in the absence of the husband.[1] Observing sharing rules and contributing behavior in the two latter games reveals whether wives' participation in the decision increases their share and their contributions. The last game also indicates to what extent co-wives are willing to coalesce at the expense of the husband.

Four main conclusions arise from the analysis. First, co-wives are not willing to cooperate more with the husband than with each other and are willing to ally to secure a high share of collective resources at the expense of the husband. Second, when they lack agency (whether in the game or in real life) their willingness to cooperate with each other (rather than with the husband) is further enhanced. Third, levels of cooperation and efficiency are not significantly higher in monogamous households (compared to polygamous ones) when household members themselves decide about the allocation of the collective pot (in fact households behave remarkably similarly). Finally, increasing women's involvement in the decision-making process increases cooperation and enables to reach higher levels of efficiency.

This paper contributes to several strands of literature. First, we con-

[1] Figure 2.A.3 in the appendix presents a comprehensive summary of games played with monogamous and polygamous couples.

tribute to the literature on the functioning of polygamous households. Our findings diverge from Barr et al. (2019) and Munro et al. (2019) who also conducted several rounds of public good games with polygamous couples and found that wives are less likely to cooperate among themselves than with husbands. We believe that the low level of agency of women in our setting and the fact that, in our experiment, household members themselves set sharing rules contribute to explaining the difference. We also go one step further and investigate whether wives are willing to coalesce against the husband's interests and whether their level of bargaining power influences their willingness to cooperate with the husband and among themselves. Second, we contribute more generally to the literature on intrahousehold resource allocation, by assessing whether intrahousehold cooperation differs across members and households depending on the prevailing balance of power. While the lack of voice or bargaining power is stated as a possible reason behind household inefficiency in developing country context by Baland & Ziparo (2018), we are not aware of papers that formally test this idea.

The remainder of this paper is organized as follows. In Section 2.2, we review the existing literature about intrahousehold cooperation and efficiency. Section 2.3 provides insights into the context and details the experimental design. The main results of the experimental games are presented in Sections 4, 5, and 6, while Section 7 briefly concludes.

2.2 Related Literature

2.2.1 Intrahousehold efficiency

The question of how resources are allocated within the household has long occupied economists and the canonical model to date is the collective model of the household (see Vermeulen, 2002 and Chiappori & Mazzocco, 2017 for recent reviews). The collective model is based on the assumption that intra-household allocations are Pareto efficient. Yet, there is now abundant evidence suggesting that these allocations may not be efficient, in poor country contexts in particular. For example, Udry (1996) provides evidence of inefficiencies in the allocation of productive resources in farming households in Africa. Duflo & Udry (2004) and Dercon & Krishnan (2000) provide empirical evidence of incomplete

insurance within households in Côte d'Ivoire and Ethiopia, respectively (which contradicts Pareto efficiency). Kazianga & Wahhaj (2017) show that levels of efficiency are lower in extended than in nuclear households in Burkina Faso and argue that this is because altruism is lower in families with weaker ties (see also Guirkinger et al. 2015). Excellent reviews of the experimental literature on intrahousehold allocations are available in Munro (2023) and Munro (2018) and reveal that inefficiencies are pervasive in a wide variety of contexts.

Baland & Ziparo (2018) review the reasons why allocations within households may not be efficient, leading to substantial losses, in particular in poor countries. They cite power imbalances, high adult mortality rates, the prevalence of early and arranged marriages, and the prevalence of extended households as key factors undermining efficiency. One important idea they develop is that when women have limited outside options and low decision-making power in the household, they may adopt passive non-cooperative behavior since they would gain little from cooperating, leading to efficiency losses in the household.

2.2.2 Intra-household cooperation in public good games

"Cooperation could be defined as the act of contributing to a common, mutually beneficial goal although behaving selfishly would be individually better, irrespective of whether others cooperate or not, as captured by stylized game-theoretic paradigms as the Prisoner's Dilemma and Public Good Games." (Alós-Ferrer & Garagnani, 2020)

Public Good Games (PGG) are frequently used to measure cooperation. In a PGG, participants receive an initial endowment that can be either retained privately or invested in a collective public good. The amounts invested in the public good are multiplied by a factor greater than one and shared among the players. The game's final payoff for each player consists of the sum of the privately retained amount and the share received from investments in the common pot. As noted by Munro (2023), PGG involving couples differ fundamentally from games with strangers due to the shared life experience that exists both before and after the experiments. While in PGG with strangers, free-riding is a maximizing strategy, the inherent interdependence in consumption within

households implies that, in games involving couples, the Pareto-efficient strategy is to maximize household surplus by investing the entire endowment, irrespective of individual levels of altruism.[2] However, in the majority of experimental studies involving couples, individuals choose to keep part of their endowment for themselves instead of investing it all in the common pot. Furthermore, conditional (or reciprocal) cooperation among spouses is typically observed, whereby contributions depend on beliefs regarding the partners' willingness to cooperate (Iversen et al., 2011; Barr et al., 2019). Barr et al. (2019) find that polygamous spouses tend to have more reciprocal motives in their contribution behaviors compared to monogamous spouses, who tend to exhibit more altruistic behaviors.

Some experiments directly investigate how the control over collective resources may affect cooperation within households. Results are mixed. Iversen et al. (2011) and Verschoor et al. (2019) report that in Uganda and northern Nigeria, household efficiency tends to increase when wives control the allocation of common resources. In contrast, they show that in India and Ethiopia, women's control tends to lower efficiency compared to men's control (see also Kebede et al., 2014). They conclude that, overall, experiments that challenge existing social norms tend to lower efficiency, particularly in patriarchal societies where giving wives control over resources generally leads to lower contributions from both women and men (Verschoor et al., 2019).

2.2.3 Cooperation in polygamous unions

Regarding cooperation in polygamous households, economic evidence indicates that wives often engage in competition, resulting in reduced cooperation. In Côte d'Ivoire, for instance, Mammen (2004) found that this competition results in inefficient investment in children. Additionally, in Senegal, Rossi (2019) demonstrates that co-wives inefficiently increase their fertility in a competitive manner to increase their claim over household resources. An important finding of experiments with

[2]This behavioral pattern is typically observed when comparing games involving strangers with those played by spouses. Notably, individuals tend to invest more when their spouse is their game partner, as opposed to when they are playing with strangers (Barr et al., 2019; Munro et al., 2019).

polygamous households is that the level of cooperation may differ across sub-sets of players. In Nigeria, Munro et al. (2019) and Barr et al. (2019) found that co-wives exhibit lower levels of cooperation with each other, but tend to cooperate more when playing with the husband. Junior wives, in particular, are in a relatively disadvantageous position as husbands tend to cooperate less with them compared to senior wives. Furthermore, when the husband controls the allocation of resources, junior wives receive a disproportionately lower share (Munro et al., 2019). This situation may induce them to contribute less to household public goods.

In summary, several empirical and experimental studies in economics suggest that inefficiencies within polygamous households stem from competition and low cooperation among co-wives. An exception is Akresh et al. (2016) who, with the help of a game-theoretical framework provides an interesting perspective on cooperation among co-wives, arguing that the lower level of altruism between co-wives (than between husband and wife) helps sustain cooperation because it makes punishment more credible. They show that the pattern of productive efficiency levels across household types matches their theoretical predictions, whereby polygamous households tend to be more efficient in their allocation of productive inputs across fields.

Interestingly, the ethnographic literature provides a more nuanced perspective on cooperation in polygamous households and suggests that social norms and perceptions play a pivotal role in shaping the relationships among co-wives. For instance, in Mali, Madhavan (2002) highlights that in certain ethnic groups, cooperation among co-wives is considered a valuable trait in women, elevating their social status. This, in turn, fosters cooperative behaviors among co-wives, in contrast to ethnic groups where such norms do not apply. Mulder (1992) insists on women's positive attitude towards polygamy and their willingness to cooperate with their co-wife in several East African societies. Jankowiak et al. (2005) review the anthropological literature and take a cross-cultural perspective to investigate the factors that heighten competitive behavior and undermine cooperation between co-wives. Their comparison of 69 cultures suggests that the two most important triggers of conflict are inequalities related to children's access to resources and rivalries regarding

sexual and emotional access, while aging decreases conflict and favors supportive relationships.

It is rather obvious that co-wives' incentives to cooperate will depend on the circumstances and the stakes. An important possibility is that co-wives may have incentives to join forces to secure a higher share of collective resources, especially in a context where they have, individually, very little say. This possibility is suggested by the theory of coalition formation in contests (De Jaegher, 2021). According to this theory, in a game involving three players competing for a prize, two players may join forces and compete against the third if it enhances their chances of winning collectively and subsequently sharing the prize. When the player with a higher individual chance of winning finds it more advantageous to leave the coalition, coalitions typically arise among players with equal probabilities of winning. While the theory of coalition formation in contests does not directly apply to our setting because we do not use a "winner takes all" structure in the games, the main idea that players in a similar disadvantageous situation may be more willing to coalesce against the third resonates with our context. In polygamous households with strong patriarchal norms, husbands typically enjoy extensive decision-making authority, so that co-wives may have incentives to coalesce to improve their access to resources, provided they have a foundation of mutual trust. Otherwise, a coalition among co-wives is less likely to emerge since each co-wife fears that the other could be disloyal and report her to the husband.

2.3 Context and Experiment Design

2.3.1 Data collection

The experiment took place in April and May 2023 across 21 villages in three municipalities in the region of Atacora in northern Benin: Boukoumbé, Cobly, and Matéri.[3] In practice, we visited one village per day with a team of four enumerators and organized two sessions in each vil-

[3]The experiment took place in villages where a Belgian NGO, Iles de Paix, is supporting agricultural production and women's entrepreneurship through various interventions. Some of the households in the experiments were surveyed in 2020, as part of an effort to evaluate the impacts of the women's entrepreneurship intervention.

lage, one with polygamous couples and one with monogamous ones.[4] In our sample, polygamous couples consist of one husband and two wives. Very few husbands have more than two wives in this area.

On average, sessions with polygamous couples lasted 2 hours and were followed by a 1.5-hour individual post-game interview where we asked detailed questions about household organization. Sessions with monogamous couples were shorter and lasted 1.5 hours, followed by a 1-hour interview. In total, 172 couples participated in the experiment, with half of them (86) being polygamous, resulting in a total of 430 individuals involved. Throughout the paper, we denote "Wife 1" as the wife who entered the polygamous union first, while "Wife 2" refers to the wife who entered later.

2.3.2 Context

According to the 2018 Demographic and Health Survey (DHS), 38% of married women in the region under study (Department of Atacora) are in polygamous marriages[5], with the majority being arranged unions. The region is characterized by deep-rooted patriarchal norms, instilled in men and women through obligatory initiation rituals (for more details, see Kaucley N'Koué, 2015). In this context, women's agency is very limited as illustrated by the following facts.

First, women have limited choice regarding marriage: as reported in Table 2.1, 26% of married women live in an extreme form of arranged marriage known as *"exchange marriages,"* where families simply exchange their daughters (without their consent), either simultaneously or on a credit basis.[6] A direct consequence of these unions is that women

[4]One year before the experiment (February 2022), we conducted a qualitative survey, consisting of individual interviews with 38 participants. This phase provided valuable insights into the context, aiding us in refining the experiment's design. In April 2023, the experiment was tested with 10 couples, further refining our approach in alignment with our research objectives.

[5]Within each cluster (Primary Sample Unit.), there exist both monogamous and polygamous households

[6]The focal point of this arrangement is the exchange of women. Interviews we conducted in February 2022 revealed that sometimes families are involved in long-term loans of women that extend beyond 20 years. In these situations, whenever a girl is born into a borrowing family, she is automatically designated to repay the loan. Occasionally, if the borrowing family fails to have a woman available for the exchange, the daughter of the originally exchanged

have limited exit options: separation in one union is supposed to imply the undoing of all other marriages from the exchange. Another consequence is that women often find themselves in marriages with strangers, frequently with a large age gap (as illustrated in Table 2.1, ranging from 7 to 14 years). The age gap between husbands and wives is greater in polygamous households compared to monogamous ones (10 years versus 6.7 years). Additionally, polygamous wives are more inclined to be in exchange marriages (28% versus 21%, difference not significant)

Second, while wives have a strong obligation to work in household (collective) fields, they have limited influence over the allocation of resulting resources, which are primarily under the authority of the husband. As Table 2.1 illustrates, only 33% of women report having a say in decision-making regarding the collective field. Husbands decide unilaterally on the crop to cultivate, and the allocation of labor and harvest (how much to sell, how much to save in granary). This fact is more observed in polygamous households: 70% of women in polygamous households report lacking agency in collective field decisions compared to 60% in monogamous ones.

Finally, children and all assets (even when financed by the wife) are considered to be the property of the husband. In the event of a divorce, the wife has no legal claim to either assets or children. Relatedly, even if wives participate in financing household expenses (including house embellishments, daily expenditures, and durable goods), they declare that they need their husband's approval before making any purchase. This necessity is particularly emphasized in polygamous households, where husbands seek to mitigate "undesirable" inequalities among co-wives.[7]

A wife's status also depends on her position in marriage: second wives are typically considered at a disadvantage. Social norms command that husbands have to maintain the superiority of senior wives whom they should entrust with greater responsibilities. When the husband

wife might be returned to her maternal family to fulfill the loan repayment. It is crucial to emphasize that in this system, a woman has no right to refuse the exchange, regardless of the age of the husband imposed upon her. Also, in the event of a separation, all the exchanged women are expected to return to their respective families of origin. We were told of cases where exchanged women refused to do so, with the support of their husbands. Yet, both women and their husbands faced social sanctions.

[7]Inequality accepted by social norms is often tied to the rank within the household structure: first wives are typically accorded more privileges than those of higher rank.

is not present, the senior wife typically assumes the responsibility of managing the granary (this situation concerns 74% of households, see Table 2.1). In addition, first wives are more likely to participate in decisions regarding food allocation[8] (50%) than second wives (28%) in cases where the husband is not the one in charge of food allocation (33% of household).

In this context of limited women's agency, co-wives report cooperating in several aspects. Specifically 69% of them report assisting each other in financial matters, domestic tasks, and agricultural activities (Table 2.1). Moreover, 54% of women report being part of the same entrepreneurship group, which also suggests some level of collaboration. Furthermore, the following quote from a 39-year-old second wife with 5 children illustrates co-wives' cooperation: *"With my co-wife, we have to collaborate to provide for our children because our husband doesn't give us much when he sells the production from the collective field"*

Other descriptive statistics are reported in Table 2.1. There appears to be no significant difference in the number of children per woman in polygamous and monogamous households. Education levels are extremely low with only 58% and 32% of men and women (respectively) with any education. All households rely on agricultural production for their living and many men (52%) and most women (88%) have other income-generating activities (IGA) such as transformation of rice, fonio, and soy. Concerning religious practices, the majority of husbands (56% in monogamous and 66% in polygamous households) follow traditional religions that strictly adhere to the cultural norms described above. However, among wives, Christianity emerges as the most practiced religion, followed by traditional beliefs. Regarding living arrangements, 52% of polygamous women reside in the same compound as their co-wives (cohabiting households), with husbands typically cohabiting with their wives.

2.3.3 Experiment Design

To assess cooperation among players, we conducted multiple rounds of public good games with polygamous and monogamous household members. We began each session by explaining the objectives and principles

[8]Participation implies that the wife decides on the allocation alone or with her co-wife.

Table 2.1: Sample Characteristics

	Husbands				Wives				Polygamous Wives		
	All	**Monogamous**	**Polygamous**	**Diff**	**All**	**Monogamous**	**Polygamous**	**Diff**	**Wife 1**	**Wife 2**	**Diff**
Cohabiting household						.	0.52				
Age (years)	44.19	41.64	46.74	**	36.10	34.99	36.66		40.23	33.09	***
Age gap (Wife1-Wife2)						.	7.14				
Age gap (Husband-wife)					8.94	6.65	10.08	***	6.51	13.65	***
Age at marriage					17.91	18.05	17.84		18.03	17.65	
Exchange marriage					0.26	0.21	0.28		0.34	0.22	*
Arranged marriage					0.57	0.49	0.61	*	0.64	0.59	
Mariage Duration (years)					17.62	16.84	18.01		21.26	14.77	***
Household Size	9.48	6.78	12.17	***							
Nb. Children	7.35	4.85	9.86	***	4.94	4.85	4.99		5.36	4.61	*
Ethnic Group											
Biali	0.30	0.29	0.30		0.29	0.28	0.29		0.29	0.29	
Ditamari	0.34	0.35	0.34		0.33	0.33	0.33		0.33	0.34	
M'berlimè	0.28	0.29	0.28		0.29	0.30	0.28		0.30	0.27	
Others	0.08	0.07	0.08		0.09	0.09	0.09		0.08	0.10	
Religion											
Traditional	0.61	0.56	0.66		0.41	0.38	0.42		0.43	0.42	
Christian	0.29	0.34	0.24		0.49	0.50	0.49		0.50	0.48	
Muslim and others	0.10	0.10	0.09		0.10	0.12	0.09		0.07	0.10	
Went to school	0.58	0.59	0.56		0.32	0.37	0.29		0.27	0.31	
Size collective field (hectare)	4.19	3.90	4.48								
Assets (score)	-0.02	-0.07	0.03		0.00	0.22	-0.22	**	-0.23	-0.18	
Occasional work	0.30	0.41	0.20	***	0.24	0.27	0.23		0.21	0.24	
Has individual field					0.85	0.83	0.86		0.86	0.85	
Size individual field (hectare)					1.24	1.26	1.23		1.31	1.16	
Has managed the granary					0.71	0.91	0.62	***	0.74	0.49	***
Husband manage food	0.33	0.23	0.38	**							
Participates in food management					0.51	0.75	0.39	***	0.50	0.28	***
Has a say on collective field					0.33	0.40	0.29		0.27	0.31	
Has a say on individual field					0.74	0.79	0.72		0.74	0.71	
Has an IGA	0.52	0.49	0.55		0.88	0.92	0.86		0.85	0.87	
Number of IGA					1.17	1.26	1.12		1.07	1.17	
Co-wives help each other						.	0.69				
Co-wives in same IGA group						.	0.54				
Knows husband's savings					0.22	0.23	0.22		0.23	0.20	
Passed test easily	0.75	0.73	0.77		0.72	0.83	0.67	***	0.64	0.70	
N	**172**	**86**	**86**		**258**	**86**	**172**		**86**	**86**	

Note: The table presents key descriptive statistics. 'Wife 1 (2)' refers to the wife who entered the polygamous marriage first (later). 'Exchange marriage'=1 if marriage was based on an arrangement between families that avoids bride-price and precludes separation (see details in Section 2.3), 'Assets' refers to the Asset score derived from Principal Component Analysis. A higher score indicates a greater likelihood of possessing durable assets, such as motorcycles, bicycles, telephones, radio, plows, etc. 'Occasional work' = 1 if the respondent reports occasional work outside the household for a salary. 'Has managed the granary' =1 if the wife has managed the granary in the last 30 days. 'Participates in food management' =1 if, in day-to-day life, the wife participates (either alone or jointly with her co-wife in polygamous households) in decisions of allocation of food (cereal) in the household. 'Has a say on collective/individual field' = 1 if the respondent participates in decisions about what type of crop to grow and how to allocate the harvest, including decisions on how much to sell or store. IGA refers to Income Generating Activities. 'Co-wives help each other'=1 if both co-wives report assisting each other in domestic, agricultural or financial questions in day-to-day life. 'Passed easily the test'= 1 if the respondent passed the comprehension test on the first attempt, and 0 if passed on the second or third attempt before playing (refer to specific questions in the Appendix 2.B.2). Note */**/*** pairwise mean difference significant at 10%/5%/1%.

of the game to the participants using real-life examples (for more details, see Script in Section 2.B in appendix). This was followed by discussions to ensure participants understood the rules. After the group training, members of each household were isolated, and one enumerator was assigned to them. Before playing, every player had to pass a comprehension test (see Subsection 2.B.2 in appendix). As shown in Table 2.1, 75% of participants passed the comprehension test on the first attempt, and 25% on the second or third attempt before starting to play.

In each round, every spouse received an initial endowment of 2000 CFA Francs (equivalent to 3 euros) and had to decide how much to keep for her/himself and how much to allocate to a common pot. The common pot was materialized by a box that was isolated from other players

and the enumerator and to which each player would go to make her / his contribution in private. The total amount contributed to the common pot was subsequently multiplied by 1.5 and then distributed among the participating players. From this perspective, a player's contribution rate to the common pot is interpreted as his degree of cooperation. To provide a familiar analogy, players were asked to imagine using their initial endowment to purchase seeds for a collective field, and to regard the revenue in the common pot (contribution*1.5) as the proceeds from selling the production[9] (see Script in the Appendix 2.B for more details). For each treatment, a player's total revenue comprised the sum of the amount retained privately and the share received from the common pot. For the final payment, a random game was selected, and the respective earnings were awarded to the player. Importantly, both the contributions and the payments were kept private, with players remaining unaware of the treatment chosen for the final payment to avoid potential retaliation.[10] These principles were communicated and explained to all players before the games began. Communication between spouses during the games was strictly controlled and occurred only when the game protocol explicitly allowed it. Each game session had two parts, which differed in terms of rules for the allocation of the common pot.

In the first part, the revenue in the common pot was shared equally among participating players. Each player played several rounds of PGG (four rounds for polygamous players and two for monogamous) that differed in terms of the identity of the partner(s). First, bilateral games were played to capture the level of cooperation among co-wives in polygamous marriages and between them and the husband. Whereas monogamous couples played only one game in this phase (between the husband and the wife), in polygamous couples three games took place, one between the husband and the first wife, one between the husband and the

[9]This analogy is likely to resonate more with the players and raise their awareness of the importance of their decisions in the game for two main reasons: (1) Agriculture is the principal source of income for these households, as they transform agricultural products for sale on the market. (2) The collective field represents the most important common good for the household, often requiring investment from each spouse in terms of the labor force, seed, and other inputs.

[10]One round was played with an anonymous player from another household, so players did not know whether the payoff was the result of decisions taken by other household members or an anonymous person.

second wife, and one between co-wives. The sequence of these games was randomized to minimize the influence of previous rounds on contributions. Second, each player participated in a round with an unknown partner selected randomly from those present at the session to test the selection of players in monogamous or polygamous households with respect to cooperative behavior.[11] Third, polygamous couples played in a three-players game, with the same principle of equal sharing. After the first part of equal sharing games, all households gathered for training on the principles of the second part of the session.

In the second part, the allocation of the common pot across players (the shares accruing to each) was set by players. Depending on the round, different combinations of players were responsible for setting the shares for all household members. Then all household members contributed, aware of who defined the rules but not aware of the rule (unless the player was directly involved in setting it). The money in the common pot was divided according to the rules set by the decision-maker (again players would not learn about the outcome). In practice, to define the rules, three scenarios with varying amounts of real money in the common pot (6000, 4000, and 2000 CFA Francs) were presented to the decision-maker, who had a maximum of five minutes to allocate the money among the players. We call the share (in percent) the average of the portions attributed by the decision-maker for each scenario.

In the first treatment (T1), mirroring everyday life, the husband made the rules in isolation from his co-wives. In the second treatment (T2), all spouses jointly determined the rules through a discussion (with all players then aware of the sharing rules). In the third treatment (T3), the co-wives were isolated from their husband and jointly decided on the sharing rules, which remained unknown to the husband. The objective of including these treatments was twofold: first, to test whether involvement in defining the sharing rules influenced contributions, and second, to analyze whether co-wives in polygamous marriages could form a coalition and potentially play against their husbands, in the sense that they would depress his share and increase their shares.

[11] As suggested by Barr et al. (2019), no difference in contribution levels between monogamous and polygamous players should be observed when playing with strangers if there is no selection based on cooperative behavior in the type of household.

One challenge in household experiments is the "undoing problem" whereby household members may "undo" any allocation in the experiment by subsequent transfers (Munro, 2018). Note that if undoing is at play, players should not be sensitive to the sharing rules (since they could always undo the allocation reached in the game) and should be more likely to contribute the full amount to the common pot. As detailed below, contributions are very much influenced by the rule-setting procedure. Furthermore, in our case, the severity of the undoing problem is limited by the fact that no player learns about the contributions of other players or the payoffs obtained.

2.4 Cooperation in polygamous households

2.4.1 Two-people games: comparing cooperation among co-wives with husband-wife pairs

In all the games we played with spouses, the household cooperative (and efficient) outcome is for members to contribute their full endowment to the collective pot, given that these contributions are then multiplied by 1.5. Yet if individuals maximize their *individual* payoff, their incentive to contribute to the common pot depends on the share they obtain from the collective pay-off and their expectation about the contribution of others. Given the multiplier chosen, it is only if their individual share is above $\frac{2}{3}$ that individual payoff maximizers would contribute a strictly positive amount, in fact their full endowment.[12] In other words, unless they are sure to obtain at least $\frac{2}{3}$, the pay-off maximizing contribution in our static games is null.[13] In this subsection, we analyze two-people

[12]Let α be the fraction of the endowment e allocated to the collective pot, C the contribution of other players and s the share obtained from the collective pot. A member maximizing her individual payoff chooses α that maximizes $(1-\alpha)e+\frac{3}{2}s(\alpha e+C)$. The first derivative of this expression with respect to α is $-e+\frac{3}{2}se$. This expression is strictly positive if $s>\frac{2}{3}$ - implying that the member would contribute the maximum amount possible e - and negative otherwise, implying a zero contribution. This reasoning is abstract from risk considerations, if there is uncertainty about s and C and individuals are risk averse, the threshold above which full contribution obtains will be strictly higher than $\frac{2}{3}$.

[13]To elaborate on this, let us consider a bilateral game with equal shares (share=$\frac{1}{2}$). Suppose one player contributes the full endowment of 2000 FCFA while the other contributes nothing. In the common pot, there will be a total revenue of 3000 FCFA ($2000FCFA\times 1.5$), to be equally divided, resulting in 1500 FCFA for each player. Consequently, the player who

games, with the objective to compare individual contributions across dyads (when the husband plays with the first wife, with the second wife, or when the two wives play with each other).

As detailed in Section 2.2, an element put forward in the literature on polygamous households is that cooperation between co-wives is typically lower than between a wife and the husband, and this fact contributes to explaining the lower level of efficiency in these households. To explore this conjecture in our context, we estimate the following simple linear equation with individual fixed effects, where the dependent variable $Y_{i,g}$ is the contribution to the collective pot:

$$Y_{i,g} = \alpha + \beta * coplayer_{i,g} + I_i + \epsilon_{i,g} \tag{2.1}$$

where the indices i and g represent the player and the game, respectively. The variable *coplayer* designates the person with whom i is playing (for a wife it is either the co-wife or the husband; for a husband, it is the first or second wife). I denotes the individual fixed effect. Standard errors are bootstrapped and clustered at the village level to account for potential error correlation, as players within each village played in the same game sessions.

Table 2.A.1 in the appendix reports descriptive statistics regarding the rates of contribution to the collective pot for each possible dyad (the dependent variable). Regression results are reported in Table 2.2 and reveal that contributions are not lower when co-wives play with each other than when they play with the husband, in fact they tend to be higher. While the difference is not significant when we pool first and second wives (Column (1) of Table 2.2), second wives contribute significantly larger amounts when playing with first wives than with husbands (Column (3) of Table 2.2). First wives contribute similar amounts when playing with their co-wife and with the husband. Interestingly, husbands make a larger contribution when playing with the first wives in line with the existing norm favoring them in polygamous households (Column (4) of Table 2.2). This confirms that second wives have a dual disadvantage regarding access to common resources as they face both gender and rank disadvantages. Second wives' behavior suggests that they are more

contributed everything ends up losing 500 FCFA, while the non-contributing player gains 1500 FCFA, bringing his total revenue to 3500 FCFA.

Table 2.2: Contribution in equal share games in polygamous households: regression analyses

	Wives			**Husband**
	All	**Wife 1**	**Wife 2**	
	(1)	(2)	(3)	(4)
Polygamous Wife1-Wife2	2.24	0.12	4.36**	
	(1.52)	(2.18)	(2.08)	
Husband-Wife2				−4.19*
				(2.21)
Reference	*Husband-Wife*			*Husband-Wife1*
Individual FE	*Yes*	*Yes*	*Yes*	*Yes*
Mean contribution (Y)	85.10	85.29	84.91	86.57
Observations	344	172	172	172

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.
Note: This table presents variation in contribution rates Y (as percent of initial endowment) in bilateral games in polygamous households using Fixed effect estimation of Equation 2.1. In all the games, participating players contribute, and the total revenue in the common pot (total contribution*1.5) is shared equally among them. Each column represents the player. Standard errors in parentheses are bootstrapped and clustered at the village level.

willing to cooperate with the spouse with whom they share at least one dimension of disadvantage. In the next section, we delve into whether co-wives can prioritize their own interests at the expense of their husbands' interests.

2.4.2 Three-people games: who sets the shares matters!

We now turn to games where co-wives and husbands jointly contribute so that the collective pot is shared among three players. Our objective is to examine how individual behavior responds to the decision-making rule regarding the allocation of the collective pot. We are interested in particular in co-wives' willingness to depress the husband's share when given the opportunity. As detailed in Subsection 2.3.3, households played three public good games where the shares accruing to each member were set by one, some, or all household members. In game T1, the husband privately set the shares (they were not communicated to the other players). In game T2, all members (husband and wives) discussed and decided on the shares and in game T3 the wives jointly decided on the shares (and again they were not communicated to the husband).

Table 2.3 displays descriptive statistics for the average share of each partner in each type of game in polygamous households. The first column of Table 2.5 compares women's shares across treatments in a regression framework.[14] Three main findings emerge from these tables. First, husbands' share is larger than wives' share, except in the case where wives decide alone on the allocation (T3), which is the treatment furthest from the usual functioning of these households.

Table 2.3: Average individual shares across games

	Total average	*Husband Alone T1*	*Joint Decision T2*	*Wives alone T3*	*Pairwise t-test*	
	(1)	(2)	(3)	(4)	(3)-(2)	(4)-(2)
Husband	36.75	45.39	39.94	24.92	-5.45***	-20.48***
	(13.98)	(12.09)	(10.97)	(9.82)		
Wife 1	32.28	27.84	30.97	38.04	3.13***	10.20***
	(7.83)	(6.42)	(7.54)	(5.66)		
Wife 2	30.96	26.77	29.08	37.04	2.32**	10.27***
	(7.13)	(6.29)	(5.34)	(5.17)		
Observations	258	86	86	86	172	172

Note: This table presents the average shares (in percentage of total revenue) allocated to each player by the decision maker(s). To construct these share, we proposed three scenarios of revenue in the common pot to the decision makers, and we asked them to allocate the revenue among all players. All players contribute, knowing who defines the rules but unaware of their individual share if they were not involved in decision making. T1 - The husband decides alone on sharing rules; T2 - All spouses decide together on sharing rules; T3 - The wives decide alone on sharing rules. Note */**/*** pairwise mean difference significant at 10%/5%/1%. Standard deviations in parentheses.

Second, across treatments, individuals obtain a larger share of the collective pot when they have been associated to the decision process. As a result, the most equitable shares are reached in T2. While women obtain more in T2 than in T1, the allocation in T2 remains more strongly in favor of husbands: they secure a share of 0.40 on average (more than 10 percentage points more than the second wife).

Finally and importantly, when given the opportunity to set the rules, wives strongly depress the husband's share (to 0.25 on average) as compared to his share in T1 or T2 (where it is 0.45 or 0.40). This is an important finding because it reveals that co-wives are ready to coalesce to decide on a rule that is in their favor, and very different from the rule set in the husband's presence. While such a behavior may be expected in a classic experimental setting where two players have an interest in coalescing against a third, this finding is remarkable in a polygamous context. This is because, if co-wives would be very untruthful and in a very conflict-prone relationship, we may expect them to simply follow

[14] Estimating equation 2.1 with *share* as the Outcome Y, and including an interaction between coplayer and the type of game.

the husband's rule[15] and not agree to change it in their favor.[16] Note that we are not in a position to compare the shares set in T3 with an alternative treatment where one of the wives and the husband would have decided over shares together (in the absence of the other wife).[17] We thus cannot compare the propensity to coalesce with a co-wife and with the husband (yet, in our opinion, this does not undermine the argument that co-wives' cooperation is non-trivial). The cooperation between co-wives in this game is further confirmed by the amounts of their contributions (Table 2.4 and Column 2 of Table 2.5): they contribute substantially more in T3 than in T1 or T2 (recalling that, even if shares are larger, the individual pay-off maximizing behavior remains to contribute nothing).

A more systematic analysis of contributions (Table 2.4 and Columns 2 of Table 2.5) reveals that husbands tend to contribute more than women and that women's contributions are higher when they are associated to the decision (and their share in the pot is higher). This is true of husbands as well, although they appear less sensitive to the share they secure: although their share is lower in T2 than in T1 they do not contribute less on average. It is only in T3 (where they were not involved in rule setting) that husbands substantially decrease their contribution.

In short, the analysis of members' behavior across treatments suggests that co-wives are ready to ally against the husband and decrease his share when they decide among themselves about the allocation of the pot. The husband, while ignorant of his wives' decision, may anticipate this outcome as he decreases his contribution in this treatment.

[15] For example the sharing rule established in T2, where all spouses jointly decide and are therefore all aware of the allocation.

[16] One might argue that the reduction in the husband's share when women decide on rules (T3) could be a result of game-related retaliation, as the husband retains a larger share in the joint decision game (T2). We can use the game randomization to investigate this possibility and check whether the husband's share in T3 is a function of his share in T2, depending on the game order. Specifically, we run an OLS regression with the husband's share in T3 as the dependent variable and as the main variable of interest, an interaction between game order and the husband's share in T2. Results are in Table 2.A.7 in the appendix. The interaction is not significantly different from zero suggesting that game-related retaliation is not present.

[17] We had to choose among treatments to maintain the duration of a session below two hours to limit players' fatigue. Choosing this alternative treatment would have meant playing it successively with each wife (increasing the number of games by 2) to avoid any presumption of more favorable treatment of one wife.

Table 2.4: Average individual contribution in players-set shares games

	Total average	*Husband Alone T1*	*Joint Decision T2*	*Wives alone T3*	*Pairwise t-test*	
	(1)	(2)	(3)	(4)	(3)-(2)	(4)-(2)
Husband	83.86	87.73	87.56	76.28	-0.17	-11.45***
	(22.58)	(20.11)	(20.90)	(24.76)		
Wife 1	79.83	74.24	81.22	84.01	6.98*	9.77***
	(23.02)	(26.72)	(22.33)	(18.40)		
Wife 2	76.92	69.07	80.17	81.51	11.10**	12.44***
	(27.90)	(30.80)	(27.11)	(24.00)		
Observations	258	86	86	86	172	172

Note: This table presents contribution rates as a percentage of the initial endowment for each game. In all the games the players define the sharing rules of the revenue in the common pot. The game treatments include: T1 - The husband decides alone on sharing rules; T2 - All spouses decide together on sharing rules; T3 - The wives decide alone on sharing rules.. Note */**/*** pairwise mean difference significant at 10%/5%/1%. Standard deviation in parentheses.

In summary, results presented in this section suggest that co-wives tend to cooperate with each other, at least as much as with their husband: in bilateral games, they are at least as cooperative (and sometimes more) with their co-wife than with the husband and, when given the opportunity, they coalesce to depress the husband share of resources. Furthermore, household members tend to cooperate more in games where they had a chance to participate in setting shares (and receive larger share).

Table 2.5: Player-set shares and contributions: regressions analyses

	Wives Shares	**Contributions**
	(1)	(2)
Joint decision T2 (A)	3.13***	−0.17
	(0.92)	(2.08)
Wives alone T3 (B)	10.20***	−11.45***
	(1.15)	(3.45)
T2 × Wife 1 (C)		7.15**
		(3.39)
T2 × Wife 2 (D)	−0.82	11.28***
	(0.87)	(3.92)
T3 × Wife 1 (E)		21.22***
		(4.92)
T3 × Wife 2 (F)	0.07	23.90***
	(0.67)	(4.84)
Reference	*Husband alone (T1)*	
Individual FE	*Yes*	
Coefficients A+C		6.98
Test A+C=0 (p-val)		0.01
Coefficients A+D	2.32	11.10
Test A+D=0 (p-val)	0.00	0.00
Coefficients B+E		9.77
Test B+E=0 (p-val)		0.00
Coefficients B+F	10.27	12.44
Test B+F=0 (p-val)	0.00	0.00
Mean Y	31.62	77.02
Observations	516	774

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

Note: This table presents variation (in percentage points) in individual share (as percent of the total revenue) and contribution rates (as percent of initial endowment) across games using Fixed effect estimation of Equation 2.1. In Column 1, only wives are observed (interaction terms contrasting first and second wives) while in column 2 husbands are observed in addition (interactions contrasting husbands and wives 1 and 2). In all the games, the players define the sharing rules. The game treatments include: T1 - The husband decides alone on sharing rules; T2 - All spouses decide together on sharing rules; T3 - The wives decide alone on sharing rules. Standard errors in parentheses are bootstrapped and clustered at the village level.

2.5 Women's agency and cooperative behavior

The question we take up now is whether the cooperation across games highlighted above is a function of the wives' agency, both in the game and in real life. As suggested in Section 2.2, individual members' incentive to cooperate may be low when they have low agency, because they have less say over the allocation of collective resources and little to gain from cooperation.

2.5.1 Agency in the games

The level of agency of individual players differs across games, depending on whether or not they are involved in deciding over shares. The descriptive analysis presented above suggests that individuals tend to contribute more when they participate in the decision-making regarding shares. Yet they also secure larger shares in this case, and may simply react to this increased stake in the collective pot. To explore more systematically whether contributions to the household public good are sensitive to the decision-making process (controlling for its effect on shares), we turn to a regression framework and estimate the following regression with individual fixed effect, where $contribution_{i,g}$ is the fraction of his/her endowment that player i contribute to the common pot in the player-set rules game g:

$$contribution_{i,g} = \alpha * participation_{i,g} + \beta * share_{i,g} + \gamma * belief_{-i,g} + I_i + \epsilon_{i,g} \tag{2.2}$$

The binary variable $participation_{i,g}$ takes the value 1 if the individual took part in the decision-making process in game g (T1 and T2 for the husband; T2 and T3 for wives). The variable $share_{i,g}$ corresponds to the share of the collective pot accruing to player i in-game g. We also control for beliefs regarding others' contributions, $belief_{-i,g}$. This is because, as detailed in Section 2.2, household members are typically conditional cooperators in the sense that their contribution is positively correlated with their expectation of others' contributions. It is interpreted as a form of reciprocity.

Results are reported in Table 2.6. Individual contributions appear strongly correlated with participation in the decision and also with individual shares and beliefs about others' contributions. It is striking that the coefficients on all three variables are quite similar for husbands and wives (columns 2 and 3 of Table 2.6). Participation in the decision has a strong impact on contribution: having taken part in the decision regarding shares increases contributions by 7 percentage points for men and 6.7 for women, suggesting that there is more to participation than just securing a higher share of the resources. Participating in the decision on individual shares empowers members to have a voice in the setting of the rule and may thereby trigger additional incentives to co-

Table 2.6: Participation in defining the shares, beliefs and contribution in polygamous households

	All	**Wives**	**Husbands**
	(1)	(2)	(3)
Participate	6.88***	6.73***	7.02**
	(1.90)	(2.04)	(3.12)
Share	0.28**	0.29**	0.27
	(0.14)	(0.14)	(0.19)
Belief about partner	0.39***	0.41***	0.36***
	(0.06)	(0.08)	(0.07)
Individual FE	*Yes*	*Yes*	*Yes*
Mean Contribution (Y)	80.87	79.17	84.27
Observations	774	516	258

* $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Note: This table presents the estimated coefficients of Equation 2.2 using fixed effect models. The outcome variable is the contribution rate when players establish the sharing rules for the total revenue. The variable 'participate' takes a value of 1 if the player was involved in defining the sharing rules (T1 and T2 for the husband; T2 and T3 for wives). 'Share' represents the individual share in each game. 'Beliefs about partner' indicate the guess about the contribution rate of the playing partners (as a percentage of the initial endowment). Standard errors in parentheses are bootstrapped and clustered at the village level.

operate, beyond the share obtained in the division of the collective pot. This participation likely gives an additional sense of control of collective resources and a sense of commitment (Dannenberg et al., 2014).[18]

Furthermore, men and women increase their contribution by 0.27 and 0.29 respectively when the share they obtain from the collective pot increases by 1 percentage point. This is not surprising since the "cost of contribution", measured as the loss of individual pay-off, is decreasing in the share. Men and women also increase their contribution by 0.36 and 0.41 percentage points respectively when they expect their partners to contribute 1 more percentage point, a behavior termed "conditional cooperation" by the literature (see Section 2.2).

When we further distinguish between the behavior of the first and second wife in polygamous unions (Column 3 to 5 of Table 2.A.6 in ap-

[18] Another reason why participation may also increase contribution is that it implies that there is no uncertainty about one's share. When a player is not part of the decision-making process, s/he does not learn about the share actually chosen.

pendix), it appears that second wives and husbands are more sensitive to the participation in the decision than first wives (coefficients A+C). Second wives, as described above, are typically the least empowered individuals in the household and may particularly value this participation, which is more disruptive from their daily life in the household (and strikingly the coefficient on "share" is much reduced in their case once participation is taken into account, coefficient D+F). The same argument could apply to explain the strong effect of participation for polygamous husbands (column 5): they are typically setting the rules and when deprived of this prerogative they substantially decrease their contribution, even after controlling for the share they expect to obtain. This discussion suggests that individual voice in the decision-making process is of importance for collective behavior (in contrast to a classic collective model of households, where efficiency is reached regardless of the distribution of shares). In the next section, we delve more directly into this possibility, focusing on the correlation between the agency of co-wives in real life and their cooperative behavior.

2.5.2 Women agency in life

In real life, households differ in women's level of agency and we now explore whether women's cooperative behavior in the game is correlated with their agency in life. More specifically, we construct household-level indicators of (lack of) women's agency using survey information and we investigate whether women with lower levels of agency tend to behave more cooperatively with each other and less with their husband. Because we expect alliances between wives to be particularly strong when they both lack agency in their household, our preferred indicators of "lack of agency" take value one when *both* wives are deprived of agency in the dimension considered.[19] In the appendix, we also report results with alternative indicators of lack of agency, constructed at the individual wife level (we comment briefly on these results at the end of the section).

To measure the lack of agency, we build four indicators based on survey questions, and two aggregate indexes and we use the husband

[19]If one wife is deprived of agency but the co-wife is not, the later may have more say in the household and more to lose in allying with the woman with low agency against the husband (who may have the power to deprive her of the control she has over resources).

share in T1 and T2 as measures of his bargaining power (higher husband power implies lower wives power).[20] The first indicator, "Have no say on collective fields", is based on women's participation in agricultural decisions and takes value 1 if the two wives declared having no say in the management of collective fields. The second indicator, "Do not manage food", takes value 1 if the wives rarely manage the distribution of cereals (when the husband declared being the only one to distribute cereals among co-wives). The third indicator, "exchange marriage", takes value 1 if both wives' marriage were based on an arrangement between families that avoids bride-price and precludes separation (see details in Section 2.3). The fourth indicator, "Do not know husband's savings" takes value 1 if wives declare having no information on husbands' savings.[21] We aggregate the four variables in one index which is a simple mean of the four variables. In addition, because the measure of "Have no say on collective fields" is not available for all households, we build an alternative aggregate index based on the last three measures of lack of agency.[22]

To understand whether wives' agency influences their level of cooperation with each other, we exploit both bilateral games and games with endogenously set shares. In bilateral games, we investigate whether women with low agency tend to cooperate more with their co-wive than with their husband and estimate the same model as in Equation 2.1, interacting the identity of the coplayer with an indicator of lack of agency.

Table 2.7 reports the results and weakly confirms our intuition. With three indicators of agency, we find that the interaction between the agency indicator and playing with the husband (HpWp) is negative and

[20] While the latter measure is based on game-behavior, we take it as an indicator of women bargaining power in real life and include it in this sub-section where we focus on inter-household heterogeneity, rather than in the previous section that focused on inter-game heterogeneity in agency.

[21] The first two indicators may be considered important measures of women's agency in our agricultural context, where the collective field is the primary common resource and cereals are the main nutritional product. The exit option, often cited in the literature as a proxy for the agency, is severely limited in exchange marriages within our context. Interviews have shown that husbands unilaterally manage household finances, including income from selling collective production. Therefore, lacking information on household finances may be regarded as a proxy for agency.

[22] A mistake in the questionnaire implied that women with no individual fields, about 15%, were not asked this question.

Table 2.7: Polygamous wives agency and contribution in bilateral game

	Collective Field	Food	Marriage	Savings	Mean agency (2-4)	Mean agency (1-4)	Share in T1	Share in T2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Husband-Wife HpWp (A)	1.48	0.57	−2.36	−6.07	2.48	7.14**	−7.15	−7.51
	(1.97)	(1.31)	(1.66)	(6.13)	(2.78)	(3.04)	(7.57)	(5.57)
HpWp × Have no say on collective field	−4.53*							
	(2.72)							
HpWp × Don't manage food		−7.31**						
		(3.26)						
HpWp × Exchange marriage			0.69					
			(2.84)					
HpWp × Don't know husband's saving				4.17				
				(6.54)				
HpWp × Mean Agency 2					−9.58			
					(6.40)			
HpWp × Mean Agency						−15.83***		
						(6.02)		
HpWp × Husband share in T1							0.11	
							(0.16)	
HpWp × Husband share in T2								0.13
								(0.14)
Reference (ref.)					*Wife1-Wife2*			
Individual FE					*Yes*			
Coeffients A+(A × agency indicator)	-3.05	-6.74	-1.67	-1.90	-7.10	-8.70	-7.04	-7.38
Test A+ (A × agency)=0 (p-val)	0.17	0.02	0.51	0.27	0.09	0.02	0.34	0.17
Mean of agency indicator	0.50	0.38	0.17	0.92	0.49	0.50	45.39	39.94
Observations	256	344	344	344	344	256	344	344

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

Note: This table presents the estimated coefficients of Equation 2.1 using fixed effect models. The outcome variable is the contribution rate in polygamy in bilateral games with an equal share of the revenue in the common pot. The table compares the contribution rates of polygamous wives when playing with their husbands (HpWp) versus when playing with their co-wives (Wife1-Wife2) while interacting with the following lack of agency proxies: "Have no say on collective fields" equals 1 if the two wives declared having no say in the management of collective fields; "Don't manage food" equals 1 if the wives rarely manage the distribution of cereals (as reported by the husband); "exchange marriage" equals 1 if both wives' marriage was based on an arrangement between families that avoids bride-price and precludes separation (see details in Section 2.3); "Don't know husband's saving" equals 1 if wives declare having no information on their husbands' savings. Mean Agency represents the simple average of lack of agency indicators. Mean Agency 2 considers 3 indicators of agency (Due to missing data in the variable 'no say on collective field'). Husband share in T1 and T2 represents the individual share allocated to the husband when he decides alone on sharing rules (T1) or when all spouses decide together (T2), respectively. Standard errors in parentheses are bootstrapped and clustered at the village level.

significantly different from zero, suggesting that women with low agency tend to contribute relatively less when playing a public good game with their husband (relative to their contribution with their co-wife). For example, women who report having no say in collective field decisions decrease their contributions by an additional 4.5 percentage points when playing with their husbands (column 1). Yet with other indicators, the estimated coefficient on the interaction term is not significantly different from zero.

Turning to games with endogenously set shares, we investigate whether women with low agency take more advantage of the opportunity to decrease their husband share from the collective pot (suggesting that they are more willing to ally against the husband). While women participate into decisions regarding shares in T2 and T3, it may be easier for them to depress the husband's share in T3 since he is absent and does not learn about it. In practice we estimate the following equation with

household fixed effects:

$$husband\_share_{h,g} = \alpha * game_g + \beta * game_g \times agency_h + H_h + \epsilon_{h,g} \quad (2.3)$$

where the indices h and g represent the household and the game. The variable *husband_share* indicates the share of the collective pot accruing to the husband in game g. The variable *agency* equals 1 if the two co-wives report lacking the agency indicator. H denotes the household fixed effects. Standard errors are bootstrapped and clustered at the village level.

Table 2.8: Polygamous wives agency and husband shares

	Collective Field	**Food**	**Marriage**	**Savings**	**Mean agency (2-4)**	**Mean agency (1-4)**	**Share in T1**	**Share in T2**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Joint decision T2 (A)	−3.44	−5.10***	−5.38***	−0.48	−3.03	−1.31		
	(2.43)	(1.48)	(1.38)	(6.29)	(2.88)	(4.66)		
Wives alone T3 (B)	−17.14***	−19.41***	−19.09***	−11.23*	−11.32**	−10.79*	14.17***	6.20
	(2.45)	(2.50)	(2.09)	(6.08)	(5.42)	(5.66)	(3.20)	(5.93)
T2 × Have no say on collective field	−2.62							
	(3.32)							
T3 × Have no say on collective field	−5.95*							
	(3.40)							
T2 × Don't manage food		−0.91						
		(1.52)						
T3 × Don't manage food		−2.79						
		(3.50)						
T2 × Exchange marriage			−0.40					
			(3.17)					
T3 × Exchange marriage			−7.96					
			(5.54)					
T2 × Don't know husband's saving				−5.42				
				(6.57)				
T3 × Don't know husband's saving				−10.07*				
				(5.82)				
T2 × Mean Agency 2					−4.92			
					(4.58)			
T3 × Mean Agency 2					−18.61*			
					(9.90)			
T2 × Mean Agency						−6.89		
						(8.09)		
T3 × Mean Agency						−18.66		
						(11.49)		
T3 × Husband share in T1							−0.64***	
							(0.09)	
T3 × Husband share in T2								−0.67***
								(0.14)
Reference					*Husband alone (T1)*			
Individual FE					*Yes*			
Coefficients A+(A × Agency)	-6.06	-6.01	-5.78	-5.89	-7.95	-8.19		
Test A+(A × Agency)=0 (p-val)	0.00	0.00	0.03	0.00	0.00	0.03		
Coefficients B+(B × Agency)	−23.09	−22.19	−27.05	−21.30	−29.92	−29.45	13.53	5.53
Test B+(B × Agency)=0 (p-val)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34
Mean of agency indicator	0.50	0.38	0.17	0.92	0.49	0.50	45.39	39.94
Observations	192	258	258	258	258	192	172	172

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

Note: This table presents the estimated coefficients of Equation 2.3 using fixed effect models. The outcome variable is the individual share of the husband when players define the rules of allocation of the revenue in the common pot. The table presents the change in the share of polygamous husbands in T1 (Husband decides alone on sharing rules), T2 (all spouses decide together) and T3 (co-wives decide alone); interacting with the following lack of women's agency proxies: "Have no say on collective fields" equals 1 if the two wives declared having no say in the management of collective fields; "Don't manage food" equals 1 if the wives rarely manage the distribution of cereals (as reported by the husband); "exchange marriage" equals 1 if both wives' marriage was based on an arrangement between families that avoids bride-price and precludes separation (see details in Section 2.3); "Don't know husband's saving" equals 1 if wives declare having no information on their husbands' savings. Mean Agency represents the simple average of lack of agency indicators. Mean Agency 2 considers 3 indicators of agency (Due to missing data in the variable 'no say on collective field'). Husband share in T1 and T2 represents the individual share allocated to the husband when he decides alone on sharing rules (T1) or when all spouses decide together (T2), respectively. Standard errors in parentheses are bootstrapped and clustered at the village level.

Table 2.8 reports the results. If women with low agency are more likely to ally and depress the husband's share, we would expect the interaction between T3 and the low agency indicator to be negative. This is the case for all eight measures we use and for five indicators the estimated coefficient on the interaction term is significantly different from zero. The effect of lack of agency is large. For example, results reported in column 5 (using a mean agency indicator) suggest that, in a household where co-wives lack agency according to the three indicators, co-wives depress the husband's share by an additional 19 percentage points in T3, compared to a household were co-wives would not jointly lack agency according to any of the three indicators. The results using the husband's share in T1 or even in T2 (columns 7 and 8) also confirm that women agree to decrease his share substantially when they have low bargaining power to start with. This last point is further illustrated by Figures 2.A.1 and 2.A.2 in the appendix which plot the cumulative distribution of the difference in the husband share in T3 and T2 (Figure 2.A.1) and T3 and T1 (Figure 2.A.2), separately for women with a low agency indicator and other women (for the various binary indicator measures). It is striking that the cumulative distribution for women with relatively lower levels of agency almost always first-order stochastically dominates the distribution for women with relatively higher levels of agency: the former are more likely to decrease the husband share when they decide among themselves about it.

Finally, Table 2.A.9 and 2.A.10 in the appendix provide similar analyses when we use indicators of lack of agency defined at the woman level (instead of household indicators of lack of agency for both women). If only one wife has a low level of agency, it is not clear that cooperation among co-wives will be particularly strong.[23] The results confirm this intuition: while the signs of the estimated coefficients suggest that women with low agency tend to be relatively more cooperative with their co-wife, the coefficients on the interaction terms are less often significantly different from zero.

Taken together, our results suggest that, when mutual interests are at stake, co-wives with low agency exhibit relatively higher levels of cooperation (compared to their cooperation with the husband). Additionally,

[23] See Footnote 19.

to protect their interests, they are more inclined to form coalitions and undermine their husbands' interests. We argue that since co-wives lack agency, they have little to gain by cooperating with the husband (as he likely appropriates most of the surplus from cooperation) and more to gain by cooperating with each other (as they increase their chances of improved access to common resources).

2.6 Overall cooperation and household efficiency: a comparison of monogamous and polygamous households

Our analyses so far suggest that, in polygamous households, the co-wives cooperation level is not lower than the cooperation between husband and wife and that woman agency is an important determinant of co-wives cooperation. In polygamous households, whether in the games or in life, husbands control an important share of collective resources. This implies that co-wives may have little to gain from cooperating with the husband (but may instead have incentives to ally with the co-wife). This conjecture suggests that inefficiencies (or lack of cooperation) in households may be related to the lower individual bargaining power of women.

In this section, we turn to a comparison of polygamous and monogamous households to investigate whether cooperative behavior differs fundamentally across household types. First, we compare overall cooperation levels between monogamous and polygamous households. We then explore whether the determinants of cooperation differ across monogamous and polygamous households, focusing on the share of the collective pot obtained by individual members, their participation in the decision regarding shares, and the belief about other's contribution.[24]

[24]Systematic differences across monogamous and polygamous households may be due to differences in the incentive to cooperate but also to differences in the "type of individuals" who are monogamous versus polygamous household members. In other words, the selection of specific members into one or another type of household could drive systematic differences. To investigate the potential selection of more cooperative individuals in monogamous households (for example), we compare the propensity to cooperate with a stranger (in a Public Good Game) across household types (Barr et al., 2019). Results in Table 2.A.8 in the appendix indicate that contribution rates when playing with strangers do not depend on the type of

To quantify effective cooperation in households, we rely on the household average contribution to the collective pot (expressed in percent). This average is equivalent to the ratio of the effective household gain from cooperation to the maximum achievable gain and can thus be interpreted as a measure of household efficiency.[25]

Table 3.2 provides descriptive statistics of household efficiency in each game, distinguishing between monogamous and polygamous couples. T-tests of equality of means are reported at the bottom of the table. Table 2.10 provides the same evidence in a regression framework, corresponding to the following linear equation:

$$efficiency_{h,g} = \alpha * game_g + \beta * game_g \times monogamous_h + X_h + \epsilon_{h,g} \quad (2.4)$$

where X_h represents game and household characteristics, including enumerator fixed effect (FE), village FE, game order, number of children, husband age, husband ethnicity, husband religion, husband education, whether husband works outside the household, household assets, whether husband has an income generating activity.[26] Standard errors are clustered at the village level. Columns 1 and 2 focus on bilateral games with equal shares (without and with household control variables) while column 3 includes games with player-set shares (with T1, where husbands decide alone about shares as the excluded category).[27]

The comparison of monogamous and polygamous households reveals that efficiency levels are higher in monogamous households, yet only in equal share games. Indeed figures reported in Panel A of Table 3.2 (and columns 1 and 2 of Table 2.10) reveal that for all two-by-two games in

household for both men and women, suggesting the absence of selection. It can also be noted that polygamy is often a transitory situation for an individual, following and/or followed by periods of monogamy.

[25] Let $\bar{\alpha}$ be the average fraction of their endowment that household members contributed to the collective pot. In a polygamous household, the net gain to the household of this average level of contribution is $0.5 * 3 * \bar{\alpha} e$ (with e being the individual endowment). The ratio of effective to maximum gain is then $\frac{0.5*3*\bar{\alpha}e}{0.5*3*e} = \bar{\alpha}$. The same reasoning applies to monogamous couples. $\bar{\alpha}$ thus represents the share of potential gain actually realized by the household.

[26] For descriptive statistics of control variables, see Table 2.1

[27] It is important to clarify that T1 is consistent across both polygamous and monogamous households, as the husband decides sharing rules. T2 involves joint decision-making by both spouses in monogamous households and by all three spouses in polygamous households. In T3, in monogamous households, the sole wife makes the allocation decision, while in polygamous households, decisions are made jointly by the two co-wives.

Table 2.9: Household efficiency across games: averages

	Equal Share	**Husband alone (T1)**	**Joint Decision(T2)**	**Wives alone(T3)**
	(A)	(B)	(C)	(D)
Monogamous Husband-Wife (1)	90.90	79.71	82.33	82.44
Polygamous Husband-Wife1 (2)	86.95			
Polygamous Husband-Wife2 (3)	83.60			
Polygamous Wife1-Wife2 (4)	86.22			
Polygamous Husband-Wife1-Wife2 (5)	82.89	77.02	82.98	80.60
Pairwise t-test (p-values)				
(1) vs (2)	0.08			
(1) vs (3)	0.00			
(1) vs (4)	0.06			
(1) vs (5)	0.00	0.36	0.83	0.47
N	86	86	86	86

Note: This table presents rates of efficiency, defined as the share of actual gain in the maximum potential gain (full cooperation gain). Each row represents the players involved in the game. In the "Equal share" games, all the participating players contribute and the total revenue in the common pot (total contribution*1.5) is shared equally among players. In T1, the husband makes the allocation decisions for the revenue in the common pot alone; in T2 all spouses decide together on sharing rules; In T3 the wives (wife) decide(s) alone on sharing rules. The four penultimate lines report the p-values of the test of equality of means (of efficiency).

polygamous couples (husband playing with either wife or wives playing with each other), efficiency is significantly lower in polygamous households. Yet the differences often lose their statistical significance when we add controls (column 2 of Table 2.10), even if the sizes of coefficients remain similar. In contrast, the differences between monogamous and polygamous households vanish in games with players-set shares (Table 3.2, pairwise ttest (1) vs (5)). The lack of difference between monogamous and polygamous households in the second set of games is an important result, as these games are more likely to reflect real-life situations, where gains from cooperation are not equally shared across household members and where sharing rules are household-specific. Taken at face value, this result suggests that willingness to cooperate in a classic public good game (with equal shares) may not reflect actual cooperation levels when household-relevant shares are applied.

The contrast between monogamous couples' behavior in equal-share games and their behavior in player-set games is intriguing. Our discussion about incentives to cooperate (in polygamous households) suggests that if players expect lower share of the public good they may decrease their contribution. Table 2.A.2 in the appendix reports shares across treatments in monogamous households and suggests that, on average, these remain more balanced than in polygamous households. Yet these averages may hide heterogeneity and we now test whether members of monogamous households respond to the same incentives to cooperate as members of polygamous households.

To this end, we estimate again Equation 2.2 including monogamous

Table 2.10: Household efficiency across games: regression analysis

	Equal shares (bilateral)		**Player-set shares**
	(1)	(2)	(3)
Polygamous Husband Wife1	−3.95**	−3.07	
	(1.71)	(2.57)	
Polygamous Husband-Wife2	−7.30***	−6.41**	
	(2.10)	(2.76)	
Polygamous Wife1-Wife2	−4.68**	−3.80	
	(2.23)	(3.04)	
Joint Decision T2 (A)			5.97***
			(1.80)
Wives alone T3 (B)			3.59*
			(1.81)
T2 × Monogamous (C)			−3.35
			(2.96)
T3 × Monogamous (D)			−0.85
			(3.09)
Monogamous			1.65
			(4.08)
Reference	*Monogamous*	*Husband-Wife*	*Husband alone*
Controls	*No*	*Yes*	*Yes*
Coefficients A+C			2.62
Test A+C=0 (p-val)			0.35
Coefficients B+D			2.73
Test B+D=0 (p-val)			0.17
Mean Efficiency (Y)	86.92	86.92	80.85
Observations	344	344	516

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

Note: This table presents the variation in efficiency rates across treatments using OLS estimation of Equation 3.A.1. Efficiency is defined as the proportion of actual gain to the maximum potential gain (full cooperation gain). In the "Equal share" games, all participating players contribute, and the total revenue in the common pot (total contribution*1.5) is shared equally among them. The first three rows present the players involved in the bilateral games with equal shares. In Player-set share games, the decision-maker regarding sharing rules varies. In T1, the husband makes the allocation decisions for the revenue in the common pot alone; in T2, all spouses decide together on sharing rules; in T3, the wives (or wife) decide(s) alone on sharing rules. Controls include: enumerator Fixed Effects (FE), village FE, game order, number of children, husband age, husband ethnicity, husband religion, husband education, whether the husband works outside the household, household assets, and whether the husband has an Income-Generating Activity. Standard errors in parentheses are clustered at the village level.

households and interacting the determinants of cooperation with a binary variable for polygamous households. Results are reported in Table 2.A.5 in the appendix. It is striking that members of monogamous and polygamous households react similarly to their participation in the decision-making process and to the share[28] they obtain in the games: the interaction terms between polygamous and these variables are not significantly different from zero (even if the size of the interaction between

[28]Even if shares are not known by all players (except in T2), it is likely that they form expectations regarding these shares and contribute accordingly.

participation and polygamy is not small and suggest that members of polygamous households may be more sensitive to this aspect).

An interesting contrast emerges for the role of belief about other's contribution: it is a stronger determinant of contribution in polygamous than in monogamous households. In three-player games (in polygamous households), we observe that each co-wife's contribution depends on her belief regarding the other co-wife's contribution, rather than on her belief regarding the husband's contribution. As for the husband's contribution, it is positively correlated with his belief regarding the first wife's contribution and is independent of his belief about the second wife's contribution (see Table 2.A.6, columns 4 and 5 in appendix). The contrasted effect of belief about co-wife versus belief about husband contribution on polygamous women contribution echoes with findings by Barr et al. (2019) in Nigeria. They conclude that reciprocity motivates co-wife cooperation while the husband-wife relationship is more likely altruistic.

All in all, our comparison of monogamous and polygamous household suggest that overall levels of cooperation are not fundamentally different across these household types (especially when household members themselves set sharing rules, as is the case in real life). This finding contrasts with the existing literature on public good games in polygamous versus monogamous households. Yet this literature relies on PGG with equal shares, which, as seen above, trigger more cooperative behavior than games with endogenously set shares (which are more likely to reflect reality). Furthermore, individual stakes in collective gains (shares) are very important determinants of cooperative behavior, both for monogamous and polygamous household members and they are overall quite sensitive to their participation in the decision-making process. The only strong difference between household types relates to the role of belief: it seems that polygamous household members are more likely to be conditional cooperators than monogamous members, possibly because altruism levels are lower.

Finally, a last important conclusion of the analysis is that, when women are involved in setting the shares (T2 and T3), efficiency levels are higher. Indeed, T1 corresponds to the lowest level of efficiency for both types of households (even if, in monogamous households, the differ-

ence in efficiency between T1 and T2 or T3 is not significantly different from zero): when husbands decide on their own on the share allocated to others (in line with the prevailing norm), the average contribution in the household is the lowest (column 3 of Table 2.10).

2.7 Concluding discussion

Our analyses reveal that in polygamous households in northern Benin, co-wives are more cooperative with each other than with their husband. In comparable public good games, Barr et al. (2019) and Munro et al. (2019) found the opposite in northern Nigeria. We hypothesize that the difference may stem both from the fact that we allow for player-set allocation rules and from the very low level of agency of women in Benin that increases incentives for wives to cooperate with each other more than with their husbands. Our findings suggest that, within our sample, women with less agency are more willing to coalesce and play against their husband's interests. As discussed by Baland & Ziparo (2018), these women have relatively little to lose by being less cooperative with their husbands. Co-wives who face challenges in obtaining better access to resources individually will be more likely to form a coalition and play against the husband (as suggested by theories of coalition formation in contests detailed in Section 2.2).

Another important result is that when women participate in the decision regarding sharing rules, they tend to contribute more to the public good even if husbands retain the highest share of common resources. Efficiency levels in polygamous households are high in this case. In this regard, our findings somehow contrast Verschoor et al. (2019) who suggest that allocations deviating from prevailing social norms result in lower levels of contribution and efficiency in public good games. Indeed in our case, granting women decision-making authority increases their willingness to cooperate among themselves, consequently leading to greater efficiency (even if the husband's contribution significantly decreases in that case).[29] This conclusion somehow echoes randomized control trials

[29] If there is some reluctance of women to deviate from prevailing decision-making processes, cooperation levels elicited in our games may be a lower bound estimate of their willingness to cooperate.

aimed at promoting joint management of collective resources in developing countries (see Pierotti et al., 2023 for a comprehensive review). In the majority of cases, these interventions led to improved intrahousehold dynamics, with women participating more in decision-making regarding collective resources. Findings from Côte d'Ivoire suggested that cooperation led to increased efficiency in agricultural production (Donald et al., 2022).

Appendix

2.A Additional Tables and Figures

Table 2.A.1: Contribution in equal share games: averages

Partner	*Monogamous HH*		*Polygamous HH*			
	Husband	Wife	Husband	Wife 1	Wife 2	*test diff=0*
Player						
Monogamous HH						
Husband		92.21				
Wife	89.59					
Polygamous HH						
Husband				88.66	84.48	0.22
Wife 1			85.23		85.35	0.97
Wife 2			82.73	87.09		0.22
Three players games			85.52	80.35	82.79	

Note: This table presents contribution rates as a percentage of the initial endowment for each game. Each row corresponds to one player and each column to a partner (for example, the figure reported in the first column indicates that monogamous wives contribute on average almost 90% of their endowment when playing with their husband). The last column reports the results of test of equality of means across partners. In all these games, participating players contribute, and the total revenue in the common pot (total contribution*1.5) is shared equally among them. The last column presents the p-values of tests on the equality of means.

Table 2.A.2: Average individual shares across games

	Total average	*Husband Alone T1*	*Joint Decision T2*	*Wives alone T3*	*Pairwise t-test*	
	(1)	(2)	(3)	(4)	(3)-(2)	(4)-(2)
Polygamous Husband	36.75	45.39	39.94	24.92	-5.45***	-20.48***
	(13.98)	(12.09)	(10.97)	(9.82)		
Polygamous Wife 1	32.28	27.84	30.97	38.04	3.13***	10.20***
	(7.83)	(6.42)	(7.54)	(5.66)		
Polygamous Wife 2	30.96	26.77	29.08	37.04	2.32**	10.27***
	(7.13)	(6.29)	(5.34)	(5.17)		
Monogamous Husband	50.07	57.92	51.08	41.23	-6.84***	-16.69***
	(14.91)	(15.28)	(12.56)	(11.76)		
Monogamous Wife	49.93	42.08	48.92	58.77	6.84***	16.69***
	(14.91)	(15.28)	(12.56)	(11.76)		
Observations	258	86	86	86	172	172

Note: This table presents the average shares (in percentage of total revenue) allocated to each player by the decision maker(s). To construct these share, we proposed three scenarios of revenue in the common pot to the decision makers, and we asked them to allocate the revenue among all players. All players contribute, knowing who defines the rules but unaware of their individual share if they were not involved in decision making. T1 - The husband decides alone on sharing rules; T2 - All spouses decide together on sharing rules; T3 - The wives decide alone on sharing rules. Note */**/*** pairwise mean difference significant at 10%/5%/1%. Standard deviations in parentheses.

Table 2.A.3: Average individual contribution in players-set shares games

	Total average	*Husband Alone T1*	*Joint Decision T2*	*Wives alone T3*	*Pairwise t-test*	
	(1)	(2)	(3)	(4)	(3)-(2)	(4)-(2)
Polygamous Husband	83.86	87.73	87.56	76.28	-0.17	-11.45***
	(22.58)	(20.11)	(20.90)	(24.76)		
Polygamous Wife 1	79.83	74.24	81.22	84.01	6.98*	9.77***
	(23.02)	(26.72)	(22.33)	(18.40)		
Polygamous Wife 2	76.92	69.07	80.17	81.51	11.10**	12.44***
	(27.90)	(30.80)	(27.11)	(24.00)		
Monogamous Husband	82.52	84.53	84.30	78.72	-0.23	-5.81
	(22.64)	(23.80)	(21.39)	(22.44)		
Monogamous Wife	80.47	74.88	80.35	86.16	5.47	11.28***
	(25.86)	(27.86)	(27.51)	(20.59)		
Observations	258	86	86	86	172	172

Note: This table presents contribution rates as a percentage of the initial endowment for each game. In all the games the players define the sharing rules of the revenue in the common pot. The game treatments include: T1 - The husband decides alone on sharing rules; T2 - All spouses decide together on sharing rules; T3 - The wives decide alone on sharing rules.. Note */**/*** pairwise mean difference significant at 10%/5%/1%. Standard deviation in parentheses.

Table 2.A.4: Player-set shares and contributions: regressions analyses

	Wives Shares		**Contributions**	
	Monogamous	**Polygamous**	**Monogamous**	**Polygamous**
	(1)	(2)	(3)	(4)
Joint decision T2 (A)	6.84***	3.13***	−0.23	−0.17
	(1.42)	(0.92)	(2.65)	(2.08)
Wives alone T3 (B)	16.69***	10.20***	−5.81***	−11.45***
	(2.96)	(1.15)	(2.21)	(3.45)
T2 × Wife 1 (C)			5.70	7.15**
			(4.24)	(3.39)
T2 × Wife 2 (D)		−0.82		11.28***
		(0.87)		(3.92)
T3 × Wife 1 (E)			17.09***	21.22***
			(4.65)	(4.92)
T3 × Wife 2 (F)		0.07		23.90***
		(0.67)		(4.84)
Reference	*Husband alone (T1)*		*Husband alone (T1)*	
Individual FE	*Yes*		*Yes*	
Coefficients A+C			5.47	6.98
Test A+C=0 (p-val)			0.13	0.01
Coefficients A+D		2.32		11.10
Test A+D=0 (p-val)		0.00		0.00
Coefficients B+E			11.28	9.77
Test B+E=0 (p-val)			0.00	0.00
Coefficients B+F		10.27		12.44
Test B+F=0 (p-val)		0.00		0.00
Mean Y	49.93	31.62	81.49	77.02
Observations	258	516	516	774

* $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Note: This table presents variation (in percentage points) in individual share (as percent of the total revenue) and contribution rates (as percent of initial endowment) across games using Fixed effect estimation of Equation 2.1. In Column 1 and 2, only wives are observed (interaction terms contrasting first and second wives in polygamy) while in column 3 and 4 husbands are observed in addition (interactions contrasting husbands and wife/wives). In monogamous households Wife 1 refers to the unique wife. In all the games, the players define the sharing rules. The game treatments include: T1 - The husband decides alone on sharing rules; T2 - All spouses decide together on sharing rules; T3 - The wives decide alone on sharing rules. Standard errors in parentheses are bootstrapped and clustered at the village level

Table 2.A.5: Participation, beliefs and contribution: regressions analyses

	All		**Wives**		**Husbands**	
	(1)	(2)	(3)	(4)	(5)	(6)
Participate (A)	6.24***	4.08**	6.38***	4.64	5.60***	3.49**
	(1.42)	(2.08)	(1.63)	(3.88)	(1.49)	(1.76)
Participate × Polygamous (B)		2.79		2.09		3.53
		(3.01)		(4.88)		(3.80)
Share (C)	0.26***	0.26***	0.29***	0.31***	0.24**	0.21**
	(0.09)	(0.09)	(0.09)	(0.12)	(0.10)	(0.10)
Share × Polygamous (D)		0.02		−0.02		0.06
		(0.16)		(0.19)		(0.21)
Beliefs about partner (E)	0.27***	0.12*	0.31***	0.13	0.21***	0.09
	(0.05)	(0.06)	(0.08)	(0.11)	(0.06)	(0.08)
Beliefs about partner × Polygamous (F)		0.27***		0.28**		0.26***
		(0.07)		(0.11)		(0.10)
Individual FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Coefficients A+B		6.88		6.73		7.02
Test A+B=0 (p-val)		0.00		0.00		0.02
Coefficients C+D		0.28		0.29		0.27
Test C+D=0 (p-val)		0.04		0.03		0.15
Coefficients E+F		0.39		0.41		0.36
Test E+F=0 (p-val)		0.00		0.00		0.00
Mean Contribution (Y)	81.08	81.08	79.52	79.52	83.52	
Observations	1290	1290	774	774	516	516

* $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Notes: This table presents the estimated coefficients of Equation 2.2 using fixed effect estimations. The outcome variable is the contribution rate when players establish the sharing rules for the total revenue. The variable 'participate' takes a value of 1 if the player was involved in defining the sharing rules (T1 and T2 for the husband; T2 and T3 for wives). 'Share' represents the individual share in each game. 'Beliefs about partner' indicate the guess about the contribution rate of the playing partner (as a percentage of the initial endowment). Standard errors in parentheses are bootstrapped and clustered at the village level.

Table 2.A.6: Participation, beliefs and contribution in polygamous unions: regressions analyses

	All		**Wives**		**Husband**
	(1)	(2)	(3)	(4)	(5)
Participate (A)	6.88***	7.02**	4.10	2.12	6.46**
Participate × Wife 1 (B)		−2.92			
Participate × Wife 2 (C)		2.23	5.16	6.20	
Share (D)	0.28**	0.27	0.36**	0.26*	0.26
Share × Wife 1 (E)		0.09			
Share × Wife 2 (F)		−0.03	−0.12	−0.19	
Beliefs about partner (G)	0.39***	0.36***	0.46***		
Beliefs about partner × Wife 1 (H)		0.11			
Beliefs about partner × Wife 2 (I)		−0.00	−0.11		
Beliefs about Husband (J)				0.01	
Beliefs about Husband × Wife 2 (K)				−0.03	
Beliefs about Co-wife (L)				0.48***	
Beliefs about Co-wife × Wife 2 (M)				−0.10	
Beliefs about Wife 2					−0.08
Beliefs about Wife 1					0.44***
Individual FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Coefficients A+B		4.10			
Test A+B=0 (p-val)		0.11			
Coefficients A+C		9.26	9.26	8.32	
Test A+C=0 (p-val)		0.01	0.01	0.01	
Coefficients D+E		0.36			
Test D+E=0 (p-val)		0.03			
Coefficients D+F		0.24	0.24	0.07	
Test D+F=0 (p-val)		0.32	0.32	0.74	
Coefficients G+H		0.46			
Test G+H=0 (p-val)		0.00			
Coefficients G+I		0.35	0.35		
Test G+I=0 (p-val)		0.00	0.00		
Coefficients J+K				−0.02	
Test J+K=0 (p-val)				0.84	
Coefficients L+M				0.38	
Test L+M=0 (p-val)				0.00	
Observations	774	774	516	516	258

* $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Note: This table presents the estimated coefficients of Equation 2.2 using fixed effect estimations for polygamous households. The outcome variable is the contribution rate when players establish the sharing rules for the total revenue. The variable 'participate' takes a value of 1 if the player was involved in defining the sharing rules (T1 and T2 for the husband; T2 and T3 for wives). 'Share' represents the individual share in each game. 'Beliefs about partner (wife i, husband)' indicate the guess about the contribution rate of the playing partner, husband or wife i (as a percentage of the initial endowment). Standard errors in parentheses are bootstrapped and clustered at the village level.

Table 2.A.7: Game order and Husband share in T3

	Monogamous		**Polygamous**	
	(1)	(2)	(3)	(4)
T2 before T3	1.23	−10.73	3.43	−10.40
	(3.82)	(12.49)	(3.57)	(11.08)
T2 before T3 × Husband share in T2		0.23		0.34
		(0.25)		(0.27)
Husband Share in T2		0.04		−0.07
		(0.29)		(0.19)
Reference		*T3 played before T2*		
Controls		*Yes*		
Mean husband share in T2		51.08		39.94
Mean T2 before T3		0.71		0.56
Observations	86	86	86	86

Note: This table compares the shares of husbands in T3 in games where T2 (all spouses decide on the sharing rules) was played before T3 (wives/wife decide(s) alone on the sharing rules) and games where T3 was played before T2 using OLS estimation. Controls include: number of children, age, ethnicity, religion, education, whether the individual works outside the household, household assets, whether the individual has an Income-Generating Activity and village Fixed Effects. Standard errors in parentheses are clustered at the village level.

Table 2.A.8: Selection: Contribution with Strangers (Equal share)

	Wives	**Husbands**
	(1)	(2)
Polygamous household	−1.97	0.04
	(5.53)	(4.39)
Reference	*Monogamous household*	
controls	*Yes*	
Mean Contribution (Y)	50.55	51.28
Observations	258	172

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

Note: This table compares contribution rates of polygamous and monogamous spouses when playing with strangers (individuals outside their household) using OLS estimation. Controls include: relation to the household head, number of children, age, ethnicity, religion, education, whether the individual works outside the household, household assets, whether the individual has an Income-Generating Activity and village Fixed Effects. Standard errors in parentheses are clustered at the village level.

Table 2.A.9: Contribution in bilateral game and co-wives' individual agency

	Collective Field	**Food**	**Marriage**	**Savings**	**Mean agency (1-4)**	**Mean agency (2-4)**
	(1)	(2)	(3)	(4)	(5)	(6)
Husband-Wife HpWp (A)	−2.78	0.52	−2.98*	−1.76	1.13	−0.08
	(3.04)	(2.22)	(1.65)	(3.72)	(4.80)	(2.60)
HpWp × Has no say on collective field	2.22					
	(3.29)					
HpWp × Doesn't manage food		−4.52				
		(3.60)				
HpWp × Exchange marriage			2.67			
			(3.23)			
HpWp × Doesn't know husband's saving				−0.61		
				(4.70)		
HpWp × Mean Agency 1					−3.87	
					(8.11)	
HpWp × Mean Agency 2						−3.86
						(5.56)
Reference (ref.)				*Wife1-Wife2*		
Individual FE				*Yes*		
Coeffients A+(A × agency indicator)	-0.56	-4.00	-0.31	-2.37	-2.74	-3.94
Test A+ (A × agency)=0 (p-val)	0.78	0.08	0.92	0.24	0.50	0.27
Mean of agency indicator	0.71	0.61	0.28	0.78	0.60	0.56
Observations	250	344	344	344	250	344

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

Notes: This table presents the estimated coefficients of Equation 2.1 using fixed effect models. The outcome variable is the contribution rate in polygamy in bilateral games with an equal share of the revenue in the common pot. The table compares the contribution rates of polygamous wives when playing with their husbands (HpWp) versus when playing with their co-wives (Wife1-Wife2) while interacting with the following lack of agency proxies: "Has no say on collective fields" equals 1 if the wife declared having no say in the management of collective fields; "Doesn't manage food" equals 1 if the wife rarely manages the distribution of cereals; "exchange marriage" equals 1 if the wife's marriage was based on an arrangement between families that avoids bride-price and precludes separation (see details in Section 2.3); "Doesn't know husband's saving" equals 1 if the wife declare having no information on her husband's savings. Mean Agency represents the simple average of lack of agency indicators. Mean Agency 2 considers 3 indicators of agency (Due to missing data in the variable 'no say on collective field'). Standard errors in parentheses are bootstrapped and clustered at the village level.

Table 2.A.10: Husband share and polygamous wife' individual agency

	Collective Field	**Food**	**Marriage**	**Savings**	**Mean agency (2-4)**	**Mean agency (1-4)**
	(1)	(2)	(3)	(4)	(5)	(6)
Joint decision T2 (A)	−3.34	−5.32***	−4.95***	−4.95	−3.70	−1.25
	(2.42)	(1.58)	(1.44)	(3.05)	(3.20)	(4.22)
Wives alone T3 (B)	−13.98***	−19.09***	−18.60***	−17.34***	−11.85**	−7.66
	(3.23)	(2.94)	(1.72)	(3.09)	(4.88)	(5.42)
T2 × Has no say on collective field	−2.29					
	(2.80)					
T3 × Has no say on collective field	−8.37**					
	(3.70)					
T2 × Doesn't manage food		−0.22				
		(1.31)				
T3 × Doesn't manage food		−2.27				
		(2.98)				
T2 × Exchange marriage			−1.80			
			(2.09)			
T3 × Exchange marriage			−6.74**			
			(3.28)			
T2 × Doesn't know husband's saving				−0.63		
				(3.09)		
T3 × Doesn't know husband's saving				−3.99		
				(4.02)		
T2 × Mean Agency 2					−3.13	
					(4.44)	
T3 × Mean Agency 2					−15.45*	
					(9.07)	
T2 × Mean Agency 1						−6.18
						(6.09)
T3 × Mean Agency 1						−20.41**
						(9.24)
Reference				*Husband alone (T1)*		
Individual FE				*Yes*		
Coefficients A+(A × Agency)	-5.63	-5.54	-6.74	-5.59	-6.83	-7.43
Test A+(A × Agency)=0 (p-val)	0.00	0.00	0.00	0.00	0.00	0.00
Coefficients B+(B × Agency)	−22.35	−21.36	−25.33	−21.34	−27.30	−28.07
Test B+(B × Agency)=0 (p-val)	0.00	0.00	0.00	0.00	0.00	0.00
Mean of agency indicator	0.71	0.61	0.28	0.78	0.56	0.60
Observations	375	516	516	516	516	375

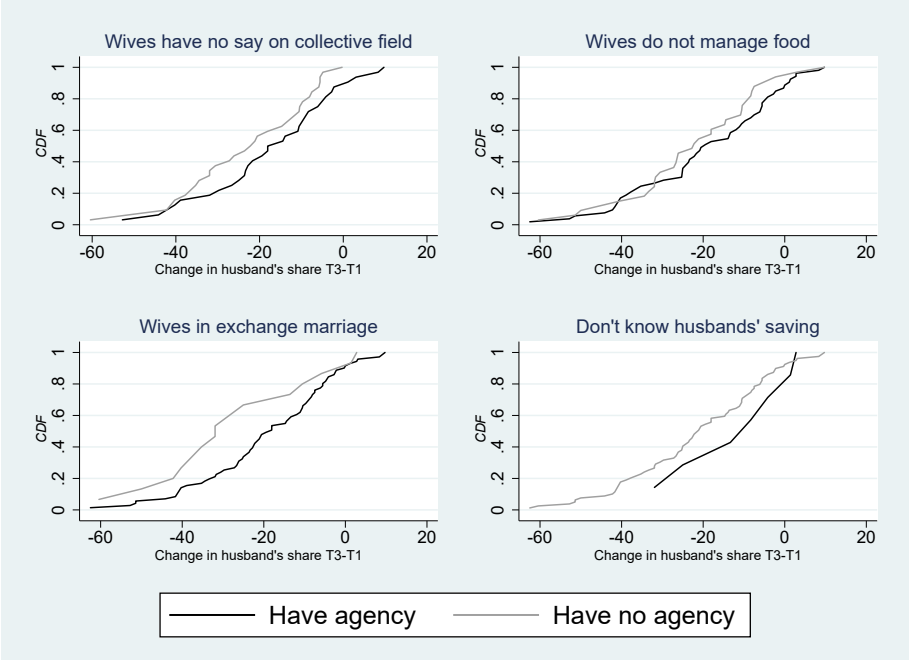
* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01.

Note: This table presents the estimated coefficients of Equation 2.3 using fixed effect models. The outcome variable is the individual share of the husband when players define the rules of allocation of the revenue in the common pot. The table presents the change in the share of polygamous husbands in T1 (Husband decides alone on sharing rules), T2 (all spouses decide together) and T3 (co-wives decide alone); interacting with the following lack of woman's individual agency proxies: "Has no say on collective fields" equals 1 if the wife declared having no say in the management of collective fields; "Doesn't manage food" equals 1 if the wife rarely manage the distribution of cereals; "exchange marriage" equals 1 if the wife's marriage was based on an arrangement between families that avoids bride-price and precludes separation (see details in Section 2.3); "Doesn't know husband's saving" equals 1 if the wife declares having no information on her husband's savings. Mean Agency represents the simple average of lack of agency indicators. Mean Agency 2 considers 3 indicators of agency (Due to missing data in the variable 'no say on collective field'). Standard errors in parentheses are bootstrapped and clustered at the village level.

Figure 2.A.1: Change in Husband share T3-T2 and wives agency

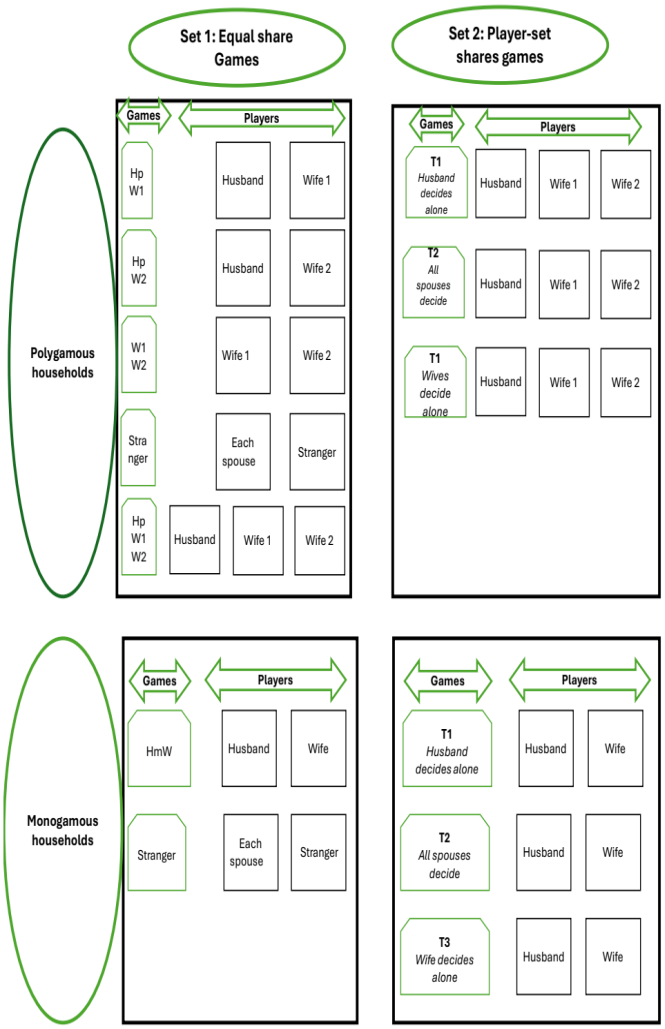
Note: This figure illustrates the cumulative distribution of the difference in polygamous husband shares when co-wives define the sharing rules of the common pot (T3) vs when all spouses jointly define the shares (T2), considering various proxies for women's lack of agency. 'Have no agency' indicates that the two co-wives report lacking agency, while 'Have agency' indicates that they possess agency.

Figure 2.A.2: Change in Husband share T3-T1 and wives agency



Note: This figure illustrates the cumulative distribution of the difference in polygamous husband shares when co-wives define the shares (T3) vs when the husband defines the sharing rules (T1), considering various proxies for women's lack of agency. 'Have no agency' indicates that the two co-wives report lacking agency, while 'Have agency' indicates that they possess agency.

Figure 2.A.3: Games played with monogamous and polygamous spouses



Note: This figure presents the games played with spouses. All games were public good games. Players decided how much to contribute to a common pot from an initial endowment of 2000 FCFA. Contributions to the common pot were multiplied by 1.5 before being allocated to players. In Set 1 games, the common pot was equally distributed across players. In Set 2 games the shares were set by (some) players (before contributions took place) and not revealed to other players . Games of Set 1 were played before games in Set 2. Within sets, the order of games was randomized.

2.B Script

Presentation by the supervisor and interpretation by an enumerator.

Welcome. Thank you for taking the time to come today. We are researchers from the University of Namur in Belgium. We are here in collaboration with the NGO Îles de Paix, and we have invited you today for two purposes. The first is to evaluate the effects of the Tidisaati project on the lives of your households. The second objective is to learn more about how you make decisions regarding the management of common resources in your household. You will play games that involve making decisions about money. For the game, we will use real bills that do not belong to you at first, but know that at the end of the activity, you will receive compensation depending on the decisions made during the game. So it is important for you to take the decisions seriously.

The decisions you will make are not difficult, and there are no right or wrong answers. All you need to think about is making decisions that would correspond to your choices in real life. It is important to seriously consider your decisions because they will affect the amount you bring home. Before asking you to make decisions, we will tell you everything you need to know about the principles of the game, but first, we want to specify a few things.

First, for the game, we will use money that is not yours, but in the end, you will receive payment in money that belongs to you. Let us clarify that the money we will use for payment is not ours or Îles de Paix's. We belong to a research organization that has given us the money to use for research. Therefore, this is an exceptional activity that is not part of the usual practices of the NGO "Îles de Paix".

Secondly, this study is about how each of you makes your own decisions. Therefore, it is important that you do not talk or communicate with each other about your decisions unless the Enumerator asks you to. Note that you will make decisions privately, and your choices will determine the final compensation that you and your game partner will receive at the end of the activity. Be aware that your partner will never know the decisions you have made or the amount of your compensation (we will come back to this later).

Finally, make sure you listen carefully to us. Each of you could earn a good amount of money here today. But this will only be possible if you understand the decisions you are making. So listen to the instructions, ask us your questions when the opportunity arises, and do not fall asleep. Okay. Now, our instructor will begin to explain the game.

2.B.1 First Part: Equal Share Games

The game begins when we give each of you an envelope like this one. [HOLD THE ENVELOPE.] It contains money. [TAKE OUT THE MONEY INSIDE AND SHOW IT.] The person you are playing the game with will also receive an envelope with the same amount of money.

Initially, you will make decisions in pairs. You will consider that each of you has a sum of money [Enumerator: give two members of the household (husband and one co-wife) the initial endowment] and that you must contribute to buy seeds for your family field, which belongs to only the two of you. The family field is located in such a way that each of you will go to the market to buy fertilizer and directly put it into the family field. Your partner will not know how much fertilizer has been put into the field. Let's consider this common urn [Enumerator: show the common urn] as representing the family field. At harvest, the production will be sold, and the profit will be half of the total seeds in the common field. In other words, from the amount in the common urn, we will add half, and the grand total will be considered as the money you earn from selling the production on the field that belongs to

both of you. This amount will be shared equally between you. For example, if each of you received 2000 FCFA [Enumerator: Take an envelope from one spouse's hands and show 2000 FCFA] and each used the entire amount to purchase seeds and inputs [Enumerator: ask each of the two spouses to put 2000 FCFA into the common urn], there will be a total of 4000 FCFA in the common pot [Enumerator: Open the common pot and show 4000 FCFA], and we will thus add half of 4000 FCFA, which is 2000 FCFA [Enumerator: Add 2000 FCFA to the common pot, making it 6000 FCFA. Enumerator: show the 6000 FCFA in the common pot representing the amount from selling the production of your common field. Each will therefore have 3000 FCFA [Enumerator: Give each 3000 FCFA in the end instead of 2000 FCFA]. Each will have earned 1000 FCFA more. If at the end of the activities, this variant is chosen by the tablet for the final payment, we will therefore give each of you 3000 FCFA. [Enumerator: Give each one]. Note that no one will know what you contributed, what you earned, or the variant chosen by the tablet for the final payment in real money.

[Enumerator: Take back the envelopes and give each spouse the envelope containing 2000 FCFA]. Another scenario. If each keeps 1000 FCFA in their pocket and only uses 1000 FCFA for purchasing seeds [Enumerator: ask each spouse to put 1000 FCFA into the common urn and keep 1000 FCFA in the envelope], There will be a total of 2000 FCFA in the common pot [Enumerator: Show the 2000 FCFA in the urn], and we will therefore add an additional 1000 [Enumerator: add 1000 FCFA]; making it 3000 representing what you earned when you sold the production on the common field. So each will ultimately have the 1000 [Enumerator: show the 1000 FCFA that remained in each spouse's hands] they kept, and 1500 coming from the sale of the production [Enumerator: give each 1500], making it 2500 FCFA for each [Enumerator: show the total each receives]. Each will have earned an additional 500 FCFA from their initial two thousand. If at the end of the activities, this variant is chosen by the tablet for the final payment, we will therefore give each of you 2500 FCFA in real money individually. Note that no one will know what you contributed, what you earned, or the variant chosen by the tablet for the final payment in real money. In short, the more you contribute to the common pot, the greater the gain. If you decide not to put anything in the urn, each returns home with their 2000 FCFA.

ATTENTION: As you will never know what your partner contributed, you will not always put the same amount. Let's look at an example [Enumerator: give the envelopes to the husband and one wife again]. If the husband uses 1500 FCFA for purchasing seeds [Enumerator: ask the husband to put 1500 FCFA into the common urn] and keeps 500 FCFA for himself, and the wife only uses 500 FCFA [Enumerator: ask the wife to put 500 FCFA into the common urn] and keeps 1500 FCFA for herself. There will be 2000 FCFA in the common urn. We will add half, which is 1000 FCFA, so there will be 3000 FCFA in total, considered as the amount earned from the sale. So each will have 1500 FCFA resulting from the sale of the production on the collective field. The husband will therefore have a total of 2000 FCFA [Enumerator: show the 2000 FCFA in the husband's hands] and will have earned nothing more than his initial situation, and the wife will have 3000 FCFA [Enumerator: 3000 FCFA in the wife's hands]. So she has earned 1000 FCFA. If at the end of the activities, this variant is chosen by the tablet for the final payment, we will give the husband 2000 FCFA and 3000 FCFA to the wife individually. Note that no one will know what you contributed, what you earned, or the variant chosen by the tablet for the final payment in real money.

ATTENTION: As you will never know what your partner used for purchasing seeds, you will not always put the same amount. Let's look at another example [Enumerator: give the envelopes to the husband and one wife again]. If the wife uses 2000 FCFA for purchasing seeds [Enumerator: ask the wife to put 2000 FCFA into the common urn] and keeps nothing for herself, and the husband keeps all 2000 for himself and does not contribute anything [Enumerator: ask the husband to pretend to contribute and put nothing into the common urn]. There will be 2000 FCFA in the common urn [Enumerator: show 2000 FCFA in the common urn]. We will add half, which is 1000 FCFA, so there will be 3000 FCFA in total

[Enumerator: show 3000 FCFA in the common urn], considered as the amount from the sale. So each will have 1500 FCFA [Enumerator: give each 1500 FCFA] resulting from the sale on the collective field. The husband will therefore have a total of 3500 FCFA [Enumerator: show the 2000 FCFA in the husband's hands] and will have earned 1500 FCFA more than his initial situation, and the wife will have 1500 FCFA [Enumerator: 1500 FCFA in the wife's hands]. So she has lost 500 FCFA. If at the end of the activities, this variant is chosen by the tablet for the final payment, we will give the husband 3500 FCFA in real money and 1500 FCFA to the wife individually. Note that no one will know what you contributed, what you earned, or the variant chosen by the tablet for the final payment in real money. Consider now that the field belongs to all three of you, and you all must contribute to purchase seeds. You will consider that each of you has a sum of money [Enumerator: give each spouse an envelope with 2000 FCFA as the initial endowment]. As you will never know what your partners used for purchasing seeds, you will not always put the same amount. Let's look at an example. If Mr. *name_husband* uses 2000 FCFA for purchasing seeds [Enumerator: ask Mr. to put 2000 FCFA into the common urn] and keeps nothing for himself, and $name\_wife1$ uses 500 FCFA and keeps 1500 FCFA for herself [Enumerator: ask Mrs. to put 500 FCFA into the common urn], $name\_wife2$ uses 1500 FCFA and keeps 500 FCFA for herself [Enumerator: ask Mrs. to put 1500 FCFA into the common urn]. There will be 4000 FCFA in the common urn [Enumerator: show 4000 FCFA in the common urn]. We will add half, which is 2000 FCFA, so there will be 6000 FCFA in total, considered as the amount from the sale. So each will have 2000 FCFA [Enumerator: give each 2000 FCFA] resulting from the sale on the collective field. The husband will therefore have a total of 2000 FCFA [Enumerator: show the 2000 FCFA in the husband's hands] and will not have earned anything more than his initial situation, $name\_wife1$ will have a total of 3000 FCFA [Enumerator: show 3000 FCFA in $name\_wife1$'s hands], and will have earned 1000 FCFA. $name\_wife2$ will have 2500 FCFA [Enumerator: show 2500 FCFA in $name\_wife2$'s hands], and will have earned 500 FCFA. If at the end of the activities, this variant is chosen by the tablet for the final payment, we will give the husband 2000 FCFA, 3000 to $name\_wife1$, and 2500 to $name\_wife2$. Note that no one will know what you contributed, what you earned, or the variant chosen by the tablet for the final payment in real money.

2.B.2 Comprehension test

TEST 1 If you received 2000 FCFA, and you contribute with your husband for seed purchase. If you both contribute the entire amount; how much will you have in total for yourself at the end by selling the production of your common field? In other words, how much will you have for yourself today if both of you contribute the entire amount received?
TEST 2 If you received 2000 FCFA, and you contribute with your husband for seed purchase. If you both contribute 1000 FCFA each; how much total revenue will you have for yourself at the end by selling the production of your common field? In other words, how much will you have in your own account today if both of you contribute half of the received amount?
TEST 3 If you received 2000 FCFA, and you contribute with $name\_wife1$ for seed purchase of your common field. If you contribute 2000 FCFA and $name\_wife1$ does not contribute anything; how much money will you have in the end for yourself? In other words, how much money will you have for yourself today?

2.B.3 Second Part: Player-set Shares

Now we will still consider that the family field belongs to all spouses, and all must contribute to the purchase of seeds for the family field. The game principle remains the same as before with some variations. We will still add half of what you have contributed to get the amount from selling the production on the family field. Note that this time the distribution will be

according to the rules that you yourselves will define. In one variant, only your husband will define the sharing rules; in another, all spouses will define them together; and in another, only the wives will define the rules. Note that in all cases, each player will have to contribute. I also remind you that each spouse will have to contribute multiple times, a decision will be chosen by the tablet; and this will define the final gain which will be known only by the spouse. Note that in all cases, you will not know what your spouse has contributed or earned, and they will not know your gain. No one will know the decision that has been selected for the payment either.

Treatment 1: *The husband decides on the sharing rules before playing. He is isolated from his wives, and his decisions are not known by players before playing. Scenarios on money in the Common pot: 6000, 4000, and 2000.*

If all of you have contributed the entire amount for purchasing seeds and there is 6000 FCFA in the common urn, we will add 3000 FCFA, making it 9000 FCFA. Imagine that at the time of selling the production, only the husband went to sell at the market; and therefore, sold for 9000 FCFA. So, for the distribution, knowing that no one knows the amount of the sale [Enumerator: give the husband 9000 FCFA], he can decide to give $name_wi$ 2500 FCFA [Enumerator: ask the husband to give 2500 FCFA to $name_wi$], 3000 to $name\_wife2$, and keep 3500 FCFA FOR HIMSELF. If at the end of the activities, this variant is chosen by the tablet for the final payment, and if everyone has contributed the entire amount, we will therefore give each 2500 FCFA in real money to $wife_name$, 3000 FCFA to $name\_wife2$, and 3500 to *name_husband*. Note that in this case, no one will know what *name_husband* has decided, nor what each has contributed, nor what you have earned, nor the variant chosen by the tablet for the final payment in real money.

When playing [For these questions, the husband will be isolated from his wives]. In this activity, all spouses will contribute a portion or all of the received amount to the common pot, according to their discretion. You, sir, have the responsibility of defining the sharing rules. To do this, imagine that you have sold the agricultural production from the FAMILY FIELD and that you must distribute the amount of the sale between you and your wives, knowing that your wives are absent and do not know the amount of the sale. How much will you give to each? To help you, we will present below the probable amounts of sale on the collective field and you will redistribute after reflecting. If the amount of the sale of the family production amounts to 6000 [Enumerator: Give the husband 6000 FCFA in real money]. I leave you to decide for a few minutes to distribute this amount. [Enumerator: leave for a maximum of 5 minutes until the husband calls you] Give me the share you intend to give to $name\_wife1$ and $name\_wife2$ [Encode the amount allocated to each and take back all the money]. If the amount of the sale of the family production amounts to 4000 [Enumerator: Give the husband 4000 FCFA in real money]. I leave you to decide for a few minutes to distribute this amount. [Enumerator: leave for a maximum of 5 minutes until the husband calls you] Give me the share you intend to give to $name\_wife1$ and $name\_wife2$ [Encode the amount allocated to each and take back all the money]. If the amount of the sale of the family production amounts to 2000 [Enumerator: Give the husband 2000 FCFA in real money]. I leave you to decide for a few minutes to distribute this amount. [Enumerator: leave for a maximum of 5 minutes until the husband calls you] Give me the share you intend to give to $name\_wife1$ and $name\_wife2$ [Encode the amount allocated to each and take back all the money].

Treatment 2: *All spouses decide on the sharing rules before playing. They decide together on the rules before playing. Scenarios on money in the common pot: 6000, 4000, and 2000.*

If *name_husband* contributed 1000 FCFA, $name_wi$ contributed 1500 FCFA, and $name\_wife2$ contributed 500 FCFA [Enumerator: Ask each to put the indicated amount into the common pot]. In the common urn, there are 3000 FCFA, we will add 1500 FCFA, making it 4500 FCFA representing the amount of the sale. Let's imagine that this time the buyer came to

the house and met everyone. This time, everyone discusses the sharing. If you all agree that the husband will have 2000 FCFA, $name_wi$ 1500, and $name\_wife2$ 1000 FCFA [Enumerator: give each the indicated amount]. In the end, the husband will have the 1000 FCFA he kept and the 2000 FCFA he received, making it 3000 FCFA [Enumerator: show 3000 FCFA that the husband has]. He has therefore gained 1000 FCFA. $name\_wife1$ will have the 500 FCFA she kept and the 1500 FCFA she received, making a total of 2000 FCFA. She therefore did not gain anything. $name\_wife2$, in turn, will have the 1500 FCFA she kept and the 1000 FCFA she obtained from the sale. This makes a total of 2500. She therefore gained 500 FCFA. If at the end of the activities, this variant is chosen by the tablet for the final payment, we will give each the amount they have in real bills. Note that in this case, no one will know what each contributed, nor what you have earned, nor the variant chosen by the tablet for the final payment in real money.

When playing [For these questions, all spouses will respond together]. In this activity, all spouses will contribute a portion or all of the received amount to the common pot, according to their discretion. You all together have the responsibility to define the sharing rules. To do this, imagine that you have sold the agricultural production of the FAMILY FIELD and that you must distribute the amount of the sale among yourselves. How much will you give to each? To help you, we will present below the probable amounts of sale on the collective field, and you will redistribute after discussing among yourselves. If the amount of the sale of the family production amounts to 6000 [Enumerator: Give the spouses 6000 FCFA in real money]. I leave you to discuss for a few minutes among yourselves to distribute this amount. [Enumerator: leave for a maximum of 5 minutes until the spouses call you] [Enumerator: Encode the amount allocated to each and take back all the money]. If the amount of the sale of the family production amounts to 4000 [Enumerator: Give the spouses 4000 FCFA in real money]. I leave you to discuss for a few minutes among yourselves to distribute this amount. [Enumerator: leave for a maximum of 5 minutes until the spouses call you] [Enumerator: Encode the amount allocated to each and take back all the money]. If the amount of the sale of the family production amounts to 2000 [Enumerator: Give the spouses 2000 FCFA in real money]. I leave you to discuss for a few minutes among yourselves to distribute this amount. [Enumerator: leave for a maximum of 5 minutes until the spouses call you] [Enumerator: Encode the amount allocated to each and take back all the money].

Treatment 3: *The wives decide on the sharing rules before playing. They are isolated from their husband, and their decision is not known by the players before playing. Scenarios on money in the common pot: 6000, 4000, and 2000.* If *name_husband* bought seeds for 1500 FCFA, $name_wi$ for 1000 FCFA, and $name\_wife2$ for 1500 FCFA [Enumerator: Ask each to put the indicated amount into the common pot]. In the common urn, there are 4000 FCFA, we will add 2000 FCFA, making it 6000 FCFA representing the amount of the sale. This time, let's consider that at the time of the sale, the husband was traveling and only the wives know the amount of the sale, so they must decide how to distribute the money from the sale [Enumerator: give the wives 6000 FCFA and ask the husband to step aside a bit. If they agree and decide to give 1000 FCFA to the husband, 3000 FCFA to $name_wi$, and 2000 to $name\_wife2$ [Enumerator: give each the indicated amount]. In the end, the husband will have the 500 FCFA he kept and the 1000 FCFA he received, making it 1500 FCFA [Enumerator: show 1500 FCFA that the husband has]. He has therefore lost 500 FCFA. $name_wi$ will have the 1000 FCFA she kept and the 3000 FCFA she received, making a total of 4000 FCFA. She therefore gained 2000 FCFA. $name\_wife2$, in turn, will have the 500 FCFA she kept and the 2000 FCFA she obtained from the sale, making a total of 2500 FCFA. She therefore gained 500 FCFA. If at the end of the activities, this variant is chosen by the tablet for the final payment, we will give each the amount they have. Note that in this case, no one will know what the co-wives decided, nor what each contributed, nor what you have earned, nor the variant chosen by the tablet for the final payment in real money.

When playing [For these questions, the co-wives will respond together, isolated from

the husband]. In this activity, all spouses will contribute a portion or all of the received amount to the common pot, according to their discretion. You, the wives, have the responsibility to define the sharing rules. To do this, imagine that you have sold the agricultural production of the FAMILY FIELD and that you must distribute the amount of the sale between your husband and you, knowing that your husband is absent and does not know the amount of the sale. How much will you give to each? To help you, we will present below the probable amounts of sale on the collective field, and you will redistribute after discussing with your co-wife. If the amount of the sale of the family production amounts to 6000 [Enumerator: Give the co-wives 6000 FCFA in real money]. I leave you to discuss for a few minutes between you to distribute this amount. [Enumerator: leave for a maximum of 5 minutes until the co-wives call you] Give me the share you think you will give to your husband [Encode the amount allocated to each and take back all the money]. If the amount of the sale of the family production amounts to 4000 [Enumerator: Give the co-wives 4000 FCFA in real money]. I leave you to discuss for a few minutes between you to distribute this amount. [Enumerator: leave for a maximum of 5 minutes until the co-wives call you] Give me the share you think you will give to your husband [Encode the amount allocated to each and take back all the money]. If the amount of the sale of the family production amounts to 2000 [Enumerator: Give the co-wives 2000 FCFA in real money]. I leave you to discuss for a few minutes between you to distribute this amount. [Enumerator: leave for a maximum of 5 minutes until the co-wives call you] Give me the share you think you will give to your husband [Encode the amount allocated to each and take back all the money].

Chapter 3

Are American Women more Deprived than Men?

by Doux Baraka Kusinza[0]

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Abstract

American men experience higher premature death than women, while women are more likely to experience poverty throughout their lifetimes. These gender inequalities are substantially different across racial groups. Based on these facts, I explore in this paper two complementary questions. First, what is the most disadvantaged gender group when combining poverty and mortality data? Second, are there racial disparities in the pattern of gender inequalities in total deprivation? This study uses the generated deprivation index, a novel indicator that aggregates poverty and mortality as components of total deprivation, to answer those questions. Two main conclusions emerge. First, since the 1990s, men and women have been experiencing very similar total deprivation rates, whereas, before then, men were more deprived than women. The reduction of the gender gap in mortality combined with the lack of significant progress in gender inequality in income poverty resulted in a steeper decline in total deprivation among men. Second, this near gender equality in total deprivation hides sizable disparities across races. The gender gap against women is higher for Hispanics and Blacks compared to Whites Non-Hispanics. This finding suggests that women in Minorities face more severe racial penalties than men.

3.1 Introduction

In several countries across the World, poverty and mortality rates are different across genders. In the United States for example, recent statistics indicate that women, at all ages above 18, are more likely to experience income poverty compared to men (US Census Bureau, 2019). However, they consistently hold an advantage in terms of life expectancy (at birth), with women reaching an average of 81 years compared to 76 years for men in 2016 for instance (Arias & Xu, 2020). This general picture in the US hides important racial disparities in terms of the size of gender differences. For instance, the income poverty gender gap is the highest among Whites Non-Hispanics[1], while the largest gender difference in mortality is in observed among Blacks.[2] Taken together, the mortality and poverty data in the US lead to unclear conclusions about the most disadvantaged gender group, on the one hand and the most (gender) unequal racial group on the other hand.

Existing research typically examines economic poverty and mortality as distinct phenomena. Yet, it is recognized that comparing deprivation between groups with a distinct focus on mortality or poverty raises the possibility of a "mortality paradox", which occurs when higher mortality rates in a population artificially result in a decrease in poverty rates among the living population, as poor are more likely to die (Lefebvre et al., 2013). Moving on to comparisons between groups, the effect of poverty masking premature mortality becomes more concerning when one group is better off in one dimension and worse off in another. This is especially the case of gender differences as shown earlier. The relatively low poverty rate among men may be a result of their higher mortality rate. In the United States, for instance, poor men are more prone to premature death than their women counterparts (Chetty et al., 2016). Furthermore, the extent of bias resulting from the mortality paradox may vary across racial groups due to differences in the magnitude of

[1] In 2016, Non-Hispanic White females were 20% more likely to experience poverty than their male counterparts, while Black women were 12% more likely to face poverty compared to Black men (Ruggles et al., 2021)

[2] The gender disparity in mortality rates stands at 0.38 percentage points for Blacks (1.08% for men and 0.7% for women), whereas for Non-Hispanic Whites, the gap is 0.24 percentage points (0.88% for men and 0.64% for women) (S. L. Murphy et al., 2021)

gender gaps in mortality and poverty, as presented earlier. Considering these established facts in the US, gender differences in deprivation based solely on the poverty status of the living population may be misleading, with biases potentially being race-specific. A possible solution lies in aggregating mortality and poverty into a single indicator to facilitate accurate comparisons between groups and over time.

Empirical studies that combine mortality and income poverty are scarce in the United States. The existing research close to this subject has focused on geographical disparities, concluding that mortality rates are highest in areas with high levels of poverty and inequality. (Chetty et al., 2016; Currie & Schwandt, 2016, Geronimus et al., 2011; McDonough et al., 1997; Ross et al., 2000). The main objective of this paper is to provide an overview of gender differences in total deprivation in the US. The persistence of large gender disparities in poverty and mortality makes the US a compelling case study (see Iceland, 2013 for poverty and Case & Deaton, 2017 for mortality). Additionally, I investigate racial differences in the deprivation gender gap, considering the pronounced racial disparities in the magnitude of gender gaps in poverty and mortality. It is crucial to emphasize that this paper explores gender differences in outcomes and does not focus on disparities in opportunities.

Several measures that aggregate poverty and mortality have been proposed in the economic literature. The first and most common is the Human Development Index, a composite index that aggregates alive and lifespan deprivations using arbitrary weights. As discussed in Baland et al. (2021), this index does not hold a constant trade-off between poverty and premature mortality leading to inconsistent comparisons across groups and over time. The second family of measures assumes an inter-temporal utility function to aggregate quantity and quality of life. The main challenge of this approach is the definition of the inter-temporal utility function since it needs to be unique across time and space (Grimm & Harttgen, 2008).[3] The third approach takes into account the mortality paradox by attributing fictitious incomes to prematurely dead individuals to compute an adjusted poverty rate (Lefebvre et al., 2013 and Lefebvre et al., 2019). The underlying assumption in

[3]This particularity limits the consensual implementation of these indices from a practical point of view.

the determination of these fictitious incomes is crucial for the validity of the measures. In this study, I use the Generated Deprivation Index (GDI), recently developed by Baland et al. (2021). The choice of GDI is dictated by its theoretical and practical advantages over other indices. The intuition behind the GDI is to avoid the mortality paradox by considering premature death as deprivation in itself.[4] The GDI respects the separability property[5], and it aggregates poverty and mortality without relying on a particular representation of the preferences. The GDI is also easy to interpret and requires less data, which makes it more practical (Baland et al., 2021).

The Generated Deprivation Index (GDI), also referred to in this paper as the total deprivation, aggregates the number of poor and the number of person-years prematurely lost, both measured in time units. A dead person is considered as lifespan deprived if he dies before a certain age threshold assumed to be the minimal lifespan in a given society. At each age, the number of person-years lost is computed by the difference between the age line and the age at death. The total number of person-years lost in the society is the sum of person-years lost at each age. With information on premature death and the number of poor (alive deprivation), the GDI is calculated by summing the prevalence of these two components in the same reference population using a weight that expresses the relative importance of premature death versus Alive Deprivation. The reference population is the sum of the poor, the non-poor, and the total number of person-years lost prematurely in the society in a given year.

The estimations in this study are based on the restrictive assumption that being alive deprived is as bad as being prematurely dead (weight=1), and the minimum lifespan is 75 years.[6] I use poverty data from the US Census Bureau, the official institution for poverty statistics. The measure considers that, within each family, all members are classi-

[4]It does not require the allocation of hypothetical fictitious income as in Lefebvre et al. (2019)

[5]The GDI provides a constant trade-off between premature mortality and poverty

[6]These parameters are required for computing the deprivation rates. The chosen age line is close to the average life expectancy in the US from 1970 to 2016. Similar to Baland et al. (2021), I opt for a conservative value of the weight (1). I conduct sensitivity analysis by varying these parameters, and the main conclusions of the paper remain consistent.

fied as poor if the pooled family income falls below the designated income threshold (Ruggles et al., 2021).[7] This definition has two implications for poverty estimation. First, any gender gap in poverty arises mainly from single-head families, as husband-wife families exhibit no gender disparity in poverty rates.[8] Second, as highlighted by Ponthieux & Meurs (2015), this methodology introduces a bias in individual poverty estimation, resulting in an underestimation of (married) women's poverty due to their lower income levels compared to men. Yet, I conducted sensitivity analyses to attempt to address these limitations.

Overall, the results indicate that the total deprivation (GDI) of both men and women decreased over the last 50 years. Before 1990, men were more deprived than women, but the higher rate of decline among men afterward led to the gender-balanced deprivation rates since the 1990s. The breakdown of the GDI highlights two main periods regarding the role of lifespan and alive deprivation components. Between 1970 and 1990, the progress made in mortality reduction over-compensated the increase in poverty, and, as a result, the GDI decreased. After 1990, the mortality rates were relatively constant while poverty continued to fluctuate such that the variations of the GDI were mainly driven by income poverty. Since 1990, the relative advantage of women over men in the premature mortality has been largely absorbed by their disadvantage in income poverty so that the gender gap in GDI has been negligible. Recognizing the limitations of poverty measures as mentioned earlier, I conducted sensitivity analysis, considering an extreme scenario where only personal income matters for individual poverty status. In this scenario, the gender gap in total deprivation favors men in all years, albeit smaller compared to when income poverty alone is considered. Thereby, it can be concluded that *even when premature death is added to poverty, American women remain more deprived than men but, the gender gap is much lower than that reported with income poverty.*[9]

[7] The income thresholds vary based on family size and age composition. They are adjusted annually to the consumer price index at the national level.

[8] On average, the gender distribution within husband-wife families in the US is balanced

[9] The extreme scenario implicitly assumes no sharing within households and no economies of scale. As women typically benefit more from sharing within households (due to their lower incomes compared to men) (Cherchye et al., 2012), this scenario sets an upper bound for the gender gap in poverty, whereas the standard approach provides a lower bound (the real gender gap being between the two bounds).

This overall trend hides important disparities across racial groups. While the income poverty suggests that the highest gender inequality against women is observed in the group of Whites Non-Hispanic, the picture is reversed when the lifespan component is taken into account: The relative position of women in the Majority group is more favorable, while serious gender inequalities against women are observed in Minorities[10] (and particularly high in the Hispanic group). In fact, White Non-Hispanic women are very often less deprived than men while the contrary characterizes Hispanics and Blacks. These facts imply that women in Minorities bear higher race penalties compared to men and that they accumulate race and gender disadvantages in a non-additive fashion. Note that within gender racial gaps (in favor of Whites Non-Hispanic) are much more alarming than within race gender inequalities.

The lack of progress in reducing income poverty, particularly among women in Minorities, can be considered as a consequence of the increased prevalence of singlehood. This trend weakens the potential impact of enhanced female participation in the labor market on poverty (Snipp & Cheung, 2016). Conversely, the progress observed in the life expectancy of men in Minorities can be attributed to advancements in medicine and the implementation of health programs targeting vulnerable groups (K. M. Murphy & Topel, 2006).)

This paper contributes to the existing literature on gendered poverty (Lichtenwalter, 2005; Iceland, 2013; Provencher & Carlton, 2018) and mortality (Case & Deaton, 2017; Case & Deaton, 2015 and Ezzati et al., 2008) in the United States. These two strands of the literature have evolved independently, without much reflection on the fact that premature death is a more extreme form of deprivation. This paper enriches this literature in two ways. First, it uses a novel index called the "Generated Deprivation Index" to combine lifespan and alive deprivations in a simple and meaningful manner. Remember that this index satisfies desirable properties unmet by commonly used indices such as the Human Development Index (see discussion above). Second, this study is among the first to have explored how the compensation in poverty and mortality has been made since 1970 as these dimensions of deprivation

[10] In the USA, racial and ethnic groups other than Whites non-Hispanics (Hispanics, Blacks, Asians, Indians, and Native Hawaiians) are classified as minorities (US Census Bureau, 2019)

yield conflicting results regarding the direction of the gender gap in the US. The findings provide some nuance to the existing literature by showing that the gender difference in total deprivation is less pronounced if mortality and poverty are studied together than when they were taken separately. In addition, the existing literature has shown that the relative women's disadvantage in income and poverty was greater in the Majority group than in Minorities (Snipp & Cheung, 2016). The results of this study take an opposite direction: women in Minorities experience more gender disadvantage in total deprivation.

The remainder of this paper is organized as follows. Section 3.2 delves into insights from existing literature on poverty and mortality in the US. In Section 3.3, the Generated Deprivation Index and the data used in this study are introduced. Section 3.4 presents the disparities in total deprivation across genders in each racial group. To take into account measurement concerns, I perform some sensitivity analysis in Section 3.5. Section 3.6 presents the conclusion.

3.2 Poverty and mortality in the United States

3.2.1 Gendered Poverty

Despite important economic performance observed over time, the United States continues to face the challenge of persistent poverty. For instance, between 1970 and 2015, the annual increase in real GDP averaged 2.8% , yet the poverty rate remained relatively stable, around 12.5% (12.6% in 1970 and 12.7% in 2016) (US Census Bureau, 2019). In this section, I present insights from the literature on poverty in the US, supplemented by statistics computed using data collected through the Current Population Surveys (CPS). These surveys are conducted annually by the US Census Bureau and provide a nationally representative picture of household socio-economic conditions.

The literature has identified socio-demographic factors such as family structure, education, and nativity as significant contributors to poverty persistence in the U.S. (Iceland, 2019; Hoynes et al., 2006). These factors disproportionately impact women and men across different racial groups, leading to persistent inequality along gender and ethnicity lines.

Education is a crucial indicator of human capital and has played a

significant role in poverty dynamics since the post-Fordism era. This period marked a restructuring of the American economy, characterized by a widening wage gap between human capital-intensive occupations and low-skilled jobs (Florida & Mellander, 2016; Gartman, 1998). Education levels vary significantly by race in the US, contributing to racial disparities in poverty rates. For instance, the lower levels and quality of education among Black Americans, exacerbated by racial residential segregation, is widely cited as a key factor driving the poverty gap between Black (21.1% in 2015) and White (10.5% in 2015) populations (Iceland, 2019; Massey & Denton, 1993).

The country of origin also impacts poverty rates, with immigrants being more susceptible to poverty even within racial groups (Proctor et al., 2016). This vulnerability stems from limited labor market networks combined with language barriers. Additionally, immigrants often have lower quality of education compared to natives, which hinders their ability to translate academic credentials into good jobs (Iceland, 2013). For instance, the substantial poverty gap between Hispanics (19.6% in 2015) and Whites (10.5% in 2015) can be attributed in part to an important share of Hispanics being immigrants in the US (Iceland, 2019).

Family structure plays a crucial role in shaping the gendered pattern of poverty within each racial group in the United States. In 2015, the poverty rate among husband-wife families stood at 5%, contrasting starkly with the 28% poverty rate among female-headed families (Proctor et al., 2016). Women are more likely to be in single-headed households due to factors such as unmarried childbirth and retaining custody after marital breakdowns (Sharma, 2023) making them disproportionately affected by poverty driven by the family structure. The share of single-head families increased from 22% in 1976 to 37% in 2016, with an average of 35% of women living in single-head families compared to 28% for men (Table 3.1). Consequently, the potential gains in poverty alleviation that could emerge with the rise of women's participation in the labor market, increasing from 57% in 1970 to 76% in 2000, have been largely offset by the increase in the number of female-headed families (Hoynes et al., 2006). It is important to highlight the disparity in poverty likelihood with respect to the gender of the single head: in 2015, while 26% of individuals in single-male families were living in poverty,

this proportion reaches 46.5% for single-female families (Proctor et al., 2016).

Table 3.1: Poverty and Singlehood rates

	Poverty rates					Singlehood rates				
	1976	**1990**	**2016**	*Pairwise t-test*		**1976**	**1990**	**2016**	*Pairwise t-test*	
	(1)	(2)	(3)	(2)-(1)	(3)-(1)	(4)	(5)	(6)	(5)-(4)	(6)-(4)
ALL										
All	0.13	0.13	0.14	0.00***	0.01***	0.22	0.30	0.37	0.08***	0.15***
Men	0.11	0.11	0.12	0.00	0.01***	0.18	0.27	0.34	0.09***	0.16***
Women	0.14	0.15	0.15	0.00***	0.01***	0.26	0.34	0.40	0.08***	0.14***
Non-Hispanic Whites										
All	0.08	0.08	0.09	-0.00	0.01***	0.19	0.27	0.31	0.07***	0.12***
Men	0.07	0.07	0.08	-0.00	0.01***	0.15	0.23	0.29	0.08***	0.14***
Women	0.10	0.10	0.10	0.00	0.01***	0.23	0.30	0.34	0.07***	0.11***
Hispanics										
All	0.26	0.26	0.21	0.00	-0.05***	0.24	0.33	0.39	0.09***	0.16***
Men	0.24	0.24	0.19	0.00	-0.05***	0.21	0.31	0.37	0.10***	0.17***
Women	0.27	0.28	0.23	0.00	-0.04***	0.27	0.35	0.42	0.08***	0.15***
Blacks										
All	0.32	0.30	0.24	-0.01**	-0.08***	0.44	0.56	0.62	0.12***	0.18***
Men	0.29	0.27	0.22	-0.02**	-0.06***	0.38	0.50	0.57	0.12***	0.19***
Women	0.34	0.33	0.25	-0.01	-0.09***	0.50	0.62	0.67	0.12***	0.17***

Note: This table presents poverty and singlehood rates by race and gender for the years 1976, 1990, and 2016, using data from the American Current Population Surveys (CPS). Poverty=1 if the individual lives in family with total income below the official poverty line, considering the family size and age composition. Singlehood=1 if the individual lives in a family with only one head (either a man or a woman, with or without children), while 0 indicates living in a family consisting of a husband and wife. Note */**/*** pairwise mean difference significant at 10%/5%/1%.

National averages hide important racial disparities in terms of the prevalence of singlehood. In 2016, singlehood averaged 62% among Blacks, compared to 31% among non-Hispanic Whites (Column 6 of Table 3.1). Sociologists attribute this phenomenon to a cultural argument, suggesting that Blacks are more accepting of singlehood than Whites (Goldscheider & Kaufman, 2006) resulting in lower marriage rates (Raley et al., 2015). These disparities in family structure correlate strongly with large differences in poverty rates across racial groups and variations in gender inequality within races. To delve deeper, Figure 3.A.1 in the appendix illustrates poverty rates by family structure while controlling for education, nativity, citizenship, age, number of children, State, and year Fixed Effect. Two main results emerge from the figure. First, within each type of family, Blacks consistently exhibit higher poverty rates, while non-Hispanic Whites are less likely to experience poverty. In single-male families, Hispanics and Whites reach similar levels of poverty rates. Second, the data reveal that individuals in female-headed households are more prone to poverty across all racial

groups, with particularly high proportions among minorities, reaching around 50%. As illustrated in Table 3.1 (Column 6), across all racial groups, women are more likely to live in female-headed families, with the largest proportions observed among minorities (e.g., 67% for women vs 57% for men in the group of Black in 2016).

Family structure and measure of poverty

The statistics on poverty provided by the US Census Bureau through the Current Population Surveys rely on total family income. Specifically, all family members are considered poor if the household's pooled income falls below the official national threshold. This approach does not account for intra-household inequality, implicitly assuming that resources are equally distributed within each household. In this regard, in husband-wife families where, on average, the composition of men and women is equal, there is no noticeable gender differential in poverty rates, as suggested by Figure 3.A.2 in the appendix. With this official approach of measuring poverty, any gender differences in poverty rates stem from singlehood.

Numerous studies have shown that this assumption does not hold in the majority of cases, leading to potential misreporting of poverty (Cherchye et al., 2012; Ponthieux & Meurs, 2015). In other words, by not accounting for intra-household income inequality, we may misclassify individuals as poor in non-poor families and vice versa. In the US, it is well established that women earn less than men in the labor market, and these gender differences persist over time (Snipp & Cheung, 2016). Given this reality, women's poverty rates in husband-wife families are more likely to be underestimated, while those of men will tend to be overestimated when intra-household inequality is not taken into account. Yet, I attempt to address this bias by computing an individualized poverty rate (see details Subsection 3.5.4)

In summary, the facts highlighted in this subsection shed some light on American women's disadvantage in income poverty. Another important dimension of deprivation in the US is mortality.

3.2.2 Gendered mortality in the United States

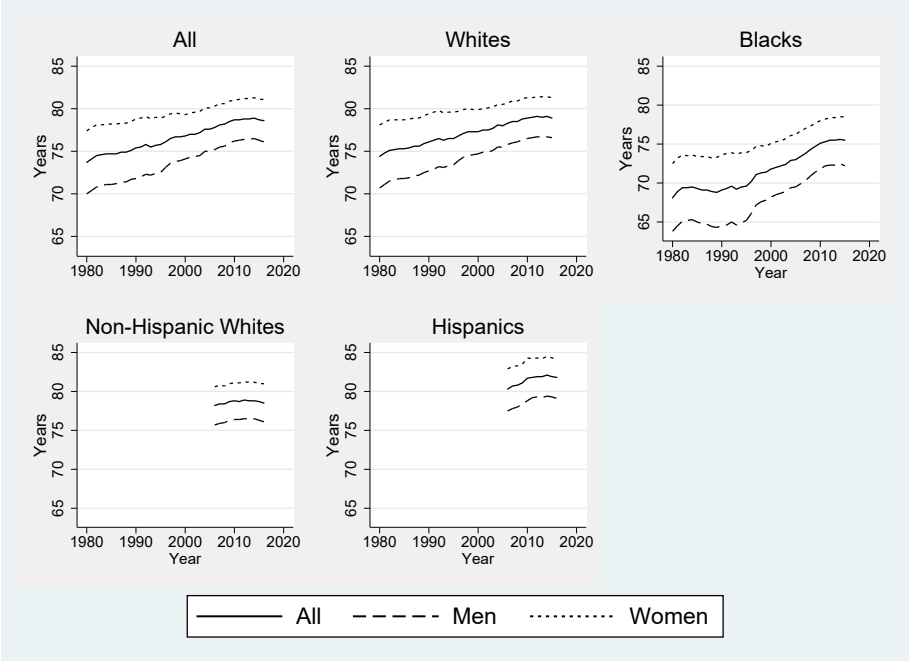
Several empirical studies conducted in the US have shed some light on the high gender and racial disparities in life expectancy at birth, with women holding a permanent advantage. This pattern persists across all racial groups, with women typically living 5 to 6 years longer than men on average. Furthermore, the disparities between the most advantaged and disadvantaged groups in terms of life expectancy are striking. Murray et al. (2006) found that in 2001, the life expectancy gap between 3.4 million high-risk urban black men and 5.6 million Asian women was nearly 21 years. Within each gender, the life expectancy gap between the most advantaged and the least advantaged groups was 15.4 years for men (Asians versus high-risk urban blacks) and 12.8 years for women (Asians versus low-income rural blacks in the South).

In terms of trends, as shown in Figure 3.1 between 1980 and 2015, men gained six years (from 70 to 76.3), while women gained four years, reducing the gender gap by two years. Black males, initially the most disadvantaged group, saw their life expectancy increase from 64 years in 1980 to 76 years in 2016, while that of Black females rose from 72.5 to 78.5, reducing the gender gap by six years. Gains in the life expectancy among Whites were more modest (six years for men versus three years for women), thereby reducing the Blacks-whites racial gap. Despite this overall decrease in mortality, Case & Deaton (2017) found that Non-Hispanic Whites without a college degree have been experiencing a reduction in life expectancy since 1990.

In the literature, it is well documented that improved nutrition, public health policies, and development in mainstream medicine led to substantial increases in life expectancy (Cutler et al., 2006). In the United States, education is often identified as a crucial factor in reducing mortality rates (Montez et al., 2011; Case & Deaton, 2017). Higher levels of education provide individuals with better incomes, enabling them to afford superior healthcare services, which are expensive in the US. Additionally, higher education is associated with a decreased likelihood of engaging in risky health behaviors such as smoking. The Black population in the US faces disadvantages in education, leading to higher mortality rates compared to other racial groups.[11] Regarding gender

[11] It is worth noting the existence of the Hispanic mortality paradox, which suggests that

Figure 3.1: Figures/Life expectancy in the US



Note: These figures present the evolution of life expectancy by race in the US constructed by the American Center for Disease Control and Prevention (CDC). Note that estimations of life expectancy by Hispanic origin start in the year 2006.

inequality in mortality, Schünemann et al. (2017) highlighted that the mortality gap can be attributed not only to biological factors but also to gender-specific preferences and health behaviors.[12] Their findings suggest that between 86% and 89% of the gender gap in mortality in the US can be explained by gender-specific preferences and behaviors.

In summary, the literature suggests that in the United States, women in each racial group are more likely to experience poverty, while also exhibiting lower mortality rates than men. However, studies on poverty and mortality have largely evolved independently, without much reflec-

despite lower socioeconomic conditions among Hispanics, they exhibit, on average, a 17.5% lower risk of mortality compared to comparable individuals in other racial groups (for a comprehensive review, refer to Ruiz et al., 2013).

[12]From a biological perspective, women have a better immune system than men. From the behavioral side, on average women are less likely to take health risky behaviors such as smoking, drinking, drug use, hazardous driving, and more likely to have healthy nutrition and to use health care services (Schünemann et al., 2017).

tion on the idea that early mortality can be considered an extreme form of deprivation. In the next sections, I aim to discuss this issue by combining poverty and mortality data to investigate the gendered pattern of total deprivation.

3.3 Methodology

In this section, I first present data that were used and then explain the computation of the Generated Deprivation Index.

3.3.1 Data

Since 1964, the US Census Bureau conducts annually the so-called "Current Population Survey (CPS)" that collects detailed information on individual poverty status and income level in the United States. The CPS data were downloaded from Integrated Public Use Microdata Series (IPUMS CPS) website (Ruggles et al., 2021). I also exploited data from The Survey of Epidemiology and End Results (SEER) that contains information on the US population from 1969 to 2016. From these two sources, I constructed a long time series of the number of poor by gender and race in the US from 1969 to 2016. It is important to note that while these poverty data were used in this study, I acknowledge the limitations of the methodology used by the Census Bureau. As discussed in Section 3.2 the Bureau's definition of poverty relies on the assumption of intrahousehold equality in resources allocation, which can result in misreported individual poverty rates, especially in underestimating poverty among women. Later in the paper (Section 3.5.4), I discuss this concern in more details.

Furthermore, age-specific mortality data for all deaths occurring in the US were downloaded from the website of the National Bureau of Economic Research (NBER). These data collected by National Center for Health Statistics are publicly available with individual characteristics at the national since 1959. For sensitivity analysis, I exploit additional data from The Bureau of Justice Statistics.

3.3.2 Computation of the Generated Deprivation Index

Following Baland et al. (2021), I proceeded as follows to compute the annual Generated Deprivation Index for each gender, and racial group. First, from mortality data, for each year, gender and racial group, I computed the number of individuals dead at each age by summing up individual records. Having information on age-specific mortality, the second step was the choice of an age line that should be seen as the normal age to die with in the US. I considered in the next steps an age line of 75 years that is close to the average life expectancy at birth in the US between 1980 and 2016 (76.5 years).[13] After, I computed for each age a, the number of person-years prematurely lost ($PY(a)$) using the following formula:

$$PY(a) = d(a) * (\widehat{a} - (a + 1)) \tag{3.1}$$

Where $\widehat{a}$ is the age line, a the age at death, and $d(a)$ the number of individuals dead at age a. I computed $PY(a)$ for all death that occurred at an age lower than the threshold. For all other deaths above, the value of $PY(a)$ is equal to zero. For each year, gender and racial group, I calculated the total number of person-years lost ($d^{GD}(x)$), measured in time units in group x, by aggregating the age-specific $PY(a)$.

$$d^{GD}(x) = \sum_{a=0}^{\widehat{a}-1} PY(a) \tag{3.2}$$

The annual number of poor for each racial and gender group (x) was estimated from the Current Population Survey (CPS, 1969-2016) and the Survey of Epidemiology and End Results (SEER) population data.[14] Having information on poor (p), non-poor individuals (f), and the number of person-years lost in the group (d^{GD}) in the group x, I was able to determine the annual GDI (P_{γ}^{GD}) at the national level using the following formula:

[13] Men's average is 73 while for women it reaches 79.4 (National Center for Health Statistics, 2021)

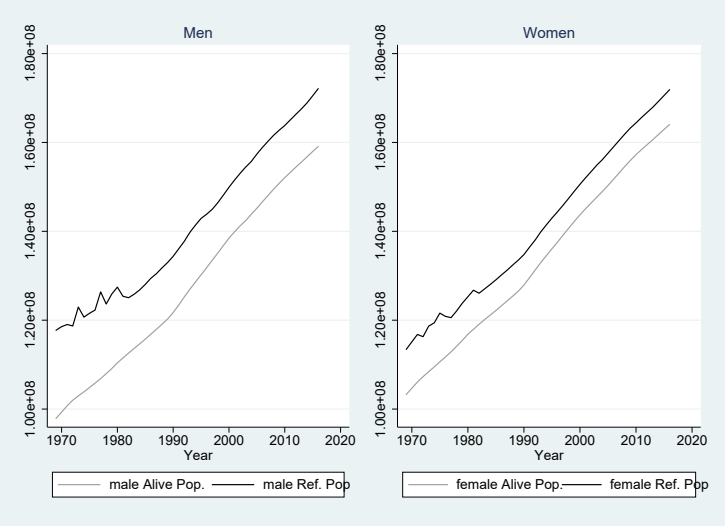
[14] Specifically, individual poverty status information is available in the CPS. Hence, I calculated the poverty rate for each gender and racial group (denoted as x), and subsequently multiplied it by the population (from SEER) to estimate the number of poor and non poor in each group x.

$$P_{\gamma}^{GD}(x) = \underbrace{\frac{p(x)}{f(x)+p(x)+d^{GD}(x)}}_{alive\ deprivation} + \gamma \underbrace{\frac{d^{GD}(x)}{f(x)+p(x)+d^{GD}(x)}}_{lifespan\ deprivation} \tag{3.3}$$

Where γ is the relative weight of lifespan over alive deprivation. Being more conservative, I considered a lower bound of γ of 1 (as in Baland et al., 2021) meaning that being alive deprived is as bad as being lifespan deprived. The traditional Head Count Ratio (HCR) is calculated based on the living population ($f(x)+p(x)$). Conversely, the reference population for the GDI (and its components) adds the number of prematurely dead individuals ($f(x)+p(x)+d^{GD}(x)$) to compute the total deprivation. Figure 3.2 shows the differences in these two reference populations for both men and women. As expected, the distance between the two populations is higher for men than for women given that the firsts are more likely to die prematurely. This implies that, once we account for lifespan deprivation, we will be less pessimistic regarding the relative position of women than the literature focusing on HCR only.

As mentioned, we need information on poverty and mortality to compute the GDI. Therefore, I calculated the GDI at the national level from 1969 to 2016. In addition, for all the periods, we computed the indicators for Whites and Blacks. Detailed information on other races was available only from 1990 onward, the year from which I computed the indices for Whites non-Hispanics (Whites NH), Hispanics, and Blacks.

Figure 3.2: Alive population and reference population for the total deprivation



Note: These figures present the difference between the Alive Population and the reference population (both measured in time units) used in the Generated Deprivation Index (GDI) calculations for both men and women. The reference population includes, the living population (poor and non-poor) and the number of person-years prematurely lost in a society for a given year

3.4 Pattern of total deprivation in the United States

In this section, I first present gender differences in total deprivation, and second, I explore racial differences.

3.4.1 Evolution of the generated deprivation index (GDI) by gender

Let us start by commenting on the overall evolution, and then we turn to gender comparisons. Figure 3.3 presents the evolution of the total deprivation (GDI) and the Head Count Ratio (HCR) by gender in the US. We observe from the left panel of Figure 3.3 that, in general, there has been no clear trend of income poverty (HCR) since 1969. The pattern is very different when premature mortality and poverty are combined: there seems to be a decreasing trend in the Generated Deprivation In-

dex (GDI) with some fluctuations. To accurately interpret this trend, I decompose the GDI into its Lifespan Deprivation (LD)[15] and Alive Deprivation (AD)[16] components.

Figure 3.4 shows that there has been a decreasing trend in the Lifespan Deprivation (LD) component while the Alive deprivation (AD) slightly increased by 0.01 percentages points (pp) on average each year (note that figures on average annual change are reported in Table 3.2). The combination of information from Figure 3.3 and 3.4 allows to distinguish two periods regarding the contribution of these two components on the GDI's behavior : Before 1990, there is a negative trend in GDI driven by a strong decrease in LD whereas, after 1990, we observe a small additional decrease in LD and large fluctuation in GDI dictated by the trend in AD. More precisely, the total deprivation rate (GDI) went from 24% in 1969 to 19% in 1990 (annual average decrease of 0.15pp) despite a slight increase of the AD from 11 to 12% (annual increase of 0.16pp). In this period, the downward trend is driven by the decrease of LD from 13 to 7% (annual decline of 0.31pp). The second period which spans from 1990 to 2016 is characterized by a slowing down of the declining rate of LD (-0.05 pp per year) and higher variability of poverty which entirely dictates the trend of the GDI.[17]

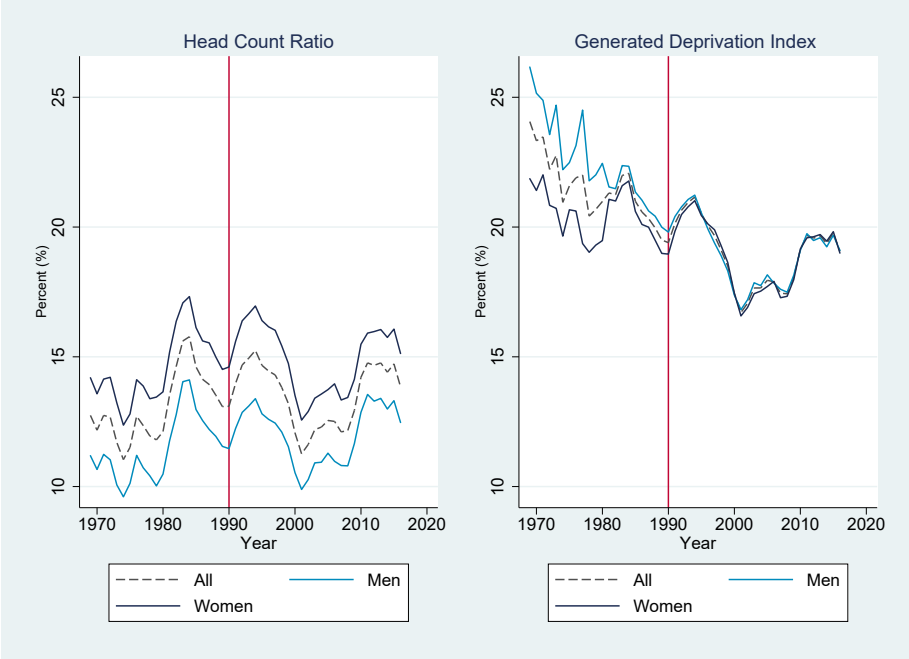
It is important to note the choice of the year 1990 as the cutoff for data analysis is based on both statistical and contextual considerations. As shown in Table 3.2, the average annual variation in total deprivation (GDI) before 1990 (-0.15pp per year) differs significantly from that observed after 1990 (-0.05). Furthermore, as discussed in Snipp & Cheung, 2016, government programs aimed at increasing opportunities for women and minorities were implemented in the US prior to this period. However, post-1990, there was a notable relaxation of these initiatives, leaving disadvantaged groups in precarious positions. While the impact of these programs on poverty remained limited, possibly due to an increase in singlehood (+ 8 percentage points, Table 3.1), they had an

[15] Proportion of Person-years prematurely dead in the reference population

[16] Proportion of poor in the reference Population

[17] For example, in this segment, the minimum levels of the GDI (16.7%) and AD (10.5%) are both observed in 2001, while the maximums are in 1994 (21% and 14% for GDI and AD deprivation). Regarding the LD, it has been below 7% since 1991 and its variability is low (minimum of 5.7% and a maximum of 7.1 %).

Figure 3.3: Evolution of the Generated Deprivation Index (GDI) and the Head Count Ratio (HCR) by gender

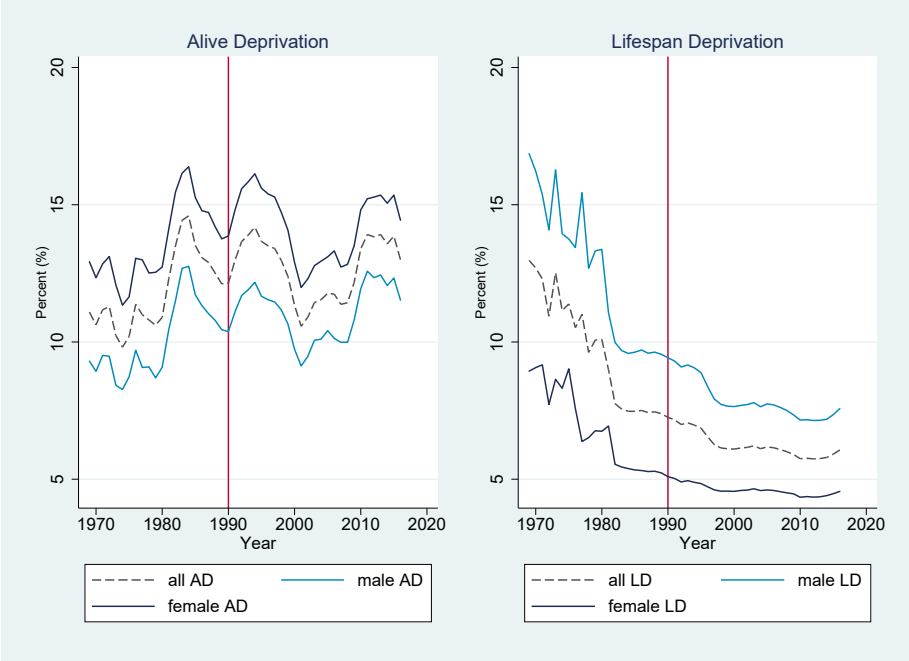


Note: These figures present, by gender, the evolution of the total deprivation (GDI) and the income poverty (HCR) in the United States from 1969 to 2017

important effect on mortality rates, particularly evident in the substantial reduction in mortality due to heart disease and strokes. This decline in mortality can also be attributed to significant advancements in medical technology (K. M. Murphy & Topel, 2006). It is worth noting that additional gains in mortality rates post-1990 were marginal, as the major causes of mortality had already been addressed or mitigated to some extent before this period. Consequently, achieving further reductions in mortality rates beyond 1990 became increasingly challenging.

Turning to gender differences, the total deprivation (GDI) provides a very different picture from the income poverty (HCR). Figure 3.3 shows that women are poorer than men and the gender gap is almost stable over the entire period (Min 2.4pp, Max of 3.6pp, st dev 0.36pp). In contrast, the GDI curve suggests that the total deprivation was higher for men until 1990 and extremely similar afterward. More precisely, over the whole period, the poverty rate of women is around 3pp higher than

Figure 3.4: Evolution of the lifespan (LD) and alive deprivations (AD)



Note: These figure decompose the GDI in Figure 3.3 into the lifespan and alive deprivations components

that of men. Regarding the total deprivation, in 1969, men's rate is 5 pp higher than women's, and since the 1990s, the gender gap has been narrowed considerably.

The similarity in men's and women's total deprivation hides important gender differences in the individual components (Figure 3.4). Men's advantage in Alive Deprivation (AD) remains stable at about 3 pp (as in HCR) over the period, while women's advantage in Lifespan Deprivation (LD) decreases. The later evolution is driven by a very rapid decrease in men's LD by 0.19 pp each year (vs 0.09 pp for women). Meanwhile, the annual changes in the AD are close across gender (+0.05 and +0.03 pp per year for women and men, respectively). We also notice that on the entire period (1969-2016), the GDI of men decreases by 0.14 pp each year on average while for women the decrease amounts to 0.06pp. Therefore, it can be deduced that the increase of Income deprivation is more compensated for men than for women by the decreasing behavior of the LD.

Table 3.2: Average annual change of deprivation rates (percentage points)

	Before 1990			After 1990			All years (1970-2016)		
	AD	**LD**	**GDI**	**AD**	**LD**	**GDI**	**AD**	**LD**	**GDI**
ALL									
All	0.16**	-0.31**	-0.15**	0.00	-0.05**	-0.05	0.04**	-0.14**	-0.10**
Men	0.16**	-0.40**	-0.24**	0.03	-0.08**	-0.06	0.05**	-0.19**	-0.14**
Women	0.16**	-0.22**	-0.06	-0.02	-0.02**	-0.04	0.03*	-0.09**	-0.06**
Whites									
All	0.17**	-0.29**	-0.12**	0.02	-0.03**	-0.01	0.06**	-0.13**	-0.07**
Men	0.17**	-0.37**	-0.20**	0.03	-0.05**	-0.02	0.06**	-0.17**	-0.11**
Women	0.17**	-0.20**	-0.04	0.00	-0.01*	-0.00	0.05**	-0.08**	-0.03*
Blacks									
All	0.10	-0.45**	-0.35**	-0.21**	-0.18**	-0.39**	-0.15**	-0.23**	-0.38**
Men	0.08	-0.54**	-0.46**	-0.12*	-0.25**	-0.37**	-0.10**	-0.30**	-0.40**
Women	0.11	-0.35**	-0.24**	-0.30**	-0.11**	-0.41**	-0.20**	-0.17**	-0.36**
Hispanics									
All				-0.18**	-0.18**	-0.37**			
Men				-0.14*	-0.25**	-0.39**			
Women				-0.23**	-0.11**	-0.34**			
Whites NH									
All				0.01	-0.00	0.01			
Men				0.03	-0.02**	0.01			
Women				-0.00	0.01**	0.01			

Note: This table reports the average annual change of each indicator in percentage points. Growth is computed by running an OLS regression of the indicator on year. White includes Hispanic and White No Hispanic (White NH). Data for Hispanic origin are available from 1990. AD: Alive Deprivation; LD: Lifespan Deprivation; GDI: Generated Deprivation Index; HCR: Head Count Ratio. */** next to the coefficient indicates significance at the 5%/1% level.

The relative contributions of mortality and poverty to the overall deprivation are not the same over the entire period. The lifespan component influenced more the GDI especially for men before the 1990s while the importance of Income deprivation became more evident for both men and women thereafter. In the beginning, in 1969, the lifespan deprivation rate of men was 8pp higher than that of women (17% and 9% for men and women, respectively). At the same time, women's income deprivation rate was 4 pp higher than men's (13 and 9% respectively). Figure 3.3 and 3.4 highlight that the declining trend in men' LD from 17% in 1969 to 9.4% in 1990 (-0.4 pp annually) led their GDI to decrease by 0.2 pp each year on average.[18] Besides, the decline in women's LD (-0.2pp per year) was fully absorbed by an increase of income deprivation (+0.2pp) so that there was no remarkable variation in their total deprivation (GDI). The period from 1990 onward is characterized by

[18]the low marginal change of GDI is due to the increase in AD for both gender groups

both a lower rate of decline and lower variability in LD, such that the GDI curves replicate the behavior of the AD.

Overall, throughout the entire period, men tended to benefit more than women from advancements in medicine and public health programs, as indicated by the decreasing gap in lifespan deprivation. This trend may be attributed to the initially higher mortality rates among men, particularly due to heart disease and strokes, compared to women (K. M. Murphy & Topel, 2006). In terms of income poverty, despite women facing initial disadvantages, there were no significant changes observed during the entire period. This lack of change can be attributed to increased rates of singlehood, which diminished the potential positive effects of greater female participation in the labor market (Snipp & Cheung, 2016). In the next section, I delve into racial differences in these patterns.

3.4.2 Racial differences in deprivation rates

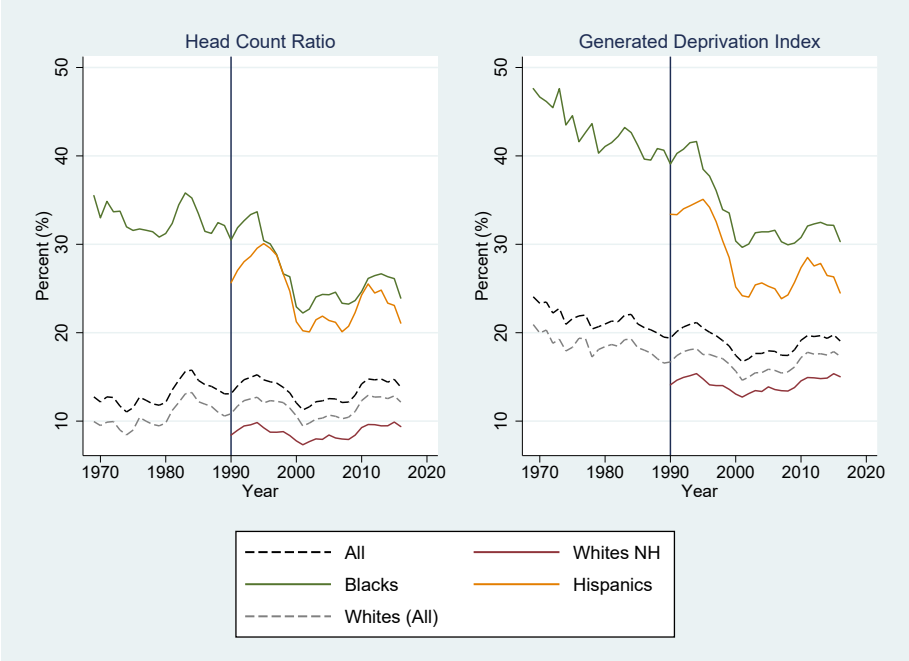
Women in minority groups face both racial and gender (dis)advantages. In this section, I first explore the racial differences in total deprivation and then examine the gender gap within each racial group.

3.4.2.1 Inter-Racial Disparities in Total Deprivation

Figure 3.5 (and 3.A.3 in the appendix) present the total deprivation (and its components) and the income poverty rates by race. Two key observations emerge. First, the deprivation rates among Minorities (Hispanics and Blacks) are particularly high compared to the majority group (Non-Hispanic Whites). Moreover, the racial disparity in total deprivation is more pronounced than that in income poverty. Second, there seems to be notable progress in the GDI reduction for Hispanics and Blacks, while no significant change is observed among Non-Hispanic Whites. These dynamics contribute to the narrowing of racial inequality, although complete convergence remains elusive.

The decline of GDI among Minorities is predominantly driven by their rapid decrease in mortality (before 1990) and income poverty (more pronounced after 1990), while changes in the Majority group are more modest. To elaborate on this, we first look at the difference between Whites (Hispanics and No-Hispanics) and Blacks and consider Hispanic

Figure 3.5: Deprivation rates (in percent) by Race



Note: These figures report (in percent) the Generated Deprivation Index (GDI) and the Head Count Ratio for each racial Group. The subdivision between Hispanic and Non Hispanic Whites starts from 1990

origin after 1990.[19] The deprivation rate is structurally higher among Blacks (mean 37,8% std 5,7) than Whites (mean 17.6% std 1.4) over the entire period.[20] An important share of these racial disparities is likely attributable to family structure, as Blacks are more prone to live in single-head families (62% in 2016, Table 3.1) compared to other racial groups. Other factors such as low levels of education and risky behaviors (such as smoking) are also commonly cited as contributors to the high levels of mortality and poverty among Blacks (Montez et al., 2011, Schünemann et al., 2017)

Among Whites, the total deprivation rate is the highest for Hispanics (mean 28.4% std 4%) compared to Whites NH (mean 14.1% std 0.8%). Nonetheless, despite the net advantage of White NH in AD, the decreas-

[19]The ethnic distinction between Hispanics and Whites NH starts in 1990

[20]Besides, the annual decreasing rate in GDI is higher in absolute value for Blacks (-0.38pp vs -0.07pp for Whites, Table 3.2) and, this reduces the gap between these two racial groups.

ing rates in AD (-0.18pp per year) and LD (-0.18pp) are the highest for Hispanics such that the intra-Whites difference in GDI has been reduced significantly (by 0.38 pp on average each year since 1990, Table 3.A.2 in the appendix). The stagnation in deprivation dimensions among Whites NH can be attributed to the deteriorating labor market opportunities for those without a college degree (Case & Deaton, 2017). Inside the Minority group, we observe that Blacks (compared to Hispanics) have been at a disadvantage in HCR and GDI since 1990.

In the remainder of this study, given the unavailability of data before 1990, I limit the analysis from 1990 to 2016 and focus on the three main racial groups: White Non-Hispanics (NH), Blacks, and Hispanics.

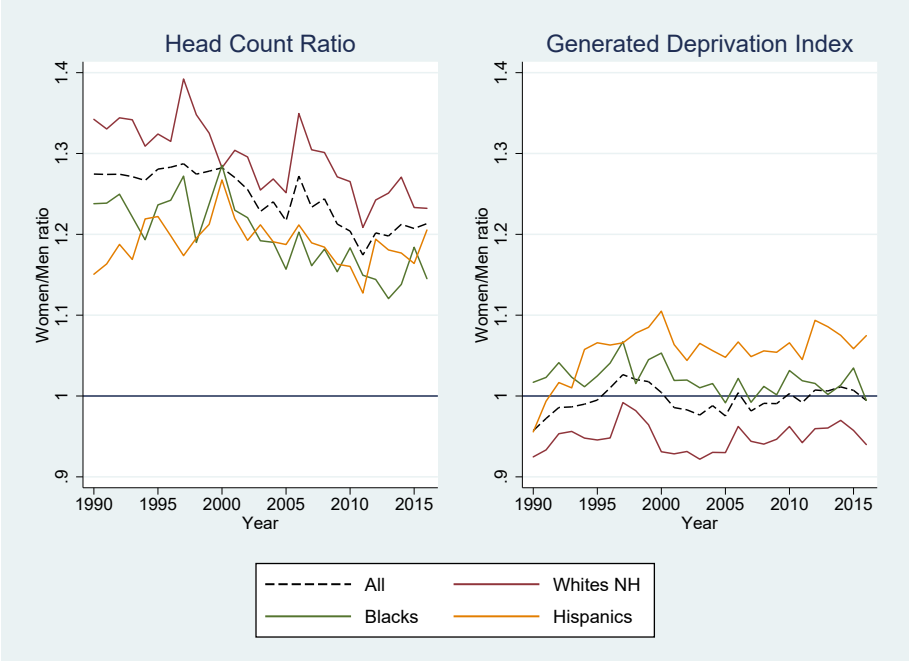
3.4.2.2 Deprivation gender gap in each racial group

To analyze intra-race gender inequality in total deprivation, Figure 3.6 presents the ratio of deprivation of women to that of men in each group. These ratios provide cross-race comparable insights in the gender inequalities, as they are less influenced by scale differences compared to absolute gaps. Absolute deprivation rates by gender are detailed in Figures 3.A.4 and 3.A.5 in the appendix. In Figure 3.6, the left panel depicts the Head Count Ratio, while the right panel focuses on the Generated Deprivation.

The right panel of Figure 3.6 highlight more pronounced gender inequality against women within the Hispanic and Black groups, whereas the curve of Whites NH reveals permanent women's advantage in total deprivation since 1990 (for several years the deprivation rate of White NH women represents on average 95% of the rate of men). In addition, the Hispanic group has the largest gender difference in the total deprivation. In absolute terms (see Figure 3.A.4 in the appendix), the GDI among White NH women is, on average, 0.75 pp lower than that of men, and the gap does not change over the period. In contrast, Hispanic women have always experienced higher deprivation rates than men (1.47pp), and the gap has been increasing since 1990 by 0.05pp each year on average. In the group of Black, the gender difference is low (0.7pp) and has been decreasing by 0.04 each year on average (Table 3.A.1 in the appendix).

The relative contribution of premature mortality and income depri-

Figure 3.6: Gender (women/men) Ratio by Race



Note: These figures present for each racial group the ratio of women's deprivation over men's. For the deprivation, we consider the Head count ratio (HCR) and the generated deprivation index (GDI) The ratio of 1 means perfect gender equality

vation in shaping the GDI gender gap varies across races. While on average, in all racial groups, women are at a disadvantage in AD and an advantage in LD, the magnitude of the gender gaps and their annual variations are different (Table 3.A.1 in the appendix). In Minorities (Black and Hispanics), for the average year, the relative advantage of women in LD (4.95 for Blacks and 3.31 for Hispanics) is not sufficient enough to compensate for their gap in AD (5.65 and 4.77 for Blacks and Hispanics, respectively). As a consequence, women in Minorities are in the worst position in total deprivation compared to men while in the Majority group, the contrary is observed. Regarding the evolution, in the group of Blacks, women experience a higher decline in AD, whereas men's LD falls more rapidly. Given these facts, we observe negligible gender differences in the GDI annual change (0.37 pp for men and 0.41 for women). In the pre-1990 period, men were more deprived, but the gender difference in LD reduction (in favor of men) dominated the gap

in AD decline (in favor of women) in the way that the gender gap in GDI (in favor of men) has been low in the group of Blacks during the post-1990 period.[21] The historical disadvantageous position of women in the Hispanic group results from the fact that, since 1990, men have always experienced a sizable decline in both AD and LD, such that the GDI has been at their advantage. In the group of Whites NH, men's advantage in income deprivation has never been high enough to compensate for their disadvantage in mortality. Therefore, White NH women have been less deprived than men since 1990.

The most interesting point is that these racial differences described above are almost reversed if we would focus on AD or HCR only (left Panel of Figure 3.6): Whites NH appear as the group with the highest women disadvantage while Hispanics and Blacks exhibit the lowest (gender bias for Hispanics and Blacks are close). In fact, AD and HCR gender ratios for Whites NH are always above the national level and women's deprivation rates represent for some years more than 140% of the rates of men. These findings are consistent with Snipp & Cheung (2016)'s paper which revealed that, in the US, the highest wage gender gap is found in the Whites NH group. The reversal in the income poverty and total deprivation gender ratios stems from the fact that men in minority groups benefited more from a decrease in racial inequality in premature mortality compared to women.[22]

As illustrated in Figure 3.1, Blacks initially experienced a notably low level of life expectancy, largely attributed to the high prevalence of major causes of mortality in the US, such as cancer, homicide, and heart diseases (Schwandt et al., 2021). Over the entire period, Black men notably benefited from programs targeting vulnerable groups, resulting in a reduction in their mortality rates. In 2016 (as shown in Column 6

[21] On average, the gap between Black men and women is 0.7pp, decline of -0.04 pp each (Table 3.A.1)

[22] To elaborate on this, consider the intra-gender racial gap for the mean year as presented in Table 3.A.2. Hispanic men and women have a racial advantage in LD (compared to Whites NH) of 0.42 and 0.60 pp, respectively. The average annual increase in the gap represents 0.23pp for men and 0.13pp for women. The following year, in relative terms, the racial advantage will increase by 0.54% and 0.22% for men and women, respectively. Using the same logic with AD, the relative decrease in the AD racial gap is 0.0123% for men and 0.0144% for women. By combining AD and LD, the racial gain for men is greater than that for women, which turns the gender difference in GDI in favor of men.

of Table 3.1), 67% of Black women and 42% of Hispanic women lived in single-head families, compared to 57% of Black men and 37% of Hispanic men. Once again, this highlights the historical disadvantage faced by women in terms of income poverty, as family structure tends to weaken the impact of anti-poverty initiatives, particularly for vulnerable groups like women in Minorities.

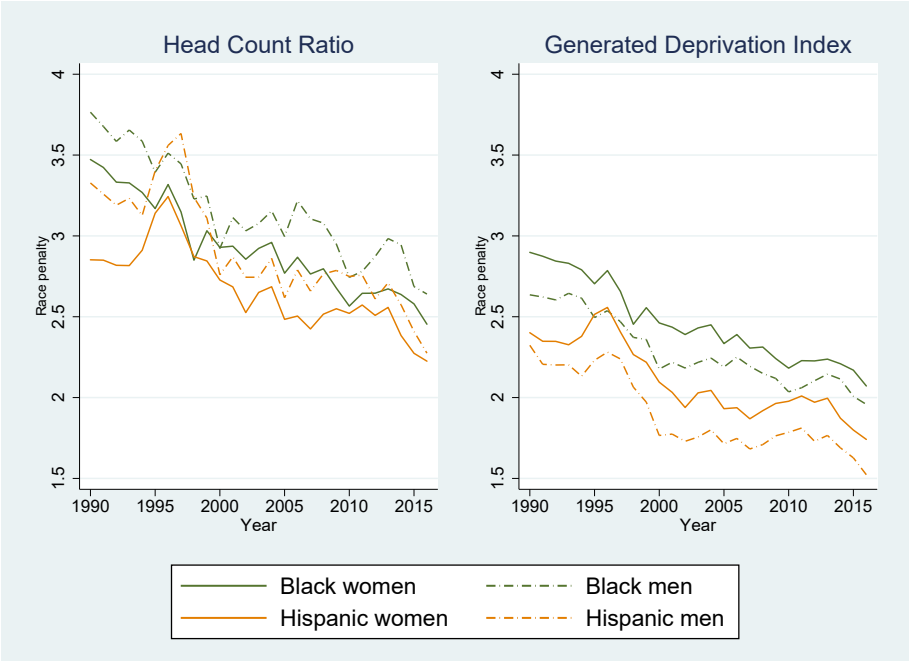
3.4.2.3 Gender and Race disadvantage of women in Minorities

An important strand of literature in Sociology has investigated women's double jeopardy hypothesis (Greenman & Xie, 2008). According to this hypothesis, women in Minorities accumulate the double disadvantage of being at the intersection of the most vulnerable groups (*Minority* and *woman*). These studies usually omit the net women's advantage in life expectancy. The question is whether once we take into account the lifespan deprivation component, could the conclusion about the double jeopardy change? From the previous findings, the highest women disadvantage in Minorities compared to the Majority group is consistent with higher race bias for Black and Hispanic women than men.[23]

This leads to a follow-up question: How do women in minorities accumulate gender and racial disadvantages? Greenman & Xie (2008) reviewed two possibilities. On one hand, women in Minorities may accumulate in an additive manner meaning that their disadvantage is the sum of race and gender penalties. On the other hand, the intersectionality perspective suggests that the size of the race penalty may differ across gender (or gender differs across race). In this regard, women's disadvantage will be different from the simple addition of race and gender penalties. I try to answer this question in the following lines by exploring the evolution of the racial penalty by gender. I proceed as in Greenman & Xie (2008) to determine the racial penalty in Minorities.

[23]It is important to note that the racial gaps in the total deprivation are more alarming than the intra-race gender gap (see more details in Table 3.A.1 and 3.A.2 in the appendix). For instance, the deprivation rate (GDI) of females Blacks is, on average, 20.19 pp higher than that of Whites NH (18.79 pp for males), while the intra-black gender difference is lower than 1pp. For Hispanics, the racial gap among females (compared to Whites NH) reaches 15.31 pp on average, whereas the gender gap represents 1.47pp. The racial gap between Hispanics and Blacks is less severe, and stems primarily from the net advantage of Hispanics (men and women) in terms of lifespan deprivation.

Figure 3.7: Minority men and women racial penalties (with respect to White Non-Hispanic Men)



Note: These figures plot racial penalties for each gender group in minority with respect to Whites NH men. The penalty is computed as the ratio between the deprivation rate (GDI and HCR) in the considered group and the group of Whites non-hispanic men considered as the reference. The higher the curve, the greater the race penalty.

I first compute each gender and racial group deprivation ratio with respect to Whites NH men considered as reference. The idea is that in the absence of intersectionality, men's race penalty should be the same as women's in the minority group.[24]

Figure 3.7 plots these intra-gender racial penalties. The left panel of Figure 3.7 for income poverty (HCR) and shows that for both Hispanics and Blacks, men's penalties are greater than women's in the majority of cases, meaning that Minority women pay lower racial penalties compared

[24]For better understanding, let us imagine that the ratios are 1 and 1.5 for Whites NH Men and Women respectively while for Minority, the ratio is 2 for men. In the absence of intersectionality women ratio in the Minority should be equal to 3 (1.5*2) meaning that men and women suffer a race penalty of 100%. The distance between men's and women's race penalties will provide an idea of intersectionality.

to men.[25] There is, however, a slight diminishing tendency of these gender differences in racial penalties. The right graph considers the total deprivation and highlights opposite evidence. For both Hispanics and Blacks, the race penalties are higher for women than men suggesting that the additive assumption does not hold. This is particularly due to a higher decline in premature mortality for men in Minorities. This confirms the previous findings that, in relative terms, the reduction of the intra-gender racial disparity in mortality is more pronounced for men than for women. Furthermore, we note that the gender differences in racial penalties are more marked in the Hispanics group compared to Blacks. Hispanic men and women have experienced a sizable reduction in mortality such that the racial difference has been at their advantage (their LD rate is lower than the White NH's) but the decline rate has been significantly higher for men than women.

To sum up this section, an overview of deprivation in the United States by gender and race reveals important disparities. Both income poverty and total deprivation rates are higher among Minorities compared to Non-Hispanic Whites. Among minorities, women generally experience a higher level of total deprivation compared to men, although this gender gap is less pronounced compared to the case in which we would only consider income. The largest most gender gap is observed in the group of Hispanics, where men have experienced a substantial decrease in both income poverty and premature mortality. Since 1990, Non-Hispanic White women have consistently exhibited lower total deprivation rates than men, due to their advantage in life expectancy which offsets their income disadvantage. Note that the picture is reversed if we would consider income poverty only: the relative position of women would be more favorable in Minorities than Whites NH.

3.5 Sensitivity analysis

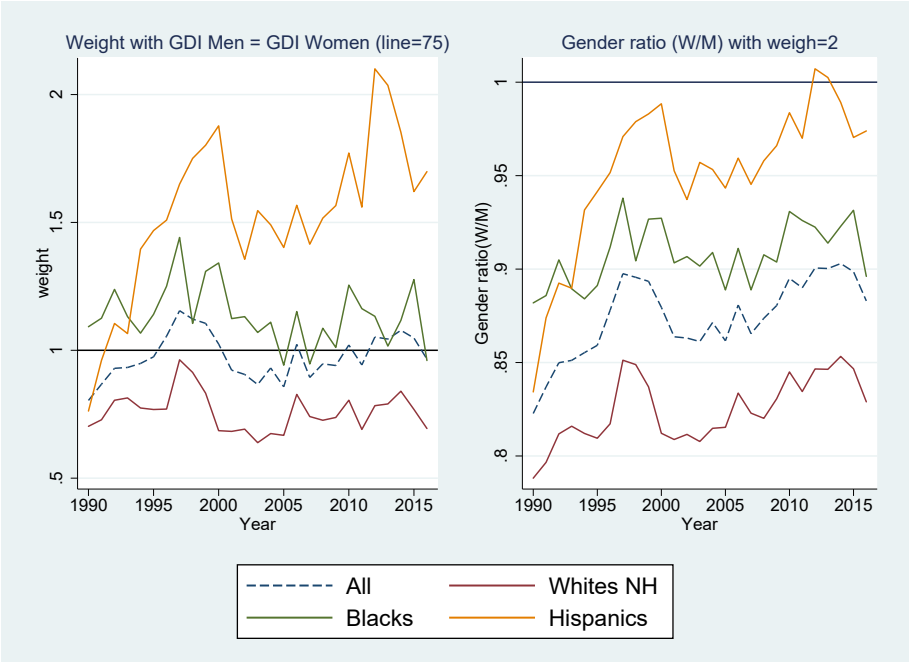
In this section, I analyze how sensitive are the results presented above to the choice of the weight and age line. I also explore the influence of some "missed individuals (prisoners)" in the poverty universe on the findings. Finally, given the measurement issues discussed previously, I

[25] We could also interpret that, Minority women pay lower gender penalty than White NH.

estimate deprivation indices using alternative definition of poverty.

3.5.1 Relative Weight and Deprivation

Figure 3.8: Relative weight and deprivation



Note: The first figure (left) displays at national level the relative importance of lifespan deprivation (relative to alive deprivation) needed to ensure perfect gender equality in GDI. The second highlights the gender ratio with the weight of 2

Let us remind that the weight represents the relative importance of lifespan deprivation over income deprivation and was set to 1 in previous estimates. Figure 3.8 reports, on the one hand, the weight needed to attain perfect gender "equality" in deprivation and the sensitivity of the gender ratios to the weight, on the other hand. The weight below 1, in the left panel, means that gender equality would be obtained even if lifespan deprivation is considered as less important than economic poverty. Overall, before 1995, the obtained weight is below 1, indicating that even with a low weight attributed to premature death, the lifespan advantage of women could compensate for their disadvantage in terms of income deprivation. After 1995, the weight fluctuates around 1 (with a maximum of 1.15 in 1997). Consistent with previous results, in the

group of Whites NH, premature mortality has to be less important than income poverty to achieve gender-balanced deprivation rates while in the Minorities, more relative weights (higher than 1) should be given to lifespan deprivation. Since it is commonly believed that individuals generally give more value to life than income (weight higher than 1), the conclusion about gender parity when lifespan is included in total deprivation is robust to the choice of weight.[26]

The right panel of Figure 3.8 shows it more clearly: if premature death is twice as detrimental as income deprivation, the relative position of women in all racial groups is always better than that of men (gender ratio below 0.9). However, racial differences remain striking. Gender differences in Hispanic groups are always higher and increasing over time meaning that for some periods, women would be more deprived than men even if living is considered twice as important as not being poor. The ranking of curves by race also reinforces the finding that women in the Majority groups are in the best relative position compared to those in Minorities.

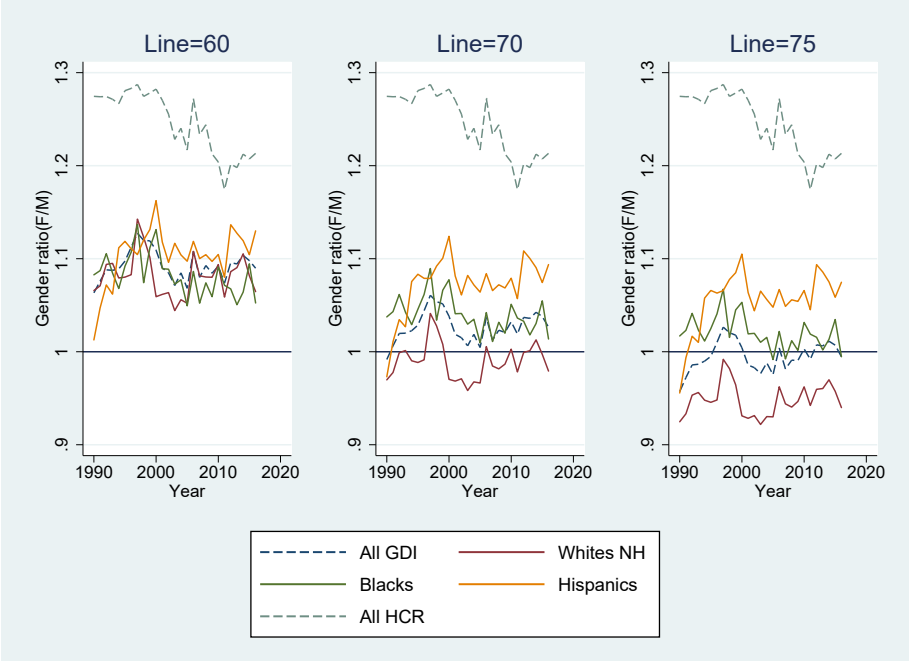
3.5.2 Age line and Gendered Deprivation

I explore in Figure 3.9 the sensitivity of the results to the age line chosen to define premature mortality (set at 75 years). I explore alternative age lines of 60, 70, and 75 years, noting that, generally, as the age line increases, the gender ratio decreases. This tendency is a consequence of the higher men's mortality rates in the retirement ages (above 65 years generally). With lower age lines (60 and 70), the ratios are very often above 1 indicating the relative advantage of men over women. The gender-balanced deprivation rate is revealed with the age line of 75 which is close to the average life expectancy in the USA (76.5). It is important to emphasize that in all racial groups whatever the age line considered, the gender ratio with income poverty is always overestimated as compared to that of total deprivation.

Moving on to racial differences in gender inequalities, two main facts are observed: First, the gap between Minorities and Whites NH narrows

[26]The HCR will yield the same gender ratio as the GDI if the weight is below 0.1. This weight value is is unlikely

Figure 3.9: Age line and deprivation gender ratios



Note: These figures report GDI gender ratios using different age lines. Recall: The age line considered in previous analysis was 75.

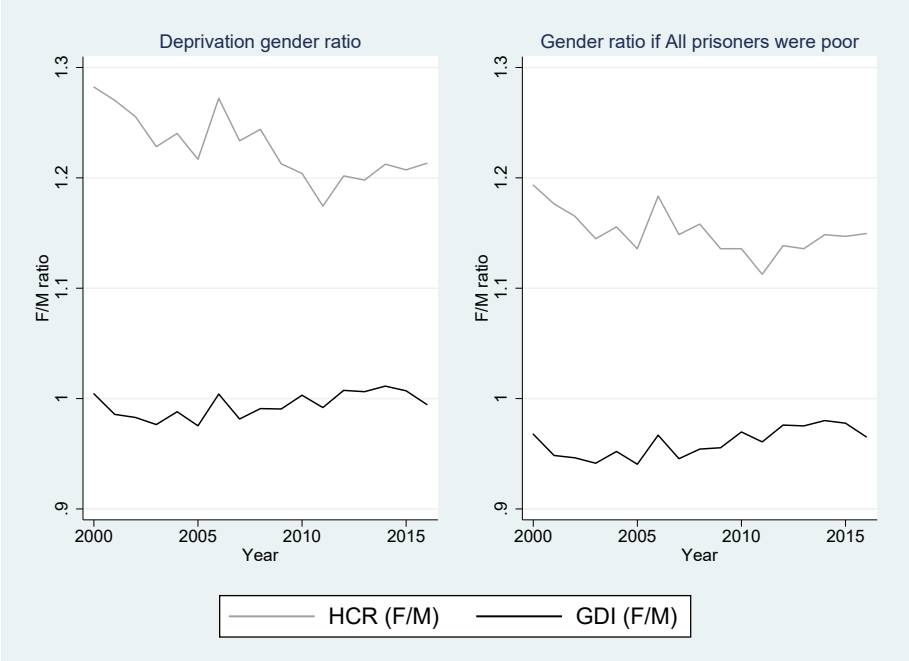
with lower age lines and, second, regardless of the age line women relative deprivation is the highest in the Hispanic group. With the age line of 60 years, Whites NH women become more deprived than men with ratios close to those observed in the group of Blacks.[27] It is commonly believed that in developed countries, not living beyond the retirement period (typically above 60 years) should be viewed as deprivation. Consequently, the result highlighting the disadvantaged relative position of women in Minority groups, compared to men, remains robust across to the age line.

3.5.3 Taking into account prisoners

It should be noted that in the United States, some individuals like soldiers, prisoners, and people in college dormitories are not included the

[27] Note that with age line of 50, the race ranking about gender differences is the same for both GDI and HCR.

Figure 3.10: Taking into account prisoners



Note: The first figure (left) displays the current deprivation gender ratio (women/men). The second presents how could be the gender ratio if all prisoners (men and women) were considered as being poor. Data are reported from 2000 due to unavailability of prisoners' data.

Source: The Bureau of Justice Statistics (2019)

poverty surveys. Prisoners constitute the largest group excluded in the poverty universe. A recent paper of Looney & Turner (2018) showed that poor and jobless individuals were more likely to be incarcerated in the US. For instance, only 49% of men in prison were employed three years prior to the incarceration and their median income (USD 6250) was largely below the full-time minimum wage (USD 15000). Based on this evidence, I hypothesize that all prisoners are poor and observe how the gender difference behave. Given the gender distribution of incarcerated population, the deprivation rate among men is likely to increase more than the women's rate. In fact, more than 6% of the living men population is in prison while this share represents less than 1% for women (see Figure 3.A.6 in the appendix).

Figure 3.10 reports the gender ratios based on this hypothesis and shows a marked reduction of gender difference based on HCR (the ratio is close to 1). The effect on the GDI ratio is more nuanced, but we observe that from 2000 all the ratios fall below 1; men being considered as more deprived than women. This pattern is also observed in the group of Whites NH and Blacks while for Hispanics, women are still more deprived than men (see Figure 3.A.7).[28] Furthermore, it follows from Figure 3.A.7 in the appendix that women in the Majority group remain in a better relative position than those in Minorities.

3.5.4 Individual poverty within households

The most challenging limitation of these analyses is that the available poverty data in the US do not account for intra-household inequality in resource distribution. When considering that resources within households are pooled and equally distributed, any gender disparities in poverty rates can only stem from the gender composition in single-head households. This holds because, in husband-wife households, men and women tend to exhibit similar poverty rates, as illustrated in Figure 3.A.2. In a comprehensive literature review, Ponthieux & Meurs (2015) presented evidence in all OECD countries, poverty rates for married men were consistently overestimated, while those for women were underestimated when assuming equal resource distribution within households.

To account for intrahousehold inequality, Cherchye et al. (2012) exploited information on consumption of private and public goods within the household and used the collective consumption model[29] to compute individual poverty rates. Unfortunately, I am unable to replicate this approach due to the unavailability of detailed information on consumption patterns within households (to the best of my knowledge). Hence, I rely on the "second-best" solution proposed by Corsi et al. (2016). In their approach, they computed the individualized financial dependency rates (FDR) in Europe considering an individual as poor if his own income is below the poverty line. The absence of sharing rules and economy

[28] The unequal distribution of prison population (dominated by black) is responsible for the heterogeneous effect of this hypothesis on different racial groups

[29] This model takes into account individual preference and the sharing rules that dictate intra-household distribution of resources

of scales in the FDR leads to an overestimation of women's poverty as sharing generally enhances their situation (Cherchye et al., 2012), given their lower income compared to men. As a consequence, the FDR provides an upper bound value of the gender gap whereas the traditional headcount ratio (HCR) gives the lower bound; the actual gap being between the HCR and FDR ratios. In the following analyses, I compute the FDR for individuals with recorded personal incomes[30]. Moreover, I use the official poverty line for a household of one member to define financial dependency status (poverty with FDR approach).[31]

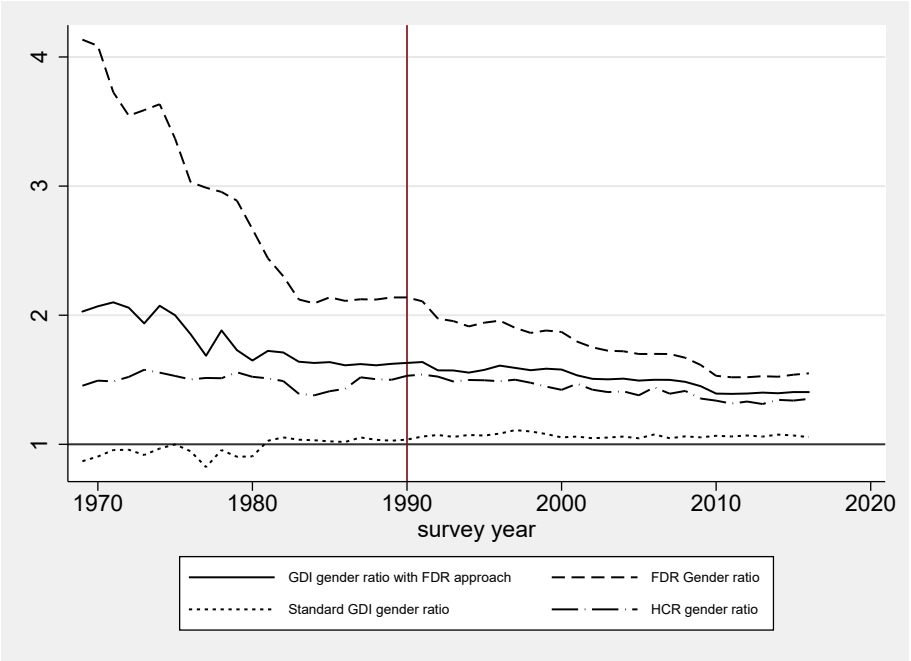
Two main observations emerge from Figure 3.11. First, as expected, the gender gap in income poverty is generally higher with the financial dependency rates (FDR) compared to the standard poverty measure as computed previously (HCR). Second, women are always more deprived than men if we rely on the alternative poverty measure (FDR) to compute the total deprivation rate (GDI with FDR approach). Nevertheless, as expected, gender ratios with total deprivation are always lower than the ones found when considering income poverty uniquely regardless of the poverty measure. The nuance that should be stressed here is that the real gender ratios are between the standard GDI ratio curve and that of the GDI gender ratio with the FDR approach (meaning they are more likely to be above 1, indicating the disadvantage of women). In summary, Figure 3.11 strengthens and shades the previous conclusion: *In the United States, with total deprivation, women are still more deprived than men but the gender bias is less severe than the one estimated with income poverty only.*

Regarding the racial differences, Figure 3.A.8 in the appendix shows that with the alternative measure (FDR), as for income poverty (HCR), women in Minorities are in a better relative position in terms of total deprivation compared to those in the Majority group. The evolution of the family structure may explain the difference between standard and alternative deprivation measures. In fact, the bias with the standard poverty measure should be greater for Whites NH since the large share

[30]Children under 15 years are excluded because they have no labor income. This exclusion should not bias the results, assuming gender-balanced poverty and mortality rates among children under 15.

[31]In other words, I analyze whether an individual would be considered poor (and thus financially dependent) if they were living alone with the same income

Figure 3.11: Gender Ratios (women/men) with the Financial Dependency Rate (FDR) and the Generated Deprivation Index



Note: This figure presents deprivation gender ratios (women/men) using various measures. 'GDI gender ratio with FDR approach' represents the total deprivation gender ratio, assuming that an individual is poor if his personal income falls below the threshold for a one-member family. 'FDR Gender ratio' indicates the income poverty gender ratio, assuming that an individual is poor if his personal income falls below the threshold for a one-member family. 'Standard GDI gender ratio' (and 'HCR gender ratio') refer to gender ratios as computed in previously analysis, assuming all family members are poor if the pooled family income is below the family poverty line.

of women in this group live in couples while those in Minorities present higher rates of singlehood (Iceland, 2013). Notwithstanding this nuance, the conclusions regarding the situation of women in Minorities still hold for two reasons. First, as mentioned earlier, the alternative approach (FDR) overestimates women's poverty given the absence of sharing in the household that might benefit more for Whites NH women, since they have more relative bargaining power (more educated). Second, the racial differences in deprivation rates are still alarming, and this reflects the hardships experienced by women in Minorities.

3.6 Concluding remarks

The main objective of this paper was to draw a picture of the gendered pattern of total deprivation in the United States. In this regard, I used the generated deprivation index, an indicator that combines poverty and premature mortality as components of total deprivation (Baland et al., 2021). This indicator is best suited for making gender comparisons regarding the total deprivation in the US since poverty and mortality yield opposite trends of the gender gap: women are poorer and have lower mortality rates than men.

The contribution of this paper is twofold. First, from 1970 to 1990, American men were more deprived than women, but since the 1990s, deprivation in the two gender groups has evolved closely. Before 1990, the larger reduction in the gender gap in mortality along with the lack of significant progress in gender disparity in income poverty resulted in a greater decline in total deprivation among men. Since the 1990s, there has been an almost perfect compensation process across genders between lifespan and income deprivation, so that the gap between men and women has been almost filled.

The second contribution is that this near gender equality in total deprivation hides important cross-race differences: in contrast to income poverty, recent trends in total deprivation show that the gender gap against women is the highest in Hispanic and Black groups (Minorities) as compared to Whites Non-Hispanics (Majority). This finding implies that Hispanic and Black women accumulate the double disadvantage of being females and in the minority in a non-additive fashion. Over time, men in Minorities have experienced a notable reduction in racial disparities in lifespan deprivation compared to women, possibly due to advancements in medicine and health programs targeting vulnerable populations. However, the historical disadvantage faced by women in Minorities in income poverty persists, as singlehood often weakens the effectiveness of anti-poverty initiatives targeting them.

This paper has two implications. First, development policies that aim to reduce gender inequalities should prioritize targeting women in Minorities, as they are the most vulnerable when combining income poverty and premature mortality in a single indicator. Second, considering the recent stagnation in terms of mortality reduction, the trend of

gender differences in total deprivation is entirely dictated by the gap in terms of economic poverty. Therefore, efforts should be made to reduce the income gap between men and women to achieve gender equality.

Appendix

3.A Additional Tables and Figures

Table 3.A.1: Gender Gap by race

Gender Gap (Women-Men)	**All**	**Whites NH**	**Blacks**	**Hispanics**
Averages (and Std. Dev.)				
Alive Deprivation	3.20	2.37	5.65	4.77
	(0.47)	(0.33)	(1.59)	(0.93)
Lifespan Deprivation	-3.30	-3.12	-4.95	-3.31
	(0.53)	(0.30)	(1.25)	(1.20)
Generated Deprivation	-0.10	-0.75	0.70	1.47
	(0.31)	(0.24)	(0.62)	(0.88)
Head Count	2.94	2.23	4.79	4.18
	(0.42)	(0.32)	(1.33)	(0.74)
Annual Variation (pp)				
Alive Deprivation	-0.05**	-0.03**	-0.18**	-0.09**
Lifespan Deprivation	0.06**	0.03**	0.14**	0.13**
Generated Deprivation	0.01	0.00	-0.04**	0.05*
Head Count	-0.04**	-0.03**	-0.15**	-0.05**

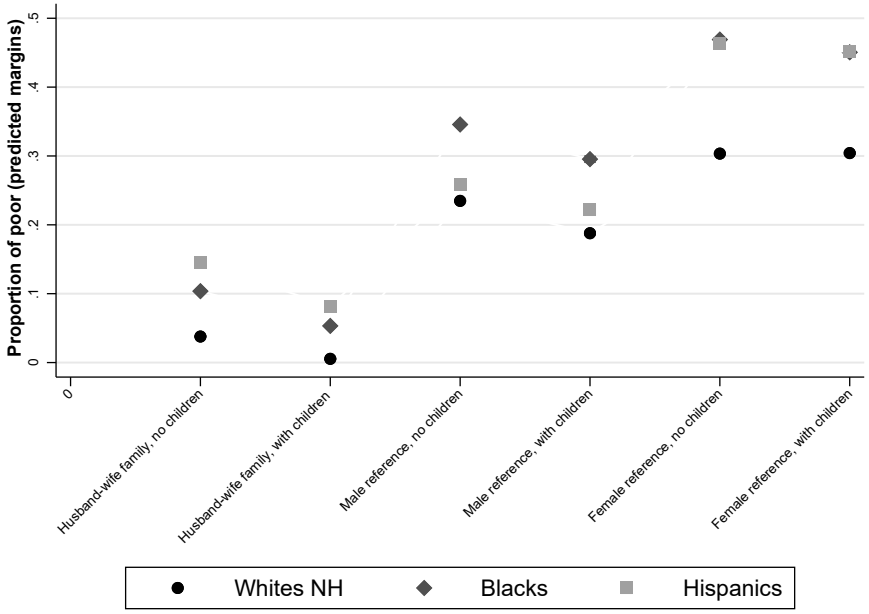
Note: This table reports the average gender gaps (women-men) for deprivation indicators in each racial group in percentage points (pp) from 1990 to 2016, and the coefficients of the regression of the gap in each indicator on the year. AD: Alive Deprivation; LD: lifespan deprivation; GDI: Generated deprivation index; HCR: Head Count Ratio. Standard Deviations in parentheses, **/* next to the coefficient means significant at 1/5%

Table 3.A.2: Racial Gap by gender group (percentage points)

Racial Gap	**Blacks-WNH**			**Hispanics-WNH**			**Blacks-Hispanics**		
	All	Men	Women	All	Men	Women	All	Men	Women
Averages (and Std. Dev.)									
Alive Deprivation	15.80	14.01	17.29	14.69	13.51	15.92	1.11	0.49	1.37
	(2.41)	(1.88)	(2.96)	(2.47)	(2.24)	(2.72)	(1.40)	(1.32)	(1.64)
Lifespan Deprivation	3.78	4.73	2.90	-0.44	-0.42	-0.60	4.22	5.15	3.51
	(1.43)	(1.90)	(0.97)	(1.61)	(2.01)	(1.12)	(0.56)	(0.66)	(0.45)
Generated Deprivation	19.57	18.74	20.19	14.25	13.09	15.31	5.33	5.64	4.88
	(3.67)	(3.52)	(3.80)	(3.62)	(3.74)	(3.48)	(1.21)	(1.19)	(1.44)
Head Count	17.91	16.42	18.98	15.53	14.55	16.50	2.37	1.87	2.48
	(3.10)	(2.66)	(3.48)	(2.89)	(2.75)	(3.01)	(1.48)	(1.39)	(1.72)
Annual Variation (pp)									
Alive Deprivation	-0.22**	-0.14**	-0.30**	-0.20**	-0.17**	-0.23**	-0.03	0.02	-0.07
Lifespan Deprivation	-0.18**	-0.23**	-0.12**	-0.18**	-0.23**	-0.13**	0.00	-0.01	0.01
Generated Deprivation	-0.40**	-0.38**	-0.42**	-0.38**	-0.39**	-0.35**	-0.02	0.02	-0.07
Head Count	-0.31**	-0.24**	-0.36**	-0.26**	-0.24**	-0.27**	-0.05	0.01	-0.09*

Note: This table displays the racial gap in each gender. The first six columns compare Blacks and Hispanics men and women to Whites NH, while the three last compare Hispanic and Blacks. The second part of the table presents coefficients of an OLS regression of the racial gap in each indicator on year. We say for instance that between 1990 and 2016, the Alive Deprivation gap between Blacks and Whites NH men decreased by 0.14pp on average each year. Standard Deviations in parentheses, */** means significant at 5%/1%

Figure 3.A.1: Poverty rate by household structure

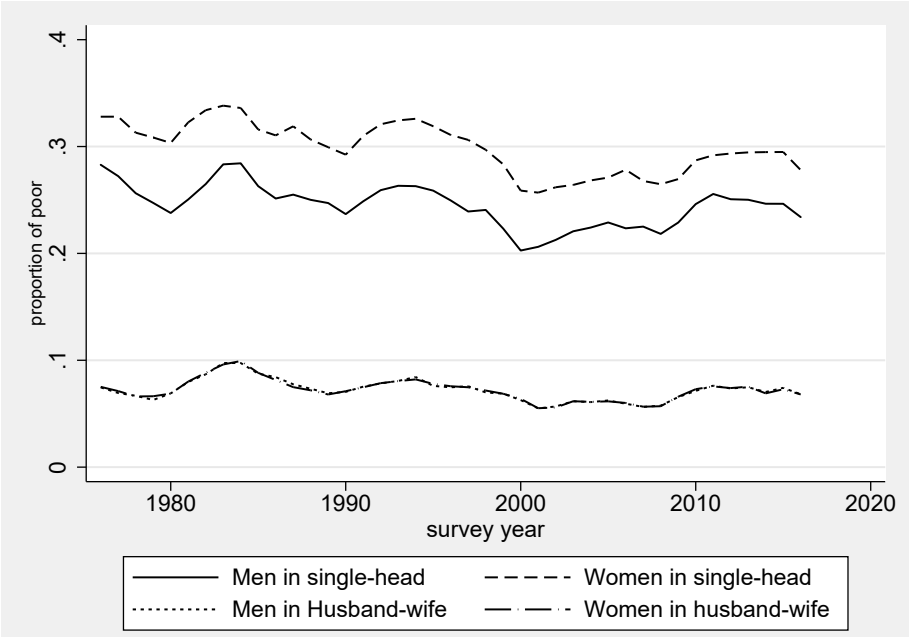


Note: This figure presents poverty rates by family type and race, reporting predicted margins from OLS estimation of the following equation:

$Y_i = \alpha * Family\_type_i + \beta * Race_i + \delta * Family\_type_i * Race_i + \theta * X_i + \varepsilon_i$

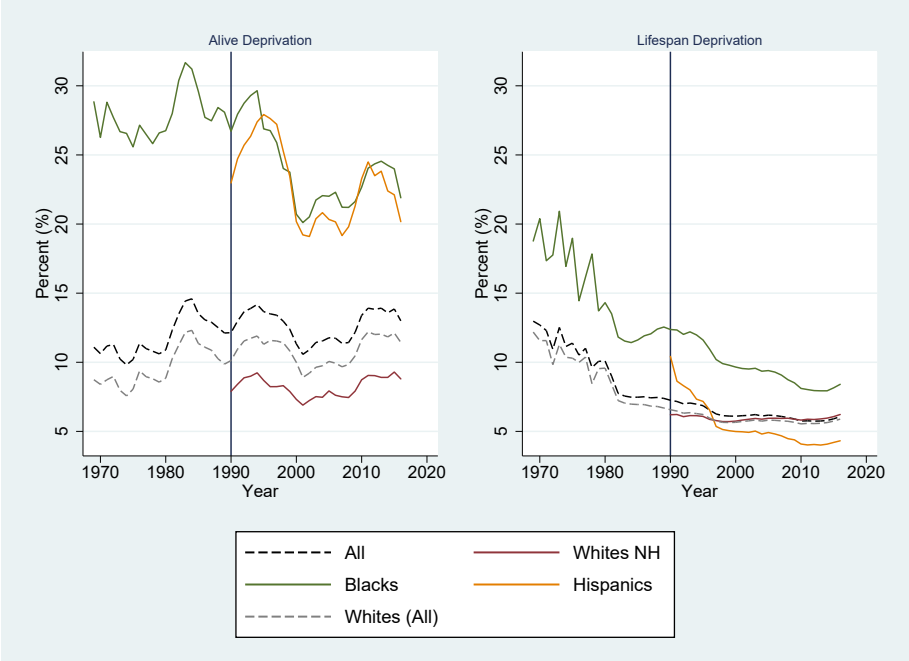
where $Y = 1$ if the individual is poor. The vector X includes controls such as education, marital status, age, number of children, citizenship status, foreign-born status, year fixed effects, and state fixed effects. Estimations are based on American Current Population Surveys data from 1976 to 2016.

Figure 3.A.2: Poverty rates by family type



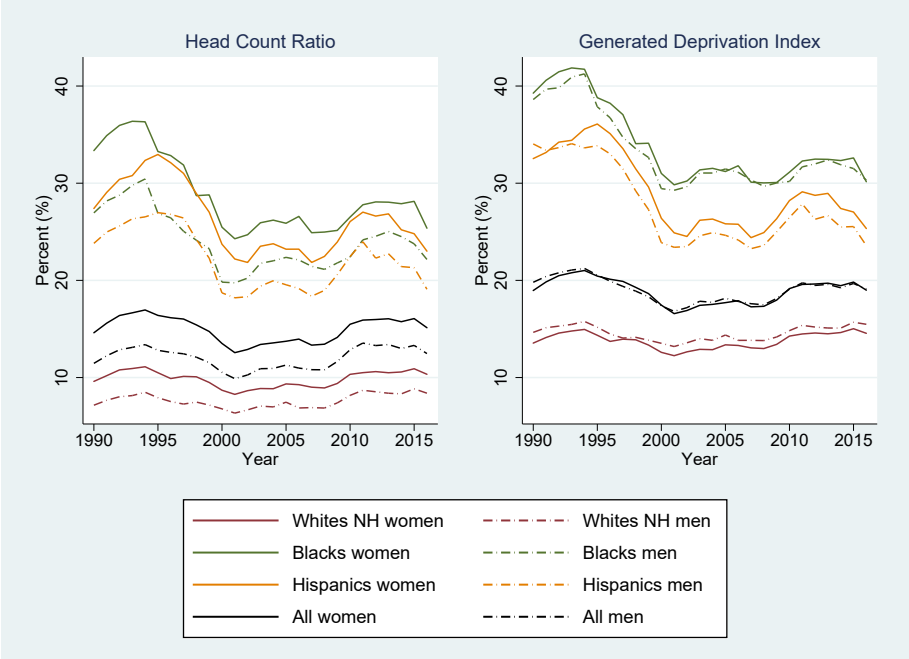
Note: This figure presents poverty rates by family type, using data from the American Current Population Surveys (CPS). Single-head family refers to a family with only one head (either a man or a woman, with or without children), while Husband-Wife Family denotes a family consisting of a husband and wife.

Figure 3.A.3: Alive (AD) and lifespan (LD) deprivation Components by Race, (in percent)



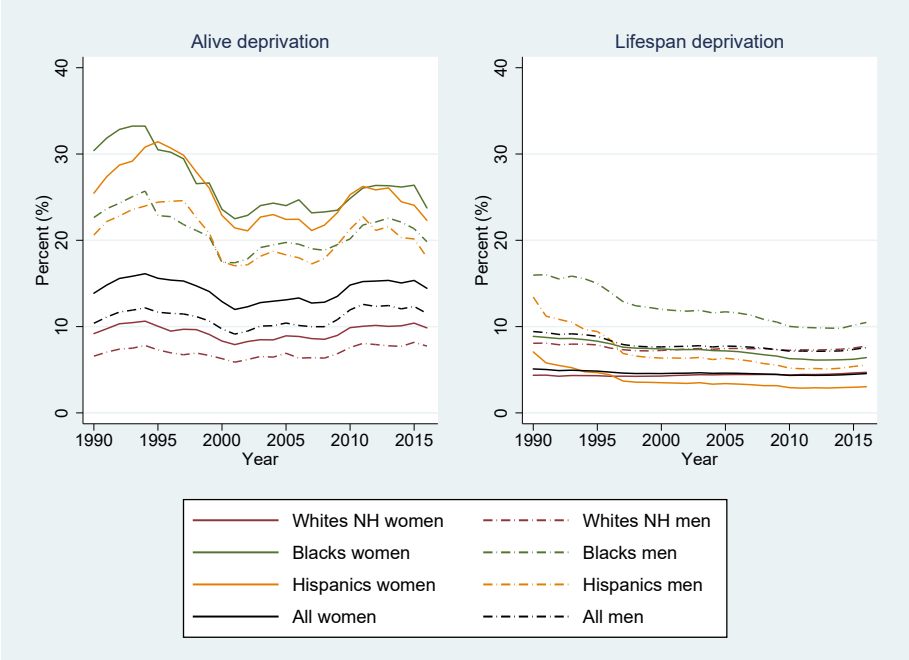
Note: These figures present the Alive and Lifespan Deprivation components (of GDI) for each racial Group. The subdivision between Hispanic and Non Hispanic Whites starts from 1990

Figure 3.A.4: Deprivation rates by Race by gender



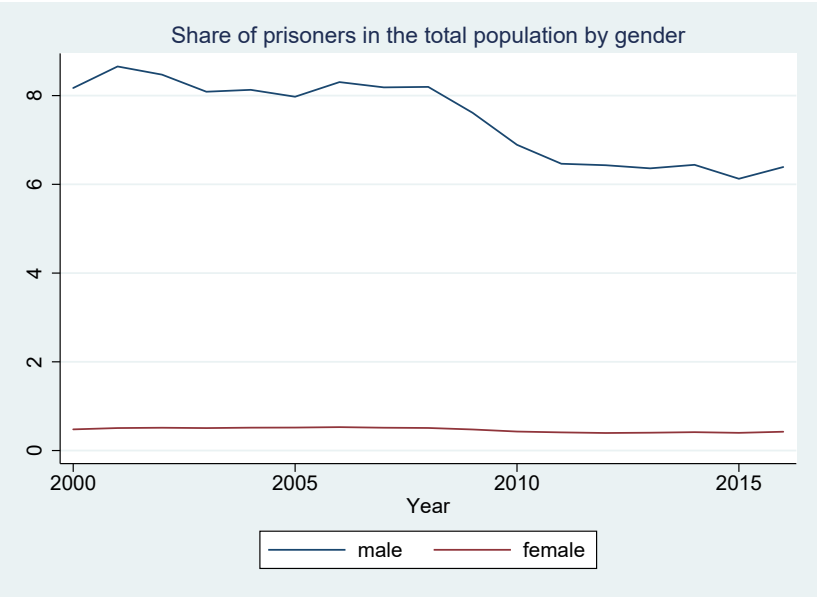
Note: These figures report the Generated Deprivation Index and the Head Count Ratio for each racial Group and for each gender group. The subdivision between Hispanic and Non Hispanic Whites starts from 1990

Figure 3.A.5: Alive (AD) and lifespan (LD) deprivation Components by Race by gender



Note: These figures report the alive and lifespan deprivation components of the Generated Deprivation Index for each racial Group and for each gender group. The subdivision between Hispanic and Non Hispanic Whites starts from 1990

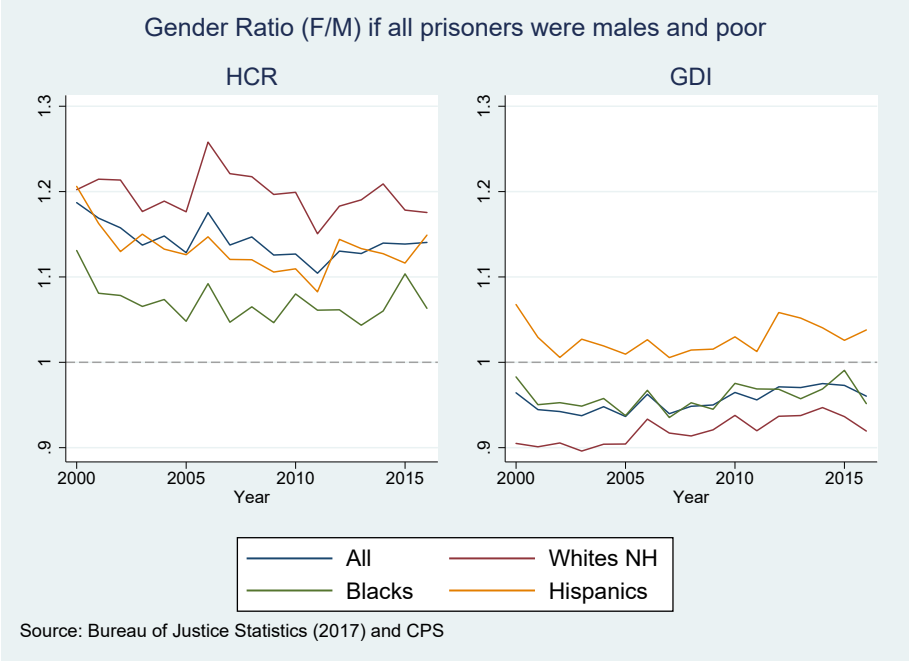
Figure 3.A.6: Prisoner Population



Note: This figure displays the share of prisoners among men and men. Data are reported from 2000 due to unavailability of prisoners' data

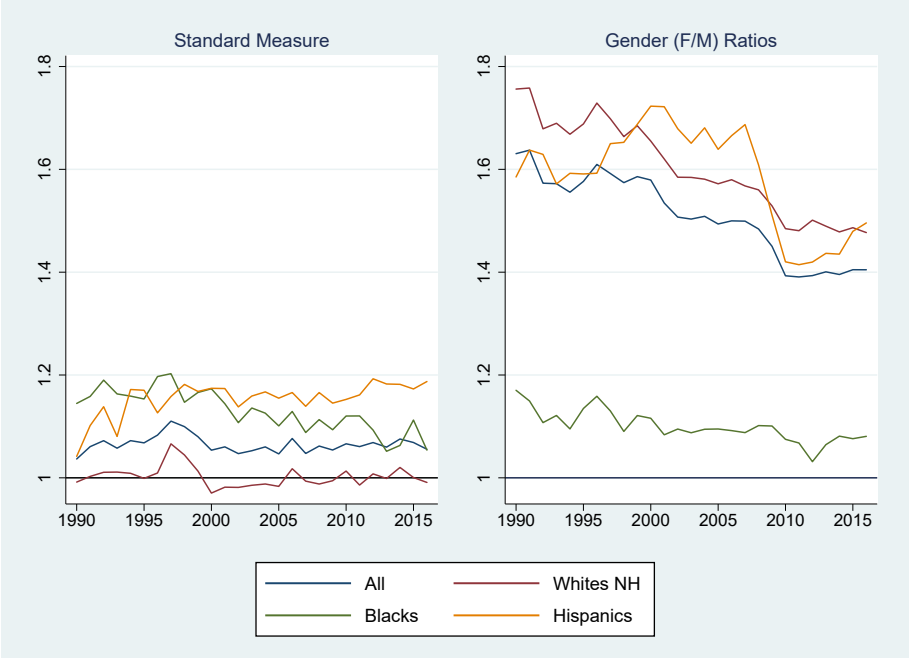
Source: Bureau of Justice Statistics (2017) and IPUMS CPS

Figure 3.A.7: Taking into account prisoners (by race)



Note: These figure display deprivation (HCR and GDI) gender ratio (men/women) by race if all prisoners were considered as being poor and men. The existing data do not provide gender distribution of prison population by race.

Figure 3.A.8: GDI Gender Ratios (W/M) by race with alternative poverty measures



Note: These figures display total deprivation (GDI) gender ratios by race using alternative poverty measures. Data are reported from 2000 due to unavailability of income data

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