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Keywords: Intra-household Allocation, Social Norms, Extended Families, Household Farms, Income Shocks
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Abstract

In many parts of Africa, traditional household structures consisting of an extended family headed by a patriarch are giving way to other types of households – e.g. nuclear families, female-headed households – as a result of migration, urbanisation and population pressures on land. In this paper, we explore whether traditional norms which determine how resources are allocated within the household are affected by the evolution of household structures. We show that the allocation of resources, for production and consumption, are closer to being efficient in nuclear family households as compared to extended family households. The findings are consistent with the hypothesis that individuals belonging to the same nuclear family have stronger ties, enabling them to commit to more efficient contracts infeasible for those connected through an extended family relation.

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1 Introduction

Existing demographic data for developing countries around the world show a gradual but steady shift away from extended family households towards nuclear family households. Households with, for instance, a married son and daughter-in-law, or co-habiting married brothers are in decline, while those consisting, exclusively, of a married couple with children are on the rise. What consequences will this evolution away from extended family households towards nuclear family households have for intra-household decision-making in the developing world?

The role of extended families and kinship networks in economic interactions has received considerable attention from economists in recent years (see Cox and Fafchamps 2008 for a review). This literature generally focuses on extended family members who inhabit separate households while relations between individuals living within the same household are covered by the now extensive literature on intrahousehold allocation for both developing and developed countries (see Bergstrom 1997, and Haddad, Hoddinott and Alderman 1998, for reviews of this literature).

However, this existing literature does not provide any direct insights regarding the question posed above. Whether cohabiting individuals with extended family ties are any different from those with nuclear family ties, and what implications these differences may have for development policy remain, fundamentally, unanswered questions.

It has been widely noted that a key element of interactions within a household is their repeated and regular nature. Game theoretic reasoning implies that individuals who expect to interact repeatedly into the future should be able to sustain greater levels of cooperation compared to those who interact sporadically. If household members care about future outcomes sufficiently, then they will be able to achieve efficiency in consumption and production decisions (Browning and Chiappori, 1988; Udry, 1996; Duflo and Udry 2004). This reasoning would apply to both extended family members and nuclear family members as long as they were living under the 'same roof'.

However, if cooperation between household members are sustained through altruism, or norms of familial rights and obligations, then the two types of households discussed here may well diverge in their behaviour. While altruism may be stronger between nuclear family members, a patriarch overseeing a large household consisting of members of the extending family may be more effective in imposing rules of coordination and collaboration. Therefore, it is not clear which type of household would be more efficient in the organisation of production and consumption within the household.

In this paper, we attempt to shed light on this topic by investigating intrahousehold allocation among nuclear family households and extended family households in rural Burkina Faso. Agricultural households in Burkina Faso provide an interesting setting for exploring the topic because of the prevalence of a type of 'collective farm' plots within the household and specific social norms relating to the contribution of labour and the use of proceeds from these plots. The norms require each able household member to contribute some labour to the 'collective farm' and for the household head, who manages the farm, to use its proceeds for expenditures on household public goods (Kazianga and Wahhaj, 2013).

Ethnographers studying West African tribes recorded this norm to be in practice at a time when the standard household structure consisted of an extended family headed by a patriarch (Hammond 1966; Fiske 1991; Lallemand 1977). 'Collective farms' have also been observed to be in existence today in other parts of West Africa (see, for example, Guirkinger and Platteau, 2014). In recent years, however, nuclear households- consisting of a husband, his wife (or wives) and their children - is becoming the norm. Our setting allows us to ask whether norms relating to the collective farms persist as extended family households give way to nuclear family households.

Using agricultural production data, we implement the test of efficiency in agricultural production based on the approach pioneered by Udry (1996). We are able to reject the hypothesis of efficiency in production for both extended family households and nuclear family households. However, yields achieved on individually farmed plots in nuclear family households are close to those achieved on collectively farmed plots while the corresponding gaps in extended family households are significantly larger. Using data on consumption expenditures by different household members, we implement the test of intrahousehold risk-sharing, following Duflo and Udry (2004). We are able to reject the hypothesis of efficient risk-sharing for extended family households but not for nuclear family households.

Using data on farm labour, we show that collective farms uses labour more intensively than 'private' farms managed by individuals belonging to the same household, controlling for the characteristics of the plots and the crops planted on the plot; and that this gap is larger for extended family households than for nuclear family households. Finally, using data on the allocation of land across different types of farm plots within the household we find that, controlling for demographic characteristics, nuclear family households, on average, allocate a greater share of total available land to the collective farm compared to extended family households. In other words, a household consisting of a couple and their son and daughter allocates, on average, a greater share of their land to the collective farm compared to a household consisting of a couple, a son and a daughter-in-law.

To explain these empirical patterns, we propose a model of household decision-making in which nuclear family members exhibit a greater alignment of preferences, compared to a pair of individuals connected by extended family ties. Then, the nuclear family household may able to achieve to efficiency in consumption and production through voluntary contributions. In the case of the extended family household, such voluntary contributions may be insufficient to achieve the first-best. But the existence of the social norm described above enables the household head to commit to using the output of the collective farm for the well-being of the entire household. This leads to a distortion of productive resources in favour of the collective farm but enables the household to achieve a second-best allocation.

The remainder of the paper is organised as follows. In the next section, we attempt to describe the evolution of household structure in West Africa during the last twenty years using household-level data and discuss possible reasons for these changes. The theoretical framework is developed in Section 3. The data used in our analysis is described in Section 4. Issues related to the endogeneity of household composition is discussed in Section 5. Section 6 investigates intrahousehold land allocation and differences between nuclear family and extended family households in this regard. Section 7 investigates plot yields and allocation of labour across different types of farm plots managed by the same household and compares the dispersion in yields across different types of households. We analyse how the proceeds from different types of farm plots affect consumption expenditures in 8 and, once again, make comparisons between nuclear family and extended family households.

2 Evolution of Household Composition in West Africa

We define a nuclear family household as one that consists only of the household head, his wife or wives and their children. Extended family households would include at least one individual who does not belong to the household head's nuclear family. In the African context, a household may be composed of one or more 'cooking units', embedded within a 'farming group' (i.e. a group of individuals who farm together) and a dwelling group (Goody, 1989).

Extended family households can arise from married sons or siblings who decide to raise their own families within their father's or brother's household and from other adult relatives who decide to join the households. (e.g. Adepoju, 2005; Akresh, 2009; Coulson, 1962; Young and Ansell, 2008). Child-fostering, a practice which is widely observed in sub-Saharan Africa, would also lead to extended family households according to our definition (Akresh 2009).

Widespread market failure in rural labour markets means that family or household members are, commonly, the main source of farm labour for small-holder agricultural households in sub-Saharan Africa. This has historically provided an impetus for the cohabitation of individuals who do not belong to the same nuclear family (Guyer 1993).

It has been argued in the literature that rising land pressures are one of the key drivers behind the individualisation of land tenure which, in turn, can cause agricultural households to split up into smaller farming units (see, for example, Guirkinger and Platteau 2014 and the references within). The same pressures, coupled with the growth of income-earning opportunities outside of agriculture would make it more difficult for agricultural households to hold on to its working members with the promise of land assets or future claims on the earnings generated by these assets. To the extent that there are stronger ties between members of a nuclear family than between members of the extended family and unrelated individuals, these pressures can lead to an evolution of agricultural households towards the nuclear family model.

The Demographic and Health Surveys (DHS), which provides data on household composition across countries and over time using consistent definitions, allow us to examine how the prevalence of nuclear family households is evolving over time. Table 1 reports the proportion of nuclear family households for 9 countries in West Africa using DHS surveys conducted in the region during the period 1993-2013. In 5 out of 9 countries, the share of nuclear family households has risen over this period. It has remained stable in 3 countries and has declined in one country (Ghana). The multiplication of urban households, by itself, cannot account for these changes; the pattern persists when we restrict the analysis to the rural subsample.

It is important to recognise that the evolution towards the nuclear family model does not imply a weakening of the extended family network or kinship-based ties. Indeed, there is a large literature emphasizing the important role that these networks continue to play in economic affairs in sub-Saharan Africa (for recent studies on the subject, see, for example, di Falco and Bulte (2011, 2013); Baland et al. (2013)). But evolution in the composition of the household raises the question whether nuclear family households, in any fundamental way, operates differently from extended family households. That is the question we address in this paper within the context of agricultural households in Burkina Faso.

3 Theoretical Framework: Intra-household Allocation of Land, Labour and Consumption Expenditures

Consider a household consisting of a head labelled h and n other adult members labelled $i = 1, .., n$. The household has total farm land of area A which is to be allocated among the different household members and a 'common' plot. Each household member i, (but not the household head), has a labour endowment of E^i which he or she would allocate across the different farm plots after the land has been divided up. There is no agricultural labour market and therefore all plots must be farmed using household labour.

We denote by A_j the size, and by L_j the total labour allocated to household plot $j \in \{1, .., n, c\}$. We assume, for simplicity, that the crop grown and the agricultural technology employed, is the same across all plots. Agricultural output from plot j is given by

$$y_j = F\left(A_j, L_j\right) \tag{1}$$

where $F(.)$, the production function is increasing and concave in both arguments. Let $\mathbf{y} = (y_1, .., y_n, y_c)$ denote the income levels of the household from its different agricultural plots.

The proceeds from the farms can be spent on either private goods or a household public good. Person i's utility from consumption is given by the function $u^i(x^i, z)$ where x^i is total expenditures on person i's private good and z denotes total expenditures by the household on household public goods. Each utility function $u^i(.)$ is assumed to be increasing and concave in both its arguments. For simplicity, we assume that the household head does not consume any private goods. His utility depends only on the level of expenditures on household public goods, and therefore denote it by $u^c(z)$ which is an increasing and concave function.

3.1 Collective Household Model

Given reservation utilities $(\underline{u}^1, .., \underline{u}^n)$, the following optimisation problem yields a Pareto-efficient allocation of land and labour across different types of farm plots, and consumption expenditures on different goods:

$$\max_{\mathbf{A},\mathbf{L}^1,..,\mathbf{L}^n,\mathbf{x},z} u^c(z) \tag{2}$$

subject to

$$u^i\left(x^i, z\right) \geq \underline{u}^i \text{ for } i = 1, .., n \tag{3}$$

$$y_j = F(A_j, L_j) \text{ for } j = 1, .., n, c \tag{4}$$

$$A_c + \sum_{i=1}^{n} A_i = A \tag{5}$$

$$z + \sum_{i=1}^{n} x^i \leq y_c + \sum_{j=1}^{n} y_j \tag{6}$$

where $\mathbf{A} = (A_1, .., A_n, A_c)$ is a vector describing the intra-household allocation of land – and $\mathbf{L}^i = (L^i_c, L^i_1, .., L^i_n)$ the allocation of labour by household member i – across the different household plots, $\mathbf{x} = (x_1, .., x_n)$ represents expenditures on private goods consumed by different household members and z captures expenditures on the household public good.

It is well-known that the optimisation problem in (2)-(6) implies efficiency in household production choices. In particular, it implies that farm yields and labour intensity across plots owned by the same household should be independent of the household member to whom the plot is assigned, and forms the basis of the test of the Collective Household Model used by Udry (1996), and subsequently by Goldstein and Udry (2008), Kazianga and Wahhaj (2013), and Goetghebuer et al. (2011).

In the following, we develop an alternative theory which yields allocations that are inefficient, building on Kazianga and Wahhaj (2013). We extend this existing theory in two ways. We make the allocation of farm land within the household to be endogenous and we investigate how the intra-household allocation is affected by the 'strength of ties' between household members, a concept discussed in more detail below.

3.2 A Model of Voluntary Contributions under a Social Norm

According to a social norm, the proceeds from the common plot must be spent on household public goods but it is up to the household head to decide how to divide up the available land between the common plot and the private plots. Each household member i has a reservation utility $\underline{u}^i$ which they can obtain if they exit the household. Therefore, to ensure that other members remain within the household, the head has to ensure that each is able to attain at least his or her reservation utility from the intra-household allocation of land, and subsequent labour and consumption choices within the household.

Violating the social norm can have costly social consequences and we assume that the head, therefore, always acts according to the norm. Thus, we have $z \geq y_c$. We focus on the case where, given the level of expenditures on household public goods by the head, all other household members make zero contribution to public goods from their own private plots.

Thus, we have $z = y_c$ and $x^i = y_i$ for each i. We denote by $z(\mathbf{y})$ and $x^i(\mathbf{y})$, $i = 1, .., n$ the household's expenditures on different goods as a function of its income from the different household plots.

Given the functions $z(\mathbf{y})$ and $x^i(\mathbf{y})$, $i = 1, .., n$, we can analyse the labour decisions by the household members. They would choose to allocate some labour to the common plot as the household head is obliged to spend it proceeds on household public goods. However, they will not contribute any labour to each other's private plots as they do not obtain any direct benefit from such labour contribution. Thus, we have $L_j^i = 0$ for $j \neq i$.

Therefore, each household member i allocates labour according to the following optimisation problem:

$$\max_{L_c^i, L_i^i} u^i\left(x^i(\mathbf{y}), z(\mathbf{y})\right) \tag{7}$$

subject to

$$\begin{aligned} y_c &= F\left(A_c, L_c^i + \sum\nolimits_{j \neq i} L_c^j\right) \\ y_i &= F\left(A_i, L_i^i\right) \\ L_i^i + L_c^i &\leq E^i \end{aligned}$$

Assuming an interior solution to the problem, we obtain the following first-order condition:

$$u_x^i \frac{\partial F\left(A_i, E^i - L_c^i\right)}{\partial L} = u_z^i \frac{\partial F\left(A_c, \sum_{j=1}^n L_c^j\right)}{\partial L} \tag{8}$$

The total labour allocation within the household would satisfy equation (8) for each household member i simultaneously. Together these equations would yield intra-household labour allocation as a function of intra-household land allocation. We denote the solution using the functions $\overline{\mathbf{L}}^1(\mathbf{A}), .., \overline{\mathbf{L}}^n(\mathbf{A})$ where $\mathbf{A} = (A_1, .., A_n, A_c)$ is a vector describing the intra-household allocation of land chosen by the household head.

Given $\mathbf{A}$ and $\overline{\mathbf{L}}^1(\mathbf{A}), .., \overline{\mathbf{L}}^n(\mathbf{A})$, we can determine the farm income from each plot $\mathbf{y}$, and thus household spending on each good $x_1, .., x_n, z$. Therefore, we can write consumption expenditures directly as a function of intra-household land allocation: $\bar{x}_1(\mathbf{A}), .., \bar{x}_n(\mathbf{A}), \bar{z}(\mathbf{A})$.

The household head cares only about spending on household public goods. Therefore, he prefers to make the common plot as large as possible. However, he also has to ensure that the private plots awarded to the other household members are large enough that they would choose to remain within the household. His optimisation problem can be written as follows:

$$\max_{\mathbf{A}} u^c(z(\mathbf{A})) \tag{9}$$

$$\text{subject to } u^i(x(\mathbf{A}), z(\mathbf{A})) \geq \underline{u}^i \text{ for each } i$$

It is evident that, if household member i is awarded a private plot, then the participation constraint corresponding to household member i will also be binding (if not, the head can improve his own utility by allocating more land to the common plot at the expense of i's private plot).

Guirkinger and Platteau (forthcoming) develop an alternative but closely related theory on the intrahousehold allocation of farm land to explain the existence of mixed farms. The key difference in their work is that the household head is able to assign not only private plots to other household members but also transfers that can be made contingent on the total output on a 'collective' plot. These transfers provide household members incentives to work on the 'collective' plot but the labour allocation is inefficient because of the problem of 'moral hazard in teams'. By contrast, we assume that the household head cannot commit to making such transfers at all but the social norm – which obliges him to spend the proceeds of the common plot on household public goods – provides an alternative source of incentives for other household members to contribute labour to the common plot.

3.2.1 The Effect of Stronger Ties within the Household

Using the framework outlined in Section 3.2, we wish to investigate how 'stronger ties' between members of the household affect the intrahousehold allocation of resources. We provide some additional structure to the preferences of household members by assuming

$$u^i(x_i, z; \delta_i) = u^c(z) + \delta_i v(x_i) \tag{10}$$

$$\underline{u}^i = \delta_i \underline{v}_i \tag{11}$$

where $\delta_i \in (0, \delta_{\max})$ is a parameter which captures both the alignment of preferences between the household head and household member i, and the strength of i's outside option. A smaller δ_i signifies closer alignment and greater willingness by i to remain part of the household.

We can show that $L_c^i(\mathbf{A};\delta_i)$ is decreasing in δ_i; i.e. for a given land allocation, a household member's labour contribution to the common plot increases as his preferences become more aligned with those of the household head.[1]

We can represent the surplus to household member i from a (partial) intrahousehold allocation (x^i,z) as

$$\begin{aligned} & u^i\left(x^i, z; \delta_i\right) - \underline{u}^i \\ = \; & u^c(z) + \delta_i\left[v(x_i) - \underline{v}_i\right] \end{aligned} \tag{12}$$

It is straightforward to show that, if the allocation (x^i,z) and the value of δ_i are such that i's participation constraint is satisfied with equality, then another individual j who is identical to i except for $\delta_j < \delta_i$ would obtain a positive surplus from the same allocation. It follows that j would opt to remain with the household even with a smaller plot of land than i. Following this reasoning, we can make the two following predictions for our empirical analysis.

Remark 1 *Other things equal, the share of land allocated to private plots is smaller and the labour intensity on the common plot greater in a household where individuals have 'stronger ties' to the household head, as represented by the preference parameter* δ_i.

It is also interesting to note that, in the extreme, if $\delta_i = 0$ for $i = 1,..,n$, then all household members would have the same preferences; thus, we would have a version of the unitary model of the household with efficient allocation of land and labour within the household. In other words, if the 'ties' between household members are 'sufficiently strong', then the allocation of resources would satisfy the conditions of productive efficiency.

Furthermore, it is easier to implement a consumption risk-sharing arrangement when δ_i is small. To be precise, imagine that there is a stochastic component to output from each plot, such that

$$y_j = F(A_j, L_j) + \varepsilon_j \text{ for } j = 1,..,n,c \tag{13}$$

where the ε_j's are identically and independantly distributed. A consumption risk-sharing arrangement can take the form of a set of state-contingent transfers $\{\tau_1(\mathbf{y}),..,\tau_n(\mathbf{y})\}$ from each household member to the head, where $\tau_i(\mathbf{y})$ may be positive or negative. For any given $\mathbf{y}$, the maximum transfer that i is willing to make in a self-enforcing agreement is decreasing in δ_i, because a smaller value of δ_i translates into a stronger preference for the expenditures made by the household head, and a weaker exit option.[2] Consequently, it can be shown that smaller δ_i values will lead to greater consumption smoothing. In the extreme,

[1] If, due to greater alignment of preferences, i provides more labour on the common plot, other household members will provide less because of the assumption of perfect substitutability of labour but the crowding-out will not be complete.

[2] Ligon, Thomas and Worrall (2002) and Fafchamps (1992) investigate in detail how changes in preference and punishment parameters affect the scope of risk-sharing within a group.

if $\delta_i = 0$ for $i = 1, .., n$, we obtain efficient risk-sharing within the group. Even if such a self-enforcing agreement cannot be implemented, some degree of risk-sharing can be achieved through voluntary (stage-dependent) transfers by each household member to the head who spends the receipts on good z. It is straightforward to show that these transfers are larger, and therefore the extent of risk-sharing greater, when the δ_i's are smaller.

4 Description of Surveys and Descriptive Statistics

We now describe the two datasets that we use for the empirical exercise. As we highlight below, one of the surveys focused on consumption and expenditures while the other focuses on farm production. We exploit the unique features of each survey in testing the hypotheses outlined above. The first dataset is a panel from a rural household survey that was collected by the Department of Economics of the University of Ouagadougou, as part of a World Bank-funded project known as 'Programme National de Gestion de Terroirs' or PNGT. We refer to this dataset as the PNGT survey. The first round of the survey was fielded in 2004, with two additional rounds in 2005 and 2006. About 1900 households were randomly sampled using a two-step process. In the first step, 60 villages were randomly selected from the 13 regions of the country. The number of villages per region was weighted to reflect the population distribution across regions. In a second step, 33 households were sampled in each village and interviewed using a standard household questionnaire. The survey is supposed to be nationally representative.

The PNGT survey collected detailed information on household expenditures and consumption. Information on production is rather terse consisting of plot characteristics and production output harvested by crop. Expenditures and consumption information were recorded at the individual level. The questionnaire on household expenditures recorded information not only on the identity of the household member who made each purchase but also the identity of the person or persons for whom the expense was incurred. Following Kazianga and Wahhaj (2013), we define expenditures on household public goods as expenditures which were destined to benefit all household members.

The second dataset is a panel of households surveyed by the Office of Agricultural Statistics of the Ministry of Agriculture (MA). We refer to this dataset as the MA dataset. The sample consists of 747 villages and about 6 households per village and is designed to be nationally representative. The survey rounds that we used were fielded in 2010, 2011 and 2012. The survey was mainly focused on collecting information related to farm activities. Hence it contains detailed information on household demographics and farm activities, but has very limited information on consumption. The collected information includes farm characteristics (farm size, topography and distance to the homestead), production technologies, agricultural inputs and outputs, and farm labour. Information relating to each farm plot was obtained from the individual in the household who had responsibility for it during that season. The survey distinguished between household plots managed collectively and plots managed individually. The enumerators lived in the sampled villages and were instructed to visit the sample households at the end of each farming activity, i.e. field preparation, planting, weeding and harvesting.

Information on farm labour was collected at the individual-plot level; i.e. the survey recorded how many days each household member laboured on each farm plot. We combine this detailed information on farm labour and plot ownership to provide a full description of labour and land exchange within the household, a feature which is unique to this survey.

Characteristics of Nuclear and Extended Family Households: We use the demographic information in each survey to distinguish between extended and nuclear family households. As per the definitions given in the preceding section, we have 8,080 observations of extended family households and 5,723 observations of nuclear family households from the MA survey, as shown in Table 2.[3] On average, extended family households are larger, consisting of 11.78 household members versus 7.30 for nuclear family households. But this difference is almost exactly accounted for by the average number of extended family members in the former households (4.59). Furthermore, extended family households have significantly more married men (1.76 versus 1.04) and the household head have significantly more wives (1.57 versus 1.47). The head in extended family households is also slightly older and marginally more likely to be literate. Turning to the farm characteristics in the table, we see that extended family households have significantly more land, and have, on average, more farm plots under cultivation in a specific year.

Table 3 provides descriptive statistics by farm plot, broken down by plot-type (i.e. private plots and common plots) and by household-type (nuclear family households and extended family households). Common plots managed by the household head are an order of magnitude larger than the other plots (average area of 4.21 hectares as compared to 0.50 hectares for male private plots) but labour use intensity and yields are broadly similar across all types of plots.

Common plots in extended family households are significantly larger than in nuclear family households, but nuclear family households allocate a slightly larger share of household farm land to the common plots. Members of nuclear family households allocate a greater share of their labour to common plots, compared to members of extended family households (82 per cent versus 79 per cent for men and 67 per cent versus 64 per cent for women). Based on average yields, men's private plots are the most productive and women's private plots the least productive in nuclear family households. In extended family households, the head's common plots are the most productive and, as within nuclear households, women's private

[3]Note that households may change status from one year to the next, an issue that we shall address in the subsequent discussions.

plots are the least productive. The yield gap between the most productive and the least productive type of plots is larger within extended family households[4]. This suggests that extended family households may be relatively less efficient than nuclear family households in allocating its productive resources. We will revisit these issues in the econometric analyses.

Table 4 shows the labour allocation of adult household members across different types of household plots. For both men (top panel) and women (bottom panel), the average amount of labour allocated to the household head's common plots is an order of magnitude higher than on any other type of plot. Men allocate about 69 percent of their time and women about 62 percent of their time on the head's common plots. Men allocate on average 4 days to female private plots which is almost as many days as they spend working on their own private plots (6 days). By contrast, women allocate 17 days to their own private plots and about 4 days on male private plots. Common plots that are not managed by the household head receive the least labour.

Shadow Price of Family Land and Labour: The data on labour and land allocation within the household allows us to calculate how much labour an adult household member contributes to the household's common plots per unit of land it receives for private farming. In the absence of labour contribution by household members, the head would have to hire workers to work on the collective plot; and in the absence of the land that these household members receive from the household head for private farming, they would, at least in theory, have to make use of land markets. Therefore, the ratio described above can be regarded as the "shadow price of land" within the household or the inverse of the "shadow price of labour".[5]

Table 5 summarizes the "shadow" prices of land and labour implied by the allocation of land and labour discussed above. On average, nuclear family household members contribute 263 days of labour on common plots per hectare of land (allocated for private farming) while extended household members contribute 209 days of labour on common plots for one hectare of land. In both extended and nuclear family households, women contribute less labour on common plots per hectare of land than men do. Men and women in extended family households contribute, respectively, 446 and 181 days of labour per hectare of land while the corresponding figures for nuclear family households are 320 and 159. Overall, the patterns are consistent with the hypothesis that household heads are able to extract more labour from nuclear family members. Another possible explanation is that the household

[4]For nuclear households, the ratio of the least productive plots (female plots) to the most productive plots (male plots) is 0.89. In extended households the ratio of the least productive plots (female plots) to the most productive plots (head managed common plots) is 0.86.

[5]The previous literature has highlighted the practice of labour and land 'exchanges' within the family – albeit in the context of bequests – in the case of India and Israel (Rosenzweig 1985; Rosenzweig 1988; Kimhi 2004). A number of studies on West Africa have also emphasized that the contribution of labour to collective farm plots constitutes part of an intrahousehold exchange (see, for example, Von Braun and Webb 1989).

head's commitment to allocate the proceeds from the common plots to household public goods is more credible (e.g. because of stronger altruism) in nuclear family households than for extended family households, and this induces household members to voluntarily contribute more labour on common plots.

5 Endogeneity of Household Composition

In the following empirical analysis, we investigate how the composition of the household – i.e. whether it consists entirely of the household head's nuclear family members or whether it also includes members of the extended family and unrelated individuals – affects land and labour allocation, and yields across farm plots owned by the household. However, it is important to recognise that the composition of the household is endogenous, influenced, for example, by marriages, births and deaths as well as decisions of individual household members to remain with the original household or break away at any point in time.

If household composition is affected by unobserved household characteristics, then this will potentially confound the estimated effects of household composition. Ideally the estimates must be robust to this form of endogeneity. In this section, we outline how the various specifications we use in the empirical analysis account for this selection process.

A simple linear model of household structure can be expressed as:

$$n_{hvt} = \mathbf{X}_{hvt}\boldsymbol{\beta} + \lambda_{hv} + \lambda_{vt} + \lambda_{hvt} + \varepsilon_{hvt} \tag{14}$$

where n_{hvt} is a binary variable indicating whether household h in village v is nuclear (one) or extended (zero) in period t; $\mathbf{X}_{hvt}$ is a vector of variables correlated with n; λ_{hv} represent household-fixed effects; λ_{vt} represent village-year fixed effects; and λ_{hvt} represent household-year fixed effects. This specification make clear that selection into nuclear (or extended) family household is correlated with some household-level observable characteristics, household-level time-invariant unobserved characteristics, village-level time-varying characteristics (whether observed or not), and household-level time-varying characteristics (whether observed or not).

In the following empirical analysis, we use, broadly speaking, two groups of specifications. The first group – designed to investigate intra-household land allocation, and consumption expenditures within the household – control for household fixed-effects and village-year fixed effects. The second group – designed to investigate variations in plot yields and labour intensity across farm plots managed by the same household – control for household-year fixed effects. Thus, the specifications we use either control simultaneously for household fixed-effects (λ_{hv}) and village-year fixed effects (λ_{vt}), or for household-year fixed effects (λ_{hvt}). The first set of regressions control for household-level time-invariant and village-level time-varying unobserved factors that possibly influence household selection into nuclear or extended family status. The second group of specifications control for household level time-varying unobserved factors that influence the household selection into nuclear or extended family status. Given that the data used in the analysis is annual, these specifications control for most types of unobservable factors that would influence the selection process.

6 Intra-household Land Allocation

Among agricultural households in rural Burkina Faso, different farm plots belonging to the household are typically managed by specific household members (Udry 1996). At the beginning of the agricultural season, the head of the household divides the household's farm land between a 'common' plot and 'private' plots assigned to other household members. These household members retain control rights over the proceeds of the 'private' plots while the household head is expected to use the proceeds of the 'common' plot for the welfare of the entire household (See Kazianga and Wahhaj, 2013, for a discussion of the ethnographic literature which documents this social norm).

In this section, we analyse the determinants of the allocation of the land to different uses within the household. The Collective Model of the Household yields the well-known property of 'separability' between household production and consumption (Bardhan and Udry 1999) which, in the present instance implies, that farm plots should be allocated efficiently, from the point of view of management, regardless of the intended use of the proceeds from farm output.

However, in the presence of commitment or enforcement problems, the household head may deviate from the efficient allocation of land among household members (Fafchamps 2001). Motivated by a similar context to that which prevails in Burkina Faso, Guirkinger and Platteau (forthcoming) argue that, in allocating household farm land between individually and collectively farmed plots, the household head is motivated by two factors. On the one hand, granting land to individual plots improves efficiency by reducing the problem of 'moral hazard in teams', and ensures that these family members do not split from the household to pursue their outside options.On the other hand, maintaining collective plots allows the head to retain control rights over the output.

If nuclear family members share stronger 'ties' than extended family members, this can have potentially important implications for intra-household land allocation as discussed in Section 3.2.1. Nuclear family members, with stronger ties to the household head, should require less compensation (in the form of private plots) to dissuade them from splitting away from the main household. On the other hand, extended family members with potentially weaker ties of altruism, would be less willing to make voluntary contributions to household public goods; in the Burkinabe context, the social norms around the common plot allows the household head to *commit* to expenditures on household public goods, and thus induces (voluntary) contributions by other household members by means of their labour on the common plot.

Which of the aforementioned effects will dominate cannot be determined on the basis of theory alone. However, using existing data on common plots and private plots among Burkinabe agricultural households, we can test whether intrahousehold land allocation indeed differs between nuclear family household and extended family households. For this purpose, we use data from the MA survey to estimate the following equation:

$$S_{hvt} = \alpha + \beta \ln (N_{hvt}) + \gamma \ln (A_{hvt}) + \sum_{k=1}^{K-1} \delta_k (D_{k,hvt}/N_{hvt}) + \mathbf{H}_{hvt}\boldsymbol{\zeta} + \varepsilon_{hvt}$$

where S_{hvt} is the share of household land in household h in village v in period t which is allocated to the common plot, $\ln (A_{hvt})$ represents the natural logarithm of the area of the household's total farmland, $\ln (N_{hvt})$ is the natural logarithm of the household size, each $D_{k,hvt}$ represents the number of household members in age-gender group k, and $\mathbf{H}_{hvt}$ is a vector of household characteristics including the age, gender and marital status of the household head and a binary variable indicating whether it is a nuclear family household or an extended family household. The terms $\alpha, \beta, \gamma, \delta_k$ and $\boldsymbol{\zeta}$ are parameters to be estimated and ε_{hvt} is an i.i.d. error term. The specification is based on Deaton's (1997) estimation of Engel curves extended to include household demographic variables.The equation is estimated using (i) year dummies and village fixed-effects and (ii) village-year fixed-effects.

The results are reported in Table 6. We find, in all specifications, that the share of the household's land allocated to common plots is increasing in the total land farmed by the household, and decreasing in the household size. Households with female heads allocate, on average, a smaller share of land to the common plot, between 7 and 11 percentage points. Turning to our key coefficient of interest, the share of land allocated to common plots in extended family households is 2 percentage points smaller that the share of land allocated to common plots in nuclear family households. The variable 'Married Men' – which takes a value of 1 if there is more than one married male within the household and zero otherwise – provides an alternative indicator for extended family households. The estimates indicate that the presence of multiple married men within the household reduces the share of the land allocated to common plots between 2 and 5 percentage points. It is interesting to note that Guirkinger and Platteau (2014) find a similar effect in the context of rural Mali where individual farms and collective farms can co-exist within the same household: according to their estimates, the presence of multiple married men increases the share of household farm land allocated to individually managed farm plots.

Our estimate imply that a household consisting of a husband and wife, and a son and daughter would, on average, allocate a larger share of farmland to the common plot compared to a household consisting of a husband and wife, and a son and daughter-in-law, which is similar in other respects. It suggests that the ability to commit transfers and expenditures differ across nuclear family households and extended family households. As per our preceding discussion, commitment problems have two countervailing effects on intrahousehold land allocation. Therefore, although the estimated effect is small, this need not imply that differences in the level of commitment across the two types of household are small.

7 Household Agricultural Production

Informational asymmetry and commitment problems can prevent household members from engaging in the exchange of productive resources – e.g. land, labour and other agricultural inputs – and therefore prevent efficiency in household production (Udry, 1996). In this context, altruism within the household can induce voluntary intra-household transfers and enable the household to achieve a more efficient allocation of resources in the spirit of the well-known 'Rotten Kid Theorem' (Becker 1990). One of the key distinguishing features between extended family households and nuclear family households, besides household size and the demographic composition, is, potentially, the level of altruism between household members. Therefore, we investigate whether these two types of households differ in terms of their efficiency in agricultural production.

For this purpose, we implement the test of efficiency in household production using the approach first adopted by Udry (1996). Since Udry's original work in Burkina Faso, a number of studies have found evidence of inefficiency in agricultural production in West African households including Goldstein and Udry (2008) for Ghana, and Guirkinger and Platteau (2014) for Mali.

Following Udry (1996) and Kazianga and Wahhaj (2013), we estimate a farm plot yield equation which includes household characteristics, physical characteristics of the plot and features of plot ownership, as follows:

$$Q_{htci} = \mathbf{X}_{hci}\boldsymbol{\beta} + \mathbf{G}_{hi}\boldsymbol{\gamma} + \lambda_{htc} + \varepsilon_{htci} \tag{15}$$

where Q_{htci} is the log of yield on plot i in year t, planted to crop c and belonging to household h; $\mathbf{X}_{hci}$ is a vector of physical characteristics of plot i including the plot area, topography and distance to the household; λ_{htc} is a household-crop-year fixed effect; and $\mathbf{G}_{hi}$ is a vector of characterstics of plot i in household h including the gender of the person responsible for the plot and whether the plot is classified as being 'common' or 'private'. In the previous literature, these ownership characteristics have been found to have a significant effect on plot yields within the same household (after controlling for plot characteristics and the crops planted): Udry (1996) and Goldstein and Udry (2008) in the case of gender, and Kazianga and Wahhaj (2013) and Goetghebuer et al. (2011) in the case of the plot type ('private' versus 'common'/'collective').

Table 7 shows the estimated results for equation (15), using agricultural data from the MA survey. In these regressions, we divide the farm plots into three categories: (i) household common plots, (ii) private plots managed by male household members, and (iii) private plots managed by female household members. We find that the yields achieved on private plots managed by men and women are lower than that achieved on household common plots (the omitted category) and the differences are statistically significant at the 1% level in each instance. This holds true for the full sample of households (regression results shown in column 1 of the table) as well as for the subsample of extended family households (shown in column 2) and nuclear family households (shown in column 3).

Pareto efficiency would imply that yields across all three plot categories are equal, after controlling for the crops planted, the physical characteristics of the plot and the skills of the plot owner. An F-test for the hypothesis that the yields are the same across all three plot categories is strongly rejected for both extended family households and nuclear family households (yielding an F-statistic of 244.8 in the first case, and 53.25 in the second case).

In words, these households are achieving significantly higher yields on common plots compared to private plots which have been planted with the same crops, controlling for observable physical characteristics of the plot and the plot owner. But the divergence in plot yields between common plots and private plots is higher for extended family households than for nuclear family households. The estimated coefficients imply that, relative to household common plots, private male plots achieve yields which are 24% lower in extended family households and 13% lower in nuclear family households; the corresponding figures for female plot yields are 42% and 29% respectively.

The gender difference in plot yields has been noted in the previous literature, with potential explanations provided by Goldstein and Udry (2008) and Kazianga and Wahhaj (2014). However, the gap between extended family and nuclear family households is just as striking. Uncovering the reason may reveal deeper insights about the functioning of households in the West African context.

7.1 Plot Yield Dispersions

We can also use the data on plot yields from the MA survey to see graphically the variation in plot yields across different plots within nuclear family households and within extended family households. In Figure 1, we plot the residuals from estimations of equation (15) without $\mathbf{G}_{hi}$ – i.e. without the male and female-plot dummies, and the age and education of the plot manager. The resulting graphs show the distribution of plot yields for farm plots belonging to the same household and planted to the same crop, in the same year, after controlling for physical characteristics of the plots.

For comparison, we also show the residuals from corresponding regressions for the pooled

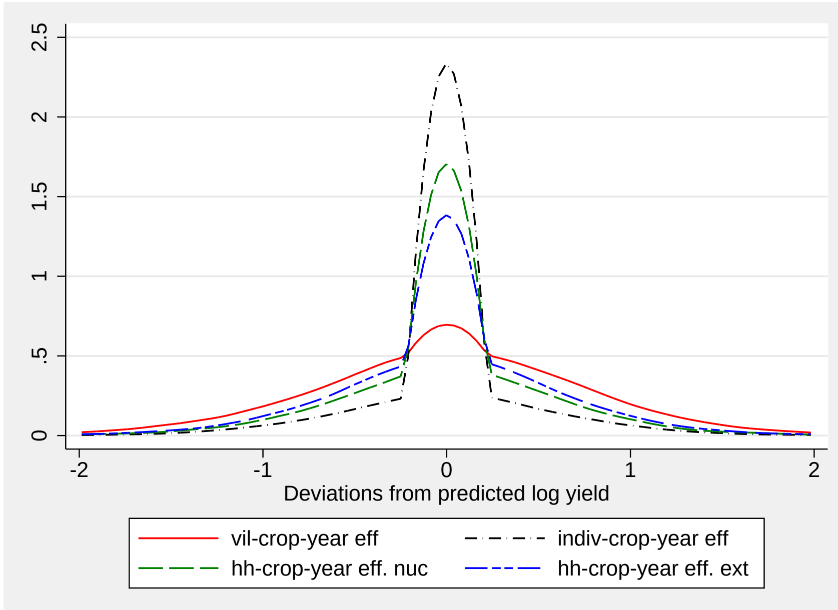

Figure 1: Yield dispersions

sample with (i) village-crop-year fixed effects, and (ii) individual-crop-year fixed effects. Greater dispersion in the residuals indicates greater inefficiency in the allocation of farm resources within the relevant group (and more scope for improving output through a reallocation of resources). The household-level distributions, for both subsamples, lie between the village-level and individual-level distributions. This is consistent with the findings by Udry (1996) and Kazianga and Wahhaj (2013) and implies that the household is more efficient than the village at allocating resources across farm plots that belong to the group, but not as efficient as the individual.

We also see from the figure that there is greater variation in plot yields across apparently identical plots for extended family households as compared to nuclear family households. The equality of the two distributions is rejected at any conventional level using a Kolmogorov-Smirnov test. The graphs for the nuclear and extended family households are consistent with our estimated coefficients in the previous section and suggests that nuclear family households are more efficient at allocating productive resources across farm plots than extended family households.

7.2 Explaining the Plot Yield Gaps across Different Household Types

Why are plot yield dispersions greater in the case of extended family households as compared to nuclear family households? Table 2 shows that, on average, extended family households have 11.78 members while nuclear family members have 7.30 members, with the difference being strongly statistically significant. The presence of extended family members in the former group largely accounts for this difference: on average, extended family household have 4.59 extended family members while nuclear family households, by definition, have none. The table also shows that the two groups of households are similar in terms of the age, gender, literacy and marital status of the household head. Therefore, the difference in household sizes and the presence of extended family members present themselves as natural candidates to account for the observed difference in plot yield dispersions.

Household Size: To investigate whether the difference in household sizes can account for the wider dispersion of plot yields across extended family households, we match nuclear and extended households based on the predicted probability of a household being 'nuclear' conditional on its size. In practice we use a logit regression of the binary variable "nuclear family household" on household size, and then retain nuclear and extended family households with close predicted probabilities. In the resulting sub-sample, average household size is 7.67 for extended family households and 7.65 for nuclear family households and the two means are statistically indistinguishable. Arguably, any differences we detect between these two subsamples of nuclear and extended family households are not due to differences in household sizes.

We redo the plot yield estimation with these subsamples. The results are shown in Table 8. The only noticeable difference in the estimated coefficients for this subsample is a smaller yield differential between female plots and common plots in extended family households, as compared to the base estimates in Table 7. But we can still reject a null hypothesis of equality in the female plot coefficients across the subsamples of nuclear and extended family households. Similarly, we can reject the null hypothesis of equality of the corresponding male plot coefficients. Therefore, we conclude that the wider dispersion of plot yields across extended family households cannot be attributed to household size alone.

Extended Family Members: To investigate whether the presence of extended family members can account for the wider dispersion of plot yields across extended family households, we introduce a set of categorical variables to the plot yield regressions indicating the relation of the plot owner to the household head. The estimated results for the whole sample, the sample of extended family households and nuclear family households are shown in Table 9.

The omitted plot category in the table is 'common plots managed by the household head'. We introduce a single category for all other common plots, and separate categories for private plots farmed by different relations of the household head. The first point to note for this table is that, even putting aside the common plots, the household head achieves a higher yield on private plots compared to other household members, with the differences being statistically significant.

Being outside of the nuclear family does not, however, seem to be a disadvantage in itself: we cannot reject the hypotheses that (i) the yield coefficient for the household head's sons is the same as that for other male relatives and unrelated male household members; and that (ii) the yield coefficient for the household head's daughters is the same as that for other female relatives and unrelated female household members. This holds true for both the subsample of extended family households and for the full sample.

The wider dispersion in plot yields in extended family households can be traced to two sources. First, in nuclear family households, the household head achieves almost the same yield on his private plots as on the common plots under his control (the coefficient is not statistically significant) while in extended family households, the corresponding yield gap is about 19% (and statistically significant). Second, the yield gap between the head's common plots and the private plots farmed by members of the nuclear family (i.e. the son, daughter and spouse of the household head and the head himself) is smaller in the case of nuclear family households than for extended family households. A joint test of equality between the relevant coefficients for the two subsamples is strongly rejected.

In summary, the wider dispersion of plot yields in extended family households is not due to the presence of extended family members per se. Rather, it is because the plot yield gap (relative to the household's common plots) is larger for household members in extended family households than for household members in nuclear family households who hold the same 'position' (defined in terms of their relation to the household head). To better understand the source of these plot yield differences, we examine how agricultural inputs, in particular farm labour, is allocated across household plots. We discuss this in the following section.

7.3 Allocation of Labour Across Farm Plots

If the production technology used by agricultural households exhibits diminishing marginal product of labour, then productivity efficiency requires that farm plots with the same physical characteristics (including plot size, soil quality, etc.) and planted to the same crops, should make use of equal amounts of labour. If not, it would be possible to increase output by reallocating labour towards farm plots with lower labour use intensity.

Therefore, we can test for efficiency in labour allocation across farm plots belonging to the same household by using a specification similar to (15) (see Kazianga and Wahhaj 2013). Given the patterns in farm plot yields highlighted in the previous section, we would expect labour use intensity (total labour per unit area) across farm plots to be more uniform in the case of nuclear family households than for extended family households.

We estimate the following equation separately for nuclear family and extended family households and different labour types:

$$l^{j}_{htci} = \mathbf{X}_{hci}\hat{\boldsymbol{\beta}} + \mathbf{G}_{hi}\hat{\boldsymbol{\gamma}} + \hat{\lambda}_{htc} + \hat{\varepsilon}_{htci} \tag{16}$$

where l^{j}_{htci} is the log of the amount of labour of type j applied to plot i per unit area, in year t, and plot i belongs to household h and is planted to crop c. The labour types include 'adult male', 'adult female', 'child' and 'total'. The results are shown in Table 10.

First, we observe that the labour use intensity (for total labour) is significantly higher for the common plots managed by the household head than for all other types of plots owned by the household (controlling for plot characteristics and the planted crop); and this holds for both nuclear family and extended family households. For both sets of households, the differences are statistically significant which implies that they are not allocating labour efficiently across farm plots.

Second, the labour use intensity gap between the head's common plots and the private plots farmed by members of the nuclear family (i.e. the son, daughter and spouse of the household head and the head himself) is smaller in the case of nuclear family households than for extended family households. A joint test of equality between the relevant coefficients for the two subsamples is strongly rejected. This is exactly the pattern we obtained in the case of plot yields.

Turning to extended family households, we cannot reject the hypothesis that the labour use intensity coefficient (for total labour) of the household head's sons is the same as that for other male relatives and unrelated male household members. The corresponding coefficients for the household head's daughter, other female relatives and unrelated female household members are very close (-0.65, -0.68 and -0.72) but estimated precisely enough that we can reject the hypothesis that they are equal. Nevertheless, the pattern is broadly similar to what we saw in the case of plot yields: private plots managed by household members who are not part of the head's nuclear family are not at a disadvantage relative to the head's own children (of the same gender) in terms of labour inputs.

In summary, the findings discussed in this section suggests that the wider dispersion of plot yields within extended family households can be accounted for by the wider dispersion of labour use intensity within these same households.

Labour Contributions of Different Household Members: Estimates based on equation (16) reveal the pattern of labour use intensities across farm plots but they do not tell us how different household members are dividing their own labour across different plots maintained by the household.

If members of a nuclear family household are characterised by stronger ties, we would expect them to contribute more to the household's common plots and to each other's private plots than members of an extended family household (controlling for the intra-household allocation of land, and the demographic characteristics of the household).

To explore these hypotheses, we regress the total labour contribution of each household member to the household's common plots, on the total size of the individual's private plots and of the household's common plots, demographic characteristics of the household, and characteristics of the household member as per the following equation:

$$n^k_{ihvt} = \tilde{\mathbf{H}}_{hvt}\tilde{\boldsymbol{\zeta}} + \tilde{\mathbf{G}}_{ihvt}\tilde{\boldsymbol{\gamma}} + \tilde{\lambda}_h + \tau_t + \tilde{\varepsilon}_{ihvt} \tag{17}$$

where n^k_{ihvt} is the log of total labour provided by individual i in household h on plot type k in period t (k can be 'common plots' or 'private plots of other household members'), $\tilde{\mathbf{H}}_{hvt}$ is a vector of household characteristics, including the size of the common plot, and the fraction of household members in different age-sex groups, $\tilde{\mathbf{G}}_{ihvt}$ is a vector of individual characteristics of individual i in period t, including the total area of his/her private plots, age, age squared, level of education and relation to the household head; $\tilde{\lambda}_h$ is a household fixed-effect, $\tilde{\tau}_t$ represent time fixed-effects and $\tilde{\varepsilon}_{ihvt}$ is an error term that is clustered at the village-level in the estimation. The vectors $\tilde{\boldsymbol{\zeta}}$ and $\tilde{\boldsymbol{\gamma}}$ are parameters to be estimated.

The estimated results for labour contributions to the household's common plots are shown in Table 11. In columns 1-3, we control for household fixed effects and observable household characteristics such as the area of the common plot and the demographic composition of the household. In columns 4-6, we control for household-year fixed effects. Including household-year fixed effects allows us to account for time-varying household and village-level unobservables. In particular, we account for annual variations in prices (crops, land and wages) that can influence labour supply and land allocation. It is reassuring that the point estimates and the statistical significance are stable across the two specifications.

The omitted relationship category is the 'household head'. Focusing on columns 1-3, we see that, within extended family households, the estimated coefficient in all the other relationship categories is negative and statistically significant. Therefore, we can conclude that the household head contributes the most amount of labour to the household's common plots. This is expected since the head has overall responsibility for the common plots. Furthermore, the point estimates indicate that the son contributes more labour than other male relations and unrelated male individuals living within the household, although only the difference with other male relations is statistically statistically significant (at the 10 percent level). We are able to reject the hypothesis that the daughter, other female relations and unrelated female individuals all contribute the same amount of labour to the common plots. We obtain a similar pattern when we control for household-year fixed effects in columns 4-6.

Turning to nuclear family households, we see that the coefficient on the labour contribution of each type of family member (spouse, son and daughter) to the common plot is larger than the corresponding coefficient in extended family households. A test of the equality of the coefficients is strongly rejected. This means that, taking the head's own labour contributions as a reference point, contributions of the head's spouse, son and daughter to the common plot are higher in nuclear family households than that in extended family households. These results are robust to controlling for household-year fixed effects.

8 Consumption Expenditures within the Household

As previously discussed, the ethnographic literature highlights a particular social norm among the predominant ethnic groups in Burkina Faso, which requires the household head to use the proceeds from the common plots on household public goods. Kazianga and Wahhaj (2013) investigate how household expenditures in a sample of agricultural households in Burkina Faso respond to rainfall shocks which affect crop income, and find evidence of such a norm in practice.

In this section, we adopt a similar methodology to investigate whether the norm is prevalent for both nuclear and extended family households. If the income generated on the common plot is systematically spent on household public goods, then this can incentivise junior household members to contribute labour to the common plot voluntarily. Therefore, variations in the observance of the norm can potentially account for the differences in labour allocation among nuclear and extended family households highlighted in the preceding section.

Before proceeding to discuss the empirical results, we briefly describe the methodology used to analyse consumption decisions. The methodology is adapted from Duflo and Udry (2003), where the the intuition and underlying theory are discussed in greater detail. Rainfall shocks can have a differential impact on the output and income generated from different farm plots owned by the same household, due to differences in skill of the plot managers, plot characteristics, crops planted and inputs applied. Therefore, variations in rainfall can be used to examine whether an income shock for one household member affects household consumption differently from an income shock to another household member. These comparisons can also provide the basis for testing efficiency in consumption decisions within the household, as discussed below.

Following a common approach in the literature (e.g. Fafchamps, Udry and Czukas, 1998, Kazianga and Wahhaj, 2013, Paxson, 1992), we assume the following log-linear relationship between rainfall and household farm income:

$$\log\left(y_{iht}\right) = \left(\mathbf{X}_{iht} \otimes \mathbf{R}'_{vt}\right) \boldsymbol{\lambda}_i + \boldsymbol{\delta}_h + \boldsymbol{\delta}_{vt} + \xi_{iht} \tag{18}$$

where y_{iht} represents income from plot i, farmed by household h in period t, $\mathbf{X}_{iht}$ is a vector of physical characteristics of plot i, $\mathbf{R}_{vt}$ is a vector of rainfall measures in village v in period t, $\boldsymbol{\delta}_h$ and $\boldsymbol{\delta}_{vt}$ are, respectively household and village-year fixed effects and ξ_{iht} is an error term to capture other exogenous shocks that affect farm income in period t.[6]

[6]Note that measures of rainfall do not appear in the equation on their own as these effects are entirely

The estimated coefficients from (18) are used to compute a linear combination of rainfall variables as follows: $\hat{y}_{iht} = (\mathbf{X}_{iht} \otimes \mathbf{R}'_{vt})\,\hat{\boldsymbol{\lambda}}_i$. These fitted values represent the (log of the) component of household farm income that is explained by rainfall variations. If we assume that the demand for each consumption good can be expressed as a log-linear function of total expenditures, household Pareto weights and other household and regional characteristics, then we can derive the following specifications relating household expenditures and income:

$$\log(e_{ht}) = \sum_{i=c,m,f} \pi_{ei}\hat{y}_{iht} + \mathbf{H}_{hvt}\boldsymbol{\zeta}_e + \delta_{eh} + \delta_{evt} + \nu_{eht} \tag{19}$$

$$\log(x_{ht}) = \sum_{i=c,m,f} \pi_{xi}\hat{y}_{iht} + \mathbf{H}_{hvt}\boldsymbol{\zeta}_x + \delta_{xh} + \delta_{xvt} + \nu_{xht} \tag{20}$$

where e_{ht} represents total expenditures, and x_{ht} represents expenditures on some specific consumption good, in household h in period t. The vector $\mathbf{H}_{hvt}$ includes, potentially time-varying, household characteristics including the demographic composition of the household. The terms δ_{eh} and δ_{xh} are household fixed-effects and δ_{evt} and δ_{xvt} denote village-year fixed years. This specification controls for village-level annual covariate shocks, and hence is frequently used in the village-level risk sharing literature (e.g. Townsend 1994, Ravallion and Chaudhuri 1997 and Kazianga and Udry, 2006).

If there is indeed a social norm in practice which requires the household head to spend the proceeds of the common plot on household public goods, then $\pi_{xc} > 0$ if x is a household public good and $\pi_{xc} = 0$ for private goods.[7] In words, a rainfall shock which affects the income generated from the common plot would affect expenditures that benefit the entire household but not expenditures which are specific to an individual. To investigate whether the prevalence of the norm varies across different types of households, we interact the terms π_{xi} in (20) with a binary variable indicating whether the household is composed of a nuclear family or an extended family.

The estimates from equations (19) and (20) also provides a test for the Collective Model of the household. Consumption efficiency requires that

$$\frac{\pi_{xi}}{\pi_{ei}} = \frac{\pi_{xj}}{\pi_{ej}} \tag{21}$$

Following Duflo and Udry (2003), we test for (21) using a non-linear Wald test, separately for nuclear family and extended family households.

subsumed in the village-year fixed-effects.

[7] If the norm requires all the proceeds from the common plot to be spent on household public goods, then we would obtain $\pi_{xc} = 1$. It is more likely that part of the proceeds will be stored for future use, e.g. storage of grains in a granary, in which case we would expect $\pi_{xc} < 1$.

8.1 Results using the Ministry of Agriculture Survey Data

As indicated in Section 4, the Ministry of Agriculture Survey has limited information on consumption expenditures within the household. But the data can be used to construct measures of food consumption, including both home-grown food and food purchases. Therefore, the methodology outlined above can be used to investigate how rainfall shocks which impact upon farm income affects consumption of home-grown food and purchased food within the household.

Table 12 shows the first-stage results for (i) household common plots, (ii) male private plots and (iii) female private plots using data from the Ministry of Agriculture Survey. Categorical variables indicating the topography of the plot and the location of the plot are interacted with the level of annual rainfall in the village where the plot is located. The effect of rainfall on farm plots on flat ground ("*plaine/plateau*") and farm plots located in "*cases*" are subsumed in the village-year fixed-effects. Compared to plots on flat ground, we find that rainfall has a strong positive effect on farm output derived from plots on low ground ("*bas-fond*") and sloping ground ("*versant*") across all three types of plot ownership (i.e. 'common', 'male' and 'female'). Compared to "*cases*" plots, we find that rainfall has a strong positive effect on farm output derived from "brousse" plots and "campement" plots across all three types of plot ownership. Table 12 also report F-tests on joint significance of the estimated coefficients for all the interaction variables. The F-tests indicate that the coefficients are jointly signifcant across all three types of plot ownership.

The second-stage results are shown in Table 13. The results indicate that an income shock for the common plot has a strong effect on consumption of home-grown food but not food purchases. Splitting the sample into nuclear family households and extended family households, we find that the effect is driven entirely by nuclear family households. The estimate suggests that a 10% increase in income from the common plot leads to a 7% increase in consumption of home-grown food. The corresponding effect for extended family households, although positive, is statistically insignificant. The hypothesis that the two coefficients are equal is rejected at the 1% level. We also test the hypothesis that the 3 coefficients (common plots, male plots and female plots) of own consumption in extended households are equal to those in nuclear households. The hypothesis is rejected at the 5 % level. Overall the evidence indicates that extended households and nuclear households allocate the proceeds from the common plots (and from private plots as well) to own-consumption differently. The effect on food purchases is close to zero for both sets of households.

Income shocks for male private plots has no statistically significant impact on food consumption in either nuclear family or extended family households.

Income shocks for female private plots impact upon both home-grown food consumption and food purchases (albeit significant only at the 10% level). Looking at the corresponding coefficients for the subsamples of nuclear and extended family households, we are not able to detect statistically significant differences between the corresponding coefficients for nuclear family and extended family households, due to large standard errors.

We also investigate whether the rainfall shocks affected food security within the household. For the estimates shown in columns 4, 8 and 12, the dependent variable is a binary variable which takes a value of 1 if the household did *not* report experiencing any food shortage during the 12 months preceding the survey and 0 otherwise. We find that adverse shocks to the common plot negatively affects food security in both nuclear family and extended family households. The same is true for adverse shocks to the private female plots, but only in nuclear family households.

The key point that emerges from these results is that proceeds from the common plot make an important contribution to home-grown food consumption. But this role is more important in the case of nuclear family households than for extended family households. Moreover, there are differences in the use of the proceeds from different types of household plots: particularly between male private plots and common plots.

Table 14 reports the results from the non-linear Wald test for consumption efficiency, as described in (21), for the full sample of households, and for nuclear family and extended family households separately. We reject the hypothesis of consumption efficiency for the full sample. In words, the responsiveness of home-grown food consumption to changes in total food consumption varies, depending on the type of income shock that causes the change in total food consumption. This contradicts one of the key implications of Collective Household model. Repeating the test with the two subsamples, we are able to reject consumption efficiency for extended family households but not for nuclear family households.[8]

8.2 Results obtained from the PNGT Survey Data

As mentioned in Secion 4, the PNGT survey recorded information not only on the identity of the household member who made each consumption expenditure but also the identity of the person or persons for whom the expense was incurred. This information allows us to distinguish between expenditures on household public goods and on private goods in the data. Specifically, we classify all purchases which were destined for the use of all household members as expenditures on household public goods and expenditures on items intended for individual consumption (by the person who incurred the expense) as private goods.

The purpose of making this distinction is to examine whether the social norm about the use of the proceeds of the common plot, discussed earlier, prevails for the households in our

[8]It is important to note that the food consumption categories 'own produce' and 'purchased food' can be used to test for consumption efficiency if the commodities purchased are distinct from those which are produced for own consumption. The PNGT survey data, which provides a more detailed breakdown of food consumption, can be used to verify that this is indeed the case for agricultural households in Burkina Faso.

sample. We follow the methodology outlined at the beginning of Section 8 to examine the data.

A shortcoming of the PNGT data is that the household's agricultural produce is recorded at the level of the individual but not at the level of the plot; i.e. it indicates which individual who was responsable for the parcel of land from which the produce was harvested, but not the plot itself. Therefore, we classify farm output by the identify of the plot owner: household heads, 'junior' male household members, and 'junior' female household members. As the common plots are managed, predominantly, by the household head, and those managed by others within the household are mostly private, this classification should approximate roughly that used for the analysis with the MA survey, discussed in the preceding section.

The first-stage regression results are shown in Table 15. The rainfall variables include the deviation of annual rainfall from its long-term average interacted with plot characteristics; as well as the level of rainfall during the planting season – July, August and September – when adequate rain is critical for a successful harvest. We also include in the regressions the prices of the principal cash crops and food crops during the agricultural season – peanuts, cowpeas, bambara nuts, millet and sorghum – as these can significantly affect crop choices and farm output. Finally, the regressions include household fixed-effects and year dummies. F-tests indicate that the rainfall coefficients are jointly significant in each regression.

The second-stage results are shown in Table 16. The consumption categories used are (i) household public good expenditures; (ii) household food consumption; (iii) private expenditures; (iv) private food consumption. We find that a positive shock to the income generated on the household head's plots significantly increases public good expenditures and household food consumption. The point estimates for the corresponding coefficients for plots managed by junior household members are positive but not statistically significant. Large standard errors mean that the hypothesis that coefficients across all three plots are equal cannot be rejected.

Income shocks for the household head and the junior female members have no significant effect on private expenditures and private food consumption, with the point estimates being close to zero. By contrast, income shocks for junior male household members has a strong positive effect on private expenditures and a small but statistically significant effect on private food consumption. We can reject the hypothesis that the coefficient for private consumption is the same across all three types of plots. These patterns correspond reasonably well with the social norm that proceeds from the common plot should be used primarily for expenditures related to household public goods.

In columns (5) to (12) of Table 16, we interact the predicted income shock variables with a binary variable indicating whether the household consists of a nuclear family or an extended family. The key difference to note here is that we find a positive and significant effect on household public goods and household food expenditures stemming from a shock on junior male plots in nuclear family households but not in extended family households. Furthermore, we find a positive and significant effect on private expenditures stemming from a shock to the household head's plots in nuclear family households but not in extended family households. Otherwise, the standard errors on the estimated coefficients of the interaction terms are too large for precise statements.

We test for efficiency in consumption, as per (21), using a non-linear Wald test (See Table 17). Once again, we are able to reject efficiency for the full sample and the sample of extended family households but not for nuclear family households.

9 Discussion

The evidence shows clear differences between the allocation of resources in nuclear family and extended family households in rural Burkina Faso. Extended family households exhibit a wider dispersion of agricultural yields and intensity of labour use across its plots (controlling for plot characteristics and the crops cultivated). The evidence indicates that the differences are not due to the larger size of extended family households or differences between nuclear and extended family members.

Rather, it is because of different labour allocation decisions – by individuals who share the same tie to the household head – in nuclear versus extended family households. For example, we find that, in nuclear family households, the household head's son contributes on average the same amount of labour on the household's collective plots as the head himself (controlling for household-year fixed-effects) but the son within the extended family household contributes significantly less (by about 37%). There are similar patterns for the spouse and daughter of the household head.

Individually managed plots uses labour less intensively than the collectively managed plots in both nuclear and extended family households; but we find that the gap is larger in the case of extended family households *even when comparing across individuals who share the same nuclear family tie with the household head*.

Also noteworthy, a larger share of the household's farm land is allocated to individually managed plots in extended family households (controlling for farm land area and household size).

A theory that reconciles all these findings must explain why household members would have different incentives in nuclear and extended family households. A simple, and plausible, assumption that can potentially account for the observed patterns is that the preferences of the household head are aligned to a greater extent with those of members of the nuclear family than with those of members of the extended family. As argued in Section 3, under this assumption, the equilibrium allocation of resources will be closer to the first-best in nuclear family households.

Extended family members and unrelated individuals in extended family households have weaker incentives than nuclear family members to work on the 'common' plots. The 'common' plots are, nevertheless, farmed more intensively because the non-nuclear family members can contribute to it. But these same non-nuclear family members have to be compensated, by the household head, by the allocation of (larger) individual farm plots.These incentives would account for all the patterns in the data described earlier on land, labour and agricultural output.

The analysis suggests, in the context of small-holder agricultural households, that the evolution of household composition from extended to nuclear family households will lead to more efficient allocation of productive resources within the household because of the ties that bind together members of the nuclear family.

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Tables

Table 1: Trends in household composition in West Africa

Country	Year	Share nuclear households		Country	Year	Share nuclear households	
		All	Rural			All	Rural
Benin				Mali			
	1996	0.51	0.54		1996	0.67	0.73
	2001	0.58	0.61		2001	0.70	0.75
	2006	0.65	0.68		2006	0.68	0.73
	2012	0.68	0.72	Niger			
Burkina Faso					1992	0.50	0.54
	1993	0.53	0.61		1998	0.56	0.58
	1999	0.57	0.61		2006	0.60	0.63
	2003	0.60	0.63		2012	0.72	0.74
	2010	0.69	0.74	Nigeria			
Ghana					1990	0.65	0.67
	1993	0.73	0.74		1999	0.71	0.72
	1998	0.71	0.71		2003	0.65	0.67
	1999	0.72	0.71		2008	0.72	0.74
	2003	0.63	0.64		2013	0.72	0.73
	2008	0.66	0.66	Senegal			
Guinea					1993	0.24	0.20
	1999	0.48	0.52		1997	0.26	0.25
	2005	0.53	0.57		2005	0.24	0.23
	2012	0.47	0.52		2011	0.24	0.24
Ivory Coast					2013	0.25	0.23
	1994	0.42	0.42				
	1999	0.39	0.39				
	2012	0.48	0.52				

Source: Data from the Demographic and Health Surveys (http://www.dhsprogram.com/).

Notes: The sample consists of the West African countries with more than DHS rounds by September 2014. Nuclear households are defined as households consisting of a spouses and their children. Extended households are defined as households consisting of spouses, their children and other household members whether related or non-related.

Table 2: Household composition and plot characteristics by extended and nuclear households

	Extended Family Households		Nuclear Family Households		Difference	t-stat
	mean	(sd)	mean	(sd)		
Household Head's Characteristics						
Gender (1 = Male, 0 = Female)	0.95	(0.22)	0.94	(0.24)	0.01	2.03
Age	50.75	(15.88)	48.79	(13.43)	1.96	7.84
Married? (1 = Yes, 0 = No)	0.92	(0.27)	0.93	(0.26)	-0.01	-1.88
# of Wives	1.57	(1.13)	1.47	(0.98)	0.10	5.56
Literate? (1 = Yes, 0 = No)	0.26	(0.44)	0.23	(0.42)	0.02	2.93
Household Size	11.78	(6.70)	7.30	(3.86)	4.48	49.60
# Married Men	1.76	(1.12)	1.04	(0.48)	0.72	51.79
# Extended Family Members	4.59	(5.00)	-	-	4.59	82.56
# Observations	8080		5723			
Household Plot Characteristics						
Total Plot Area (hectares)	7.14	(7.48)	4.50	(4.48)	2.65	25.90
Proportion of Common Plot	0.74	(0.30)	0.75	(0.33)	0.00	-0.55
# of Plots	7.54	(5.00)	5.64	(3.55)	1.90	26.11
# of Common Plots	4.29	(2.95)	3.52	(2.49)	0.76	16.39
# of Private Plots	3.17	(3.76)	2.06	(2.45)	1.11	21.07
# of Male Private Plots	2.39	(3.14)	1.62	(2.13)	0.77	17.17
# Observations	7516		5220			

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.
Notes: Nuclear households are defined as households consisting of a spouses and their children. Extended households are defined as households consisting of spouses, their children and other household members whether related or non-related. Total area is the sum of the area of all plots farmed by the household in a given year. Common plots refer to plots managed by the household head (or occasionally by another household member) and proceeds from which are shared by all household members. Private plots refer to plot managed by individual household members who then make decisions on how to allocate the proceeds.

Table 3: Summary of men and women labor allocation across different household's plots

	mean	sd	min	max
Adult Males (N=24905)				
Labor on (number of days worked each year):				
own private plots	5.87	17.18	0	241
male private plots	2.34	10.23	0	252
female private plots	4.21	10.85	0	176
head common plots	29.7	44.45	0	291
junior males common plots	0.92	8	0	202
junior females common plots	0.11	1.65	0	62
Adult Females (N=31610)				
Labor on (number of days worked each year):				
own private plots	16.69	26.44	0	288
male private plots	4.07	13.25	0	237
female private plots	3.95	11.6	0	225
head common plots	42.26	42.21	0	281
junior males common plots	1.19	8.73	0	250
junior females common plots	0.18	2.92	0	162

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.

Notes: labor is measured in number of days worked on a specific plots. For the purpose of the analysis, adult is defined as 15 year or older. "Junior male" common plots and "junior female" common plots are used to distinguish between common plots managed by the household head and common plots managed by other male of female household members.

Table 4: Labor and land allocation, and farm productivity within extended and nuclear households.

	Private plots		Common plots managed by:		Share allocated to Common Plots:	
	Men	Women	Household Head	Other Family Members	Managed by Household Head	All
All households						
Male Labor (days)	20.39	16.39	169.65	6.10	0.80	0.83
Female Labor (days)	11.39	55.29	137.24	6.18	0.65	0.68
Total Labor (days)	31.96	71.95	307.44	12.34	0.73	0.75
Area (ha)	0.50	0.87	4.21	0.16	0.73	0.76
Farming intensity (days/ha)	64.15	82.96	72.99	76.66		
Yield (CFA/ha)	88674.89	79641.86	89073.29	86037.14		
Nuclear households						
Male Labor (days)	13.90	13.70	139.05	2.46	0.82	0.84
Female Labor (days)	7.28	44.07	112.41	3.09	0.67	0.69
Total Labor (days)	21.22	57.86	251.92	5.64	0.75	0.77
Area (ha)	0.32	0.64	3.31	0.07	0.76	0.78
Farming intensity (days/ha)	66.93	90.53	76.15	84.00		
Yield (CFA/ha)	95487.73	85059.06	88304.52	81561.08		
Extended households						
Male Labor (days)	24.89	18.25	190.90	8.63	0.79	0.82
Female Labor (days)	14.24	63.09	154.48	8.33	0.64	0.68
Total Labor (days)	39.43	81.74	346.00	17.00	0.71	0.75
Area (ha)	0.62	1.03	4.84	0.23	0.72	0.75
Farming intensity (days/ha)	63.17	79.69	71.49	75.15		
Yield (CFA/ha)	86270.92	77297.68	89438.24	86959.95		

Source: Authors' calculations using data from the Ministry of Agriculture of Burkina Faso.

Notes: Nuclear households are defined as households consisting of a spouses and their children. Extended households are defined as households consisting of spouses, their children and other household members whether related or non-related. Total area is the sum of the area of all plots farmed by the household in a given year. Common plots refer to plots managed by the household and proceeds from which are shared by all household members. Private plots refer to plot managed by individual household members who then make decisions on how to allocate the proceeds. Yield is measured as the value of harvest divided by the size of the plot.

Table 5: Shadow Price of Land: Labour on common plots per unit of private farm (days/hectare)

	Extended households	Nuclear households
Men and women	263.47	209.71
Men	446.30	319.70
Women	180.73	158.71

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.
Notes: The shadow price of land is measured as total labor allocated to common plots (in days) divided by the size of private plots in hectares.

Table 6: Estimates of the determinants of land allocation between common and private plots

VARIABLES	(1) comm_prop	(2) comm_prop	(3) comm_prop	(4) comm_prop	(5) comm_prop	(6) comm_prop	(7) comm_prop	(8) comm_prop
lnd_area	0.01**	0.01**	0.01**	0.01**	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
lhh_size	-0.07***	-0.07***	-0.05***	-0.03***	-0.07***	-0.07***	-0.05***	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
_Isex_2	-0.11***	-0.08***	-0.10***	-0.10***	-0.10***	-0.07**	-0.09***	-0.09***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
_Iwidow_1		-0.05				-0.05		
		(0.03)				(0.04)		
_IsexXwid_2_1		-0.00				-0.00		
		(0.05)				(0.05)		
_Inuc_bin_1			0.02**				0.02***	
			(0.01)				(0.01)	
_Imarr_men__1				-0.05***				-0.05***
				(0.01)				(0.01)
Constant	0.89***	0.89***	0.89***	0.86***	0.90***	0.90***	0.89***	0.86***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Observations	12,736	12,736	12,732	12,732	12,736	12,736	12,732	12,732
R-squared	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05
Village fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Village-year fixed effects	No	No	No	No	Yes	Yes	Yes	Yes

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.

Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level. The dependent variable is the share of household land allocated to common plots. Columns 1-4 control for village fixed effects and a time trend. Columns 5-8 control for village-year fixed effects, hence capture village-level time varying unobserved effects. All regressions also control for household demographic composition, and age of the household head.

Table 7: Estimates of yields for extended and nuclear households

VARIABLES	(1) lny	(2) lny	(3) lny
Male_Plot	-0.24***	-0.27***	-0.14***
	(0.02)	(0.03)	(0.05)
Fema_Plot	-0.48***	-0.54***	-0.33***
	(0.02)	(0.02)	(0.03)
age	0.02***	0.02***	0.03***
	(0.00)	(0.00)	(0.00)
age2	-0.02***	-0.01***	-0.02***
	(0.00)	(0.00)	(0.00)
topo1	-0.03	-0.03	-0.01
	(0.02)	(0.03)	(0.05)
topo2	0.01	-0.01	0.04
	(0.03)	(0.04)	(0.06)
_Iplotdist_2	0.16***	0.16***	0.16***
	(0.02)	(0.02)	(0.03)
_Iplotdist_3	0.19***	0.22***	0.11
	(0.05)	(0.06)	(0.10)
Constant	12.42***	12.52***	12.05***
	(0.06)	(0.07)	(0.11)
Observations	81,485	53,366	28,119
R-squared	0.37	0.37	0.37
Number of hhcyrfe	49,750	30,813	18,937
household-crop-year fixed effects	Yes	Yes	Yes
households	all	extended	nuclear
plots	all	all	all
F-Stat. test Male_Plot = Female_Plot = 0	256.9	244.8	53.25
p value	0.00	0.00	0.00

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.
Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level.
The dependent variable is natural log of plot yield measured in the local currency per hectare. Column 1 includes all households. Columns 2 and 3 include extended and nuclear households, respectively. The regressions control for household-crop-year fixed effects. Dummy variables representing the plot manager education level and dummy variables representing plot size by deciles are included in the regressions but not shown.

Table 8: Estimates of yields for extended and nuclear households with sample restricted to same size extended and nuclear households

VARIABLES	(1) lny	(2) lny	(3) lny
Male_Plot	-0.22***	-0.27***	-0.14***
	(0.04)	(0.05)	(0.05)
Fema_Plot	-0.41***	-0.47***	-0.34***
	(0.03)	(0.04)	(0.03)
age	0.02***	0.02***	0.03***
	(0.00)	(0.00)	(0.00)
age2	-0.02***	-0.02***	-0.02***
	(0.00)	(0.00)	(0.00)
topo1	-0.03	-0.06	-0.02
	(0.04)	(0.06)	(0.05)
topo2	0.02	-0.02	0.04
	(0.05)	(0.07)	(0.06)
_Iplotdist_2	0.16***	0.16***	0.16***
	(0.02)	(0.04)	(0.03)
_Iplotdist_3	0.14*	0.19*	0.11
	(0.08)	(0.12)	(0.10)
Constant	12.24***	12.39***	12.07***
	(0.08)	(0.12)	(0.11)
Observations	46,964	20,004	26,960
R-squared	0.36	0.35	0.37
Number of hhcyrfe	31,043	13,024	18,019
household-crop-year fixed effects	Yes	Yes	Yes
households	all	extended	nuclear
plots	all	all	all
F-Stat. test Male_Plot = Female_Plot = 0	124.8	82.92	53.48
p value	0.00	0.00	0.00

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.
Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level.
The dependent variable is natural log of plot yield measured in the local currency per hectare. Column 1 includes all households. Columns 2 and 3 include extended and nuclear households, respectively. The regressions control for household-crop-year fixed effects. Dummy variables representing the plot manager education level and dummy variables representing plot size by deciles are included in the regressions but not shown. The sample consists of nuclear and extended households with approximately the same number of individuals.

Table 9: Estimates of yields differences between common plots and private plots within extended and nuclear households.

VARIABLES	(1) lny	(2) lny	(3) lny
comm_nhead	-0.27***	-0.25***	-0.41***
	(0.04)	(0.04)	(0.08)
head	-0.18***	-0.21***	-0.10
	(0.04)	(0.04)	(0.06)
spouse	-0.52***	-0.58***	-0.39***
	(0.02)	(0.03)	(0.04)
son	-0.36***	-0.36***	-0.32***
	(0.03)	(0.03)	(0.07)
daughter	-0.56***	-0.59***	-0.47***
	(0.05)	(0.07)	(0.08)
other_rel_male	-0.33***	-0.35***	
	(0.04)	(0.04)	
other_rel_female	-0.50***	-0.53***	
	(0.03)	(0.03)	
no_rel_male	-0.38***	-0.42***	
	(0.14)	(0.14)	
no_rel_female	-0.55***	-0.59***	
	(0.03)	(0.03)	
age	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)
age2	-0.01***	-0.01***	-0.02***
	(0.00)	(0.00)	(0.00)
topo1	-0.02	-0.03	-0.01
	(0.02)	(0.03)	(0.05)
topo2	0.01	-0.01	0.04
	(0.03)	(0.04)	(0.06)
_Iplotdist_2	0.16***	0.16***	0.17***
	(0.02)	(0.02)	(0.03)
_Iplotdist_3	0.19***	0.22***	0.11
	(0.05)	(0.06)	(0.10)

Table 9 (continued)

	(1)	(2)	(3)
VARIABLES	lny	lny	lny
Constant	12.53***	12.60***	12.27***
	(0.06)	(0.07)	(0.13)
Observations	81,485	53,366	28,119
R-squared	0.37	0.37	0.38
Number of hhcyrfe	49,750	30,813	18,937
household-crop-year fixed effects	Yes	Yes	Yes
households	all	all	all
plots	all	all	all
F-Stat. test son = other male	0.29	0.15	
p value	0.75	0.86	
F-Stat. test daughter = other female	1.42	1.54	
p value	0.24	0.22	
F-Stat. test all nuc. members and comm_nhead equal	23.95	30.33	1.71
p value	0.00	0.00	0.16
F-Stat. test all other plots equal	13.74	16.60	
p value	0.00	0.00	

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.
Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level.
The dependent variable is natural log of plot yield measured in the local currency per hectare. Column 1 includes all households. Columns 2 and 3 include extended and nuclear households, respectively. The regressions control for household-crop-year fixed effects. Dummy variables representing the plot manager education level and dummy variables representing plot size by deciles are included in the regressions but not shown.

Table 10: Labor supply and plot ownership within nuclear and extended households

	Nuclear households				Extended households			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	lnmale_labor	lnfemale_labor	lnchild_labor	lnTotLab	lnmale_labor	lnfemale_labor	lnchild_labor	lnTotLab
comm_nhead	-1.11***	-0.12	-0.00	-0.43***	-0.87***	-0.15*	-0.01	-0.34***
	(0.19)	(0.19)	(0.00)	(0.07)	(0.12)	(0.09)	(0.01)	(0.04)
head	-0.09	-0.93***	0.01	-0.27***	-0.43***	-0.73***	0.00	-0.44***
	(0.13)	(0.14)	(0.00)	(0.05)	(0.09)	(0.08)	(0.00)	(0.04)
spouse	-1.99***	0.15**	-0.00*	-0.53***	-2.22***	0.03	-0.00	-0.71***
	(0.10)	(0.07)	(0.00)	(0.03)	(0.07)	(0.06)	(0.00)	(0.02)
son	0.65***	-2.20***	0.00	-0.50***	-0.26***	-1.32***	-0.00	-0.57***
	(0.19)	(0.19)	(0.00)	(0.06)	(0.08)	(0.10)	(0.00)	(0.03)
daughter	-1.50***	0.05	-0.00	-0.43***	-2.20***	0.12	-0.00	-0.65***
	(0.24)	(0.15)	(0.00)	(0.08)	(0.15)	(0.10)	(0.00)	(0.05)
other_rel_male					-0.40***	-1.34***	-0.01*	-0.58***
					(0.08)	(0.11)	(0.01)	(0.04)
other_rel_female					-2.33***	0.16**	-0.00	-0.68***
					(0.10)	(0.08)	(0.00)	(0.03)
no_rel_male					-0.62*	-1.59***	-0.04	-0.74***
					(0.33)	(0.48)	(0.04)	(0.09)
no_rel_female					-2.22***	0.01	0.00	-0.72***
					(0.11)	(0.07)	(0.00)	(0.03)
age	0.08***	0.02***	-0.00	0.02***	0.03***	0.03***	-0.00	0.02***
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
age2	-0.06***	-0.02**	0.00	-0.02***	-0.02***	-0.03***	0.00	-0.02***
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
topo1	-0.09	-0.08	0.00	-0.05	-0.05	-0.06	-0.00	-0.02
	(0.07)	(0.07)	(0.00)	(0.04)	(0.05)	(0.04)	(0.00)	(0.02)
topo2	0.15	-0.07	-0.00	-0.04	-0.01	0.00	0.01	0.03
	(0.09)	(0.09)	(0.01)	(0.04)	(0.07)	(0.06)	(0.01)	(0.03)
_Iplotdist_2	0.00	0.15***	0.00	0.13***	0.07**	0.00	0.00	0.07***
	(0.05)	(0.04)	(0.00)	(0.02)	(0.04)	(0.03)	(0.00)	(0.02)

Table 10 (continued)

VARIABLES	Nuclear households (1) lnmale_labor	(2) lnfemale_labor	(3) lnchild_labor	(4) lnTotLab	Extended households (5) lnmale_labor	(6) lnfemale_labor	(7) lnchild_labor	(8) lnTotLab
_Iplotdist_3	-0.00	-0.01	-0.00	0.11	0.12	0.18*	0.00	0.14***
	(0.15)	(0.14)	(0.00)	(0.08)	(0.13)	(0.10)	(0.00)	(0.05)
Constant	3.49***	5.31***	0.02**	6.66***	5.02***	5.24***	0.03***	6.92***
	(0.34)	(0.23)	(0.01)	(0.10)	(0.16)	(0.12)	(0.01)	(0.06)
Observations	28,119	28,119	28,119	28,119	53,366	53,366	53,366	53,366
R-squared	0.41	0.44	0.01	0.76	0.36	0.41	0.01	0.74
hh-cr-yr fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Stat. test-1	98.99	71.79	0.94	1.45	140.10	60.98	1.20	27.13
p value	0.00	0.00	0.42	0.23	0.19	0.00	0.31	0.00
F-Stat. test son = other male					1.65	0.16	1.07	1.92
p value					0.53	0.86	0.40	0.15
F-Stat. test daughter = other female					0.63	3.88	0.98	1.71
p value					0.00	0.00	0.38	0.00
F-Stat. test all other plots equal					77.74	37.31	1.05	13.57
p value					0.00	0.02	0.34	0.18

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.

Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level.

The dependent variable natural log of male, female, child and total labor. All regressions control for household-crop-year fixed effects. All regressions also control for household demographic composition, and age of the household head, not shown. F-Stat. test-1 is short for an F-test that the coefficients of all nuclear members (son, daughter, spouse, head) and that of comm_nhead (common plots managed by non-head members) are all equal.

Table 11: Household members labour contribution on households' common plots

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	lnLab_com	lnLab_com	lnLab_com	lnLab_com	lnLab_com	lnLab_com
spouse	-0.81***	-0.88***	-0.56***	-0.92***	-0.94***	-0.66***
	(0.08)	(0.09)	(0.11)	(0.08)	(0.09)	(0.10)
son	-0.42***	-0.45***	-0.07	-0.47***	-0.47***	-0.08
	(0.09)	(0.10)	(0.18)	(0.08)	(0.10)	(0.15)
daughter	-1.61***	-1.76***	-0.98***	-1.62***	-1.78***	-0.96***
	(0.12)	(0.13)	(0.21)	(0.11)	(0.13)	(0.19)
other_rel_male	-0.54***	-0.61***		-0.57***	-0.61***	
	(0.10)	(0.10)		(0.10)	(0.10)	
other_rel_female	-2.20***	-2.24***		-2.30***	-2.31***	
	(0.13)	(0.13)		(0.12)	(0.13)	
no_rel_male	-0.56**	-0.61**		-0.80***	-0.85***	
	(0.28)	(0.29)		(0.25)	(0.25)	
no_rel_female	-1.40***	-1.49***		-1.40***	-1.46***	
	(0.14)	(0.14)		(0.13)	(0.14)	
Constant	3.68***	4.73***	1.33	3.11***	3.20***	2.57***
	(0.62)	(0.74)	(1.01)	(0.16)	(0.19)	(0.31)
Observations	55,628	39,242	16,386	55,628	39,242	16,386
R-squared	0.06	0.07	0.04	0.06	0.07	0.03
Fixed effects	hh.	hh.	hh.	hh-year	hh.-year	hd-year
F-Stat. test1	0.95	1.57		1.42	2.10	
p value	0.39	0.21		0.00	0.12	
F-Stat. test2	21.17	18.35		30.69	25.05	
p value	0.00	0.00		0.24	0.00	
F-Stat. test3	83.81	72.04	27.01	87.16	77.15	29.22
p value	0.00	0.00	0.00	0.00	0.00	0.00
households	all	extended	nuclear	all	extended	nuclear

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.

Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level.

The dependent variable is natural log of each household member contribution on common plots. Columns 1 and 4 show the estimates for the pooled sample. Columns and 5 show the estimates for extended households, and columns 4 and 6 show the estimates for nuclear households. Columns 1-3 control for household fixed effects, and columns 4-6 control for household-year fixed effects. All regressions control for age and age squared, education level and the individual's private plot's size (not shown). In addition, columns 1-3 include the size of the common plot, household size and composition and time trend (not shown). F-Stat. test1 is short for an F-test that the coefficients on son and other male are equal. F-Stat. test2 is short for an F-test that the coefficients on daughter and other females are equal. F-Stat. test3 is short for an F-test that the coefficients on all nuclear members (spouse, son, daughter) are all equal.

Table 12: Rainfall effects on income from common and private plots

VARIABLES	(1) common plots	(2) male plots	(3) female plots
Rainfall deviaton from long run average interacted with farm area of type:			
location "brousse"-female	-13.048	5.862	39.289***
	(13.959)	(8.975)	(10.977)
location "campement'-female	3.494	2.573	11.295*
	(10.944)	(6.777)	(5.949)
location "brousse"-male	-36.623***	24.796**	-4.459
	(9.121)	(10.709)	(3.367)
location "campement"-male	-0.585	11.324	-2.117
	(6.602)	(8.178)	(1.505)
location "brousse"-common	12.113***	0.145	-0.646
	(4.258)	(0.942)	(0.701)
location "campement"-common	14.710***	-2.023**	-0.171
	(3.492)	(0.975)	(0.502)
low ground-female	-5.326	-0.360	26.523***
	(11.224)	(6.463)	(5.640)
sloping ground female	-22.429**	-6.037	23.837**
	(10.853)	(7.076)	(11.076)
low ground-male	-5.885	40.710***	0.124
	(4.441)	(6.343)	(0.933)
sloping ground male	22.450	27.574***	2.944
	(13.840)	(6.836)	(5.517)
low ground-common	23.639***	0.495	-0.554
	(2.884)	(0.871)	(0.471)
sloping ground common	25.886***	-1.511	-0.339
	(7.531)	(1.613)	(1.384)
#0-5 (centered)	-4,633.951**	-1,683.972***	-1,087.002***
	(1,959.585)	(616.806)	(392.978)
#6-14 (centered)	-5,893.565***	-179.823	-784.243
	(2,127.809)	(748.969)	(573.385)
# 15 or older (centered)	-6,671.591***	-1,115.185*	-1,285.982***
	(1,912.438)	(593.339)	(408.149)
Constant	-0.000***	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Observations	11,353	11,353	11,353
R-squared	0.125	0.317	0.159
household fixed effects	Yes	Yes	Yes
Village-year fixed effects	Yes	Yes	Yes
F-Stat. test inst.	18.84	15.65	13.24
p value	0.00	0.00	0.00

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.
Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level. The dependent variables are household's harvest value from common plots (column1), male private plots (column 2) and female private plots (column 3). The regressions control household fixed effects and village-year-fixed effects. The F-statistic shown is for the excluded instruments.

Table 13: Household consumption response to shocks in income from common plots, male private plots and female private plots (table continues on next page)

VARIABLES	(1) all cons	(2) own cons	(3) food purch	(4) food secure
income from common plots	0.473***	0.488***	-0.004	0.368***
	(0.164)	(0.162)	(0.015)	(0.113)
income from male plots	0.263	0.280	0.003	0.350**
	(0.337)	(0.340)	(0.024)	(0.152)
income from female plots	0.741**	0.577*	0.120*	0.232
	(0.328)	(0.331)	(0.063)	(0.262)
#6-14 (centered)	-10,250.358*	-8,943.170	-561.929	5,622.764
	(5,889.548)	(5,610.213)	(715.075)	(4,380.324)
#0-5 (centered)	-433.581	-1,203.928	345.299	6,199.573
	(6,115.427)	(5,850.780)	(748.912)	(5,050.931)
# 15 or older (centered)	-6,227.298	-3,920.443	-1,046.327*	3,456.708
	(5,057.695)	(4,876.708)	(612.371)	(4,157.728)
Constant	-0.001***	-0.000***	-0.000	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	11,353	11,353	11,353	11,353
R-squared	0.008	0.008	0.003	0.004
households	all	all	all	all
household fixed effects	Yes	Yes	Yes	Yes
Village-year fixed effects	Yes	Yes	Yes	Yes

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.

Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level. The dependents variables are all food consumption including own consumption and food purchases (columns 1, 5 and 9), food produced and consumed by the household (columns 2 6 and 10), food purchased (columns 3, 7 and 11), and a dummy variable which is one if the household did not report any food shortage in the 12 months preceding the survey and zero otherwise (columns 4, 8 and 12). Columns 1-3 include all households, columns 4-8 include extended households only and columns 9-12 include nuclear households only. These second stage regressions use the first stage results shown in Table 13 above.

Table 13 (continued)

VARIABLES	(5) all cons	(6) own cons	(7) food purch	(8) food secure	(9) all cons	(10) own cons	(11) food purch	(12) food secure
income from common plots	0.246	0.292	-0.020	0.389***	0.799***	0.703***	0.052	0.593**
	(0.242)	(0.234)	(0.019)	(0.140)	(0.254)	(0.239)	(0.047)	(0.296)
income from male plots	-0.051	0.009	-0.022	0.237	-0.247	-0.238	0.070	0.156
	(0.397)	(0.395)	(0.025)	(0.151)	(0.785)	(0.779)	(0.067)	(0.544)
income from female plots	0.764*	0.614	0.129**	-0.042	1.340	1.483	-0.035	1.746**
	(0.404)	(0.393)	(0.061)	(0.313)	(0.935)	(0.942)	(0.118)	(0.784)
#6-14 (centered)	-16,899.477**	-13,505.573**	-961.569	8,065.752	11,006.704	11,256.975	71.790	6,526.860
	(7,318.537)	(6,736.025)	(1,018.015)	(5,542.904)	(12,641.841)	(12,433.807)	(1,241.797)	(9,813.489)
#0-5 (centered)	-4,672.770	-6,791.235	1,019.527	1,181.898	3,592.855	4,476.362	-2,356.567	22,209.140**
	(9,015.161)	(8,675.529)	(1,052.229)	(6,576.629)	(9,379.361)	(8,755.178)	(1,907.195)	(10,657.178)
# 15 or older (centered)	-5,027.162	-2,896.319	-1,369.455	5,926.814	-11,042.981	-8,119.444	28.973	-3,132.309
	(6,240.575)	(5,946.122)	(862.845)	(5,156.583)	(7,707.117)	(7,605.555)	(1,332.985)	(8,201.552)
Constant	8,834.702*	7,632.908*	1,023.553*	8,958.981***	-7,233.391	-4,989.357	-518.029	-16,176.293**
	(4,675.085)	(4,425.435)	(544.922)	(3,108.863)	(8,121.624)	(7,841.956)	(1,345.244)	(8,016.167)
Observations	6,620	6,620	6,620	6,620	4,563	4,563	4,563	4,563
R-squared	0.009	0.008	0.004	0.005	0.013	0.012	0.003	0.009
households	extended	extended	extended	extended	nuclear	nuclear	nuclear	nuclear
household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Village-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.
Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level. The dependents variables are all food consumption including own consumption and food purchases (columns 1, 5 and 9), food produced and consumed by the household (columns 2 6 and 10), food purchased (columns 3, 7 and 11), and a dummy variable which is one if the household did not report any food shortage in the 12 months preceding the survey and zero otherwise (columns 4, 8 and 12). Columns 1-3 include all households, columns 4-8 include extended households only and columns 9-12 include nuclear households only. These second stage regressions use the first stage results shown in Table 13 above.

Table 14: Tests for unitary and collective household models

	Type of households:		
	All	Extended	Nuclear
Unitary household (6 dof)			
Wald			
stat	23.08	5.34	26.62
prob	0.00	0.50	0.00
Efficient household (5 dof)			
Wald			
stat	20.59	5.34	17.46
prob	0.00	0.38	0.00

Source: Authors calculations using data from the Ministry of Agriculture of Burkina Faso.
Notes: The tests use the coefficients reported in Table 13. In practice we use total food consumption, own food consumption and food purchases.

Table 15: Effects of rainfall shocks on income from plots managed by household head, household male members and household female members.

	(1)	(2)	(3)
VARIABLES	Head	Junior Male	Female
Long run average rainfall interacted with household land area under:			
high hill-household head	1.036	0.443	0.545
	[2.608]	[0.608]	[0.897]
rocky soil-household head	-18.558***	2.851**	0.889
	[6.511]	[1.343]	[1.138]
high hill- other males	-1.778	-14.799	-8.761
	[29.558]	[30.835]	[7.360]
rocky soil-other males	-7.983	-77.626***	2.438
	[15.660]	[18.969]	[3.593]
high hill-females	8.796	-0.628	-0.177
	[8.774]	[2.967]	[8.018]
rocky soil-females	32.159	4.410	14.679
	[23.617]	[3.447]	[19.202]
previous season rainfall	0.001	0.005	0.020***
	[0.014]	[0.004]	[0.004]
July rainfall	-0.162***	0.004	-0.001
	[0.024]	[0.005]	[0.008]
August rainfall	-0.085***	-0.006	0.030***
	[0.023]	[0.006]	[0.006]
September rainfall	0.070	-0.008	-0.027***
	[0.053]	[0.015]	[0.010]
Constant	63.602**	6.207	-7.016
	[25.222]	[5.641]	[6.117]
Observations	5,282	5,282	5,282
R-squared	0.244	0.071	0.130
Number of hhfe	1,953	1,953	1,953
F-Inst	9.625	4.001	9.135

Source: Authors calculations using data from the PNGT2 survey.

Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level. The dependent variables are household's harvest value from plots managed by the household head (column 1) plots managed by men (column 2) and plots managed by women (column 3). The PNGT data do not allow a distinction of crop income between common plots and private plots. The regressions control for household fixed effects. Variables included in the regressions but not shown are age and age squared of household head, time trend and prices of peanuts, Bambara nuts, cowpea, millet and sorghum. The F-statistic shown is for the excluded instruments.

Table 16: Household consumption response to shocks in income from household head plots, male plots and female plots (table continues on next page)

VARIABLES	(1) PublicCons	(2) PublicFood	(3) PrivateCons	(4) PrivateFood	(5) PublicCons	(6) PublicFood
Predicted Head Harvest	0.226***	0.180***	0.054	0.008	0.230**	0.193**
	[0.083]	[0.069]	[0.033]	[0.016]	[0.096]	[0.080]
NuclearX Pred. Head Harvest					0.040	0.006
					[0.062]	[0.047]
ExtendedXPred Head Harvest						
Predicted OtherMale Harvest	0.193	0.139	0.422***	0.036*	0.157	0.096
	[0.160]	[0.108]	[0.108]	[0.019]	[0.165]	[0.110]
NuclearXPredicted OtherMale Harvest					1.257*	1.156**
					[0.656]	[0.537]
Extended X Predicted OtherMale Harvest						
Predicted Female Harvest	0.324	0.275	-0.031	0.018	0.356	0.314
	[0.321]	[0.249]	[0.150]	[0.047]	[0.352]	[0.270]
NuclearXPredicted Female Harvest					-0.248	-0.274
					[0.337]	[0.258]
ExtendedXPredicted Female Harvest						
Constant	21.780**	4.893	23.179**	-0.975	24.110**	4.969
	[10.317]	[8.507]	[10.437]	[1.632]	[10.189]	[8.429]
Observations	5,282	5,282	5,282	5,282	5,282	5,282

Source: Authors calculations using data from PNGT2 survey.

Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level. The PNGT survey recorded information on the identity of the household member who made each consumption expenditure but also the identity of the person or persons for whom the expense was incurred. This is used to distinguish expenditures on household public goods (columns 1-2 and 5-8) and on private goods (columns 3-4 and 9-12). These second stage regressions use the first stage results shown in Table 14 above. The regressions control for household fixed effects. Variables included in the regressions but not shown are age and age squared of household head, time trend and prices of peanuts, Bambara nuts, cowpea, millet and sorghum.

Table 16 (continued)

VARIABLES	(7) PublicCons	(8) PublicFood	(9) PrivateCons	(10) PrivateFood	(11) PrivateCons	(12) PrivateFood
Predicted Head Harvest	0.288***	0.214***	0.049	0.008	0.100**	0.017
	[0.084]	[0.068]	[0.037]	[0.018]	[0.045]	[0.015]
NuclearX Pred. Head Harvest			0.034	0.009		
			[0.037]	[0.010]		
ExtendedXPred Head Harvest	-0.106	-0.043			-0.099	-0.013
	[0.074]	[0.057]			[0.061]	[0.012]
Predicted OtherMale Harvest	0.660*	0.761**	0.395***	0.031	0.700**	0.136*
	[0.391]	[0.370]	[0.108]	[0.019]	[0.306]	[0.082]
NuclearXPredicted OtherMale Harvest			0.874	0.190		
			[0.579]	[0.161]		
Extended X Predicted OtherMale Harvest	-0.494	-0.690*			-0.282	-0.109
	[0.431]	[0.391]			[0.309]	[0.091]
Predicted Female Harvest	0.307	0.177	0.065	0.022	-0.221	0.027
	[0.354]	[0.280]	[0.152]	[0.046]	[0.244]	[0.065]
NuclearXPredicted Female Harvest			-0.396	-0.030		
			[0.323]	[0.071]		
ExtendedXPredicted Female Harvest	0.043	0.136			0.382	-0.019
	[0.376]	[0.304]			[0.304]	[0.066]
Constant	12.902	-1.916	22.857**	-0.513	19.067**	-2.482
	[11.416]	[9.707]	[9.924]	[1.656]	[8.989]	[1.939]
Observations	5,282	5,282	5,282	5,282	5,282	5,282

Source: Authors calculations using data from PNGT2 survey.

Notes: *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level. Robust standard errors, clustered at the village level. The PNGT survey recorded information on the identity of the household member who made each consumption expenditure but also the identity of the person or persons for whom the expense was incurred. This is used to distinguish expenditures on household public goods (columns 1-2 and 5-8) and on private goods (columns 3-4 and 9-12). These second stage regressions use the first stage results shown in Table 14 above. The regressions control for household fixed effects. Variables included in the regressions but not shown are age and age squared of household head, time trend and prices of peanuts, Bambara nuts, cowpea, millet and sorghum.

Table 17: Tests for unitary and collective household models using the PNGT2 data

	Type of housholds:		
	All	Extended	Nuclear
Unitary household (6 dof)			
Wald			
stat	18.930	59.990	2.780
prob	0.004	0.000	0.836
Efficient household (5 dof)			
Wald			
stat	17.890	39.39	2.78
prob	0.003	0.000	0.7343

Source: Authors calculations using data from PNGT2 survey.
Notes: The tests use the coefficients reported in Table 16.