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Noncooperative Decision Making in the Household: Evidence from Malawi

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Abstract

This paper proposes a novel test of productive efficiency in the household that also allows a test of noncooperative decision making. I extend the collective model (Chiappori 1988, 1997) to allow labor choices to affect future bargaining power by raising the value of outside options. Even if household consumption sharing is efficient, labor choices are no longer efficient. Using data on Malawi, where there is predetermined variation in land rights that determine outside options in marriage, I show that individuals spend more time on agricultural labor and less time on wage labor when household land is theirs. They also have lower overall income and consumption. The results are inconsistent with the fully efficient collective model but consistent with a noncooperative model with limited commitment, where individuals allocate their labor supply to maximize future bargaining power. Limited commitment can lead to inefficient allocations that reduce household welfare.

Keywords: collective model, noncooperative model, productive efficiency, Malawi

JEL Classification: D12, D13, J12

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1 Introduction

In developing countries, it is paramount for households to allocate their limited resources as efficiently as possible. Economic and social institutions, such as the rules governing kinship and inheritance, may enable or constrain households in reaching efficient allocations. Malawi is a unique country because of its system of inheritance: around 60% of households are matrilineal and follow descent through the female line, so that land is passed from mother to daughter at the time of marriage, while the remainder are patrilineal and follow descent through the male line. In this paper, I exploit this variation to evaluate whether land rights impact household efficiency, and to obtain broader insights about the role of limited commitment in the household.

The continued coexistence of matriliny and patriliny is interesting in its own right. Matrilineal communities resisted active efforts to convert their inheritance system to patriliny by British colonialists and religious missionaries in the early 20th century (Peters 1997, 2002). This suggests that there may be efficiency benefits to the institution of matriliny.

I study the role of spouses' land rights in the resource allocation of households in Malawi. In particular, I show that matrilineal households allocate their time more productively than patrilineal households, generating higher income and enjoying more consumption overall. I link these findings to economic theory: I analyze an extension to the standard collective model of household decision-making (Chiappori 1988, 1992), which assumes efficient household allocations. I allow for limited commitment and noncooperative choices in labor supply. The empirical results reject production efficiency and are instead consistent with noncooperative choices in labor supply.

In closely related work, Udry (1996) rejects efficiency in household production by comparing plot yields of male- and female-controlled plots and Udry and Goldstein (2008) show that individuals who have weak tenure security of their plots are less likely to leave their land fallow, which is inefficient. There are alternative models that explain inefficiency as a result of noncooperative behavior with limited commitment (Iyigun and Walsh 2007, Lundberg and Pollak 2003), but these models have not been tested.

I consider a standard model of the household, which makes two decisions: first, labor is allocated in order to maximise the total amount of consumption generated (Chiappori 1997, Apps and Rees 1997); second, consumption is shared efficiently between spouses according to a sharing rule that depends on spouses' outside options. In this case, bargaining power should not affect how labor is allocated in the first period, as long as the disutility from all types of labor (e.g. agricultural labor and wage labor) is the same. I compare this prediction with a model where the first period choice is noncooperative because spouses are unable to commit to a particular labor allocation. Bargaining power in the second period depends on previous labor allocation, because labor supply increases the value of future income, which determines outside options. In this version of the model, labor choices are no longer independent of distribution factors and are in general inefficient: individuals spend more time on the type of labor that most improves their outside option. This also results in lower overall consumption available for sharing in the second period.

I test productive efficiency by estimating how time allocation across different types of labor, and overall output, depend on predetermined variation in land ownership in Malawi. Malawi is a useful laboratory for this test because of the coexistence of matriliny and patriliny. It is well established in the literature that matrilineal women have strong outside options due to their access to land, while men have strong outside options in patrilineal communities (Lamphere 1974, Johnson 1988, Davison 1997).[1] In addition, social norms dictate that men divide their working time between agricultural labor and wage labor, while women specialise in agricultural labor.

According to the collective model, the identity of who owns the family land should not affect labor supply choices nor overall production levels, conditional on the productivity of different labor types. Instead, I find that men spend more time on agricultural labor (+1.5 hours per week) and less time on wage labor (−1.4 hours per week) when they are patrilineal, controlling for a rich set of covariates, including temperature, rainfall and household-level soil quality. They generate 10% less consumption overall than matrilineal men. I find that, consistent with an overinvestment story, patrilineal men have substantially lower agricultural productivity than wages, and the wedge between these two returns is larger for patrilineal men, compared to matrilineal men. These findings are difficult to reconcile with an efficient model, but are consistent with a mechanism where men make noncooperative choices in labor supply because this raises their bargaining power in future periods.

Patrilineal households' income could be increased if men reallocated their time away from their land and towards wage labor. This finding is inconsistent with unobserved, higher agricultural productivity in patrilineal communities, which would imply higher agricultural labor for patrilineal men but also higher income. The difference in labor supply and consumption between patrilineal and matrilineal households is not observed for a placebo group of households that do not own any land.

To address concerns over omitted variables that correlate with descent, labor and consumption, I pursue several strategies. First, I control for a rich set of geographical, community and individual characteristics, various measures of plot quality, colonial influence and ethnic group characteristics, and restrict the sample to areas where patrilineal and matrilineal groups are well mixed. The estimates are also robust to conservative assumptions of selection on unobservables (Oster 2016, Altonji, Elder and Taber 2005).

I discuss alternative interpretations of the results, in particular market failures, dynamic investment considerations and the role of marital residence and social norms. In the theoretical model, I show that most standard market failures, such as credit constraints in agriculture, and imperfect insurance for risk in agricultural production, predict a different pattern of results to what is observed empirically. There are, however, two alternative models that predict higher agricultural labor and lower output in patrilineal households: transaction costs in the wage labor market and tenure insecurity, if they are higher in patrilineal communities. In the empirical section, I show

[1] I define an individual's outside option as his or her utility when divorced because divorce is frequent and not stigmatised in Malawi: lifetime divorce probabilities are between 40-65% and over 40% of women remarry within the first two years after a divorce (Reniers 2003). For societies where divorce is uncommon, an alternative outside option is within-household noncooperation, as in the separate spheres model of Lundberg and Pollak (1993).

that while there is evidence that transaction costs, such as bus fares and the distance to the nearest government office, do reduce wage labor and output and increase agricultural labor consistent with the predictions of the theory, these costs cannot explain the estimated effect of patriliny on labor supply and consumption. This suggests that the empirical results are driven by noncooperative decision making rather than this market failure. I find no evidence that patrilineal households face more tenure insecurity than matrilineal households.

The findings produce several other interesting implications. First, the results in this paper suggest an efficiency gain to matrilineal descent. Matriliny has remained surprisingly prevalent in Malawi, despite efforts by external groups to eradicate it. Matriliny weakens men's incentives to overinvest in the land, which may be a potential reason for the persistence of matrilineal descent to this day.[2]

Second, endogenous bargaining power leads to inefficient decisions when there is limited commitment. This suggests that there may be efficiency gains to commitment devices in marriage, such as prenuptial contracts that condition on labor supply choices. This coheres with recent findings on the potential efficiency benefits of prenuptial contracts in Voena (2015) and Bayot and Voena (2015).

This paper contributes to the family economics literature by proposing a new test of efficiency in production decisions, rejecting the null hypothesis of efficiency, and finding evidence for an extension to the collective model that allows for limited commitment in the first stage. Endogenous bargaining power has been studied, for example, in a model where bargaining power is increasing in income and education and decreasing in fertility for women; women are predicted to overinvest in their education to make up for the negative effect of having a child on the sharing rule (Iyigun and Walsh 2007). In an alternative model with limited commitment, couples make location choices in the first period, which advantage one spouse in their subsequent consumption share. Even if consumption sharing is efficient, the first period location choice may not be (Lundberg and Pollak 2003). Finally, bargaining power as determined by labor income has also been endogenized in a collective model with no intertemporal commitment (Basu 2006). However, none of these papers provide empirical evidence for inefficient labor supply allocations due to endogenous bargaining power. The theory is also related to a growing literature on noncooperative models of the household (Cherchye, Cosaert, Demuynck and De Rock 2016, Lechene and Preston 2011, Chen and Woolley 2001).[3]

There is empirical evidence for noncooperative behavior in various contexts, including Kenya, where men use their power over migration decisions to reduce the ability of their wives to earn their own income (McPeak and Doss 2006), and Northern Cameroon, where women overinvest in those crops whose income they control (Jones 1983). There is also evidence of a lack of consumption smoothing in the household, with allocations depending on whether shocks affect the husband

[2] This is consistent with a related literature on tenure insecurity and long-term investments in land: e.g. Besley (1995), Place and Otsuka (2001), Kishindo (2010).

[3] The model also relates to Rainer (2007), who discusses theoretically the role of prenuptial contracts in a model where individuals invest in a relationship-specific asset that determines individuals' outside options, and therefore individuals' bargaining power over the asset during marriage.

or wife (Doss 2001, Duflo and Udry 2004) and wives bearing a larger burden of adverse shocks (Dercon and Krishnan 2000). In experimental contexts, spouses are observed to engage in income hiding (Ashraf 2009), even if this reduces their expected income (Jakiela and Ozier 2016). This paper provides a more general test of efficiency in production by taking into account choices across several types of labor income, rather than focusing only on agricultural work.

The paper proceeds as follows. In Section 2, I discuss descent in Malawi. Section 3 outlines the collective model of labor supply and consumption, as well as a noncooperative extension to the collective model and alternative constraints such as market failures. In Section 4, I describe the data and empirical approach. Section 5 presents the key empirical results. Section 6 considers alternative mechanisms and Section 7 concludes.

2 Background

In rural Malawi, individuals belong to ethnic groups (sometimes referred to as tribes), whose rules are important for family life. Ethnic groups follow either matrilineal or patrilineal descent, and of the eleven main ethnic groups, six are matrilineal and five are patrilineal (Spring 1995). In a matrilineal household, the woman traditionally receives land from her mother when she marries, which she keeps if the couple divorce (Berge et al. 2014, Peters 2010, Davison 1997).[4] The husband has no rights to this land.[5] Note that this differs from other matrilineal societies studied in the literature (e.g. La Ferrara 2007), where land passes from brother to sister's son.[6] In patrilineal households, the opposite happens: men receive land from their families on marriage and keep this land if the couple divorce, with the woman returning to her family. Divorce matters: Malawi has one of the highest divorce rates on the continent, with one in two marriages dissolving (Reniers 2003).

I interpret descent as a measure of outside options, because its most important role is in determining land inheritance at the time of marriage. However, there may be other economically salient features of descent that could drive labor supply and consumption allocations, such as succession to political rank or status (Adams 1999). It will be important to show that the results obtained in the empirical section are not driven by the role of descent in succession to political office.

Figure 1, a map of Malawi, depicts the dispersion of descent by district.[7] Darker shading represents districts where matriliny is more common. In the Southern region, most districts are over 50% matrilineal. In the Central region, there is a similar number of matrilineal and patrilineal

[4] Matrilineal households also tend to be matrilocal, with the husband locating in the wife's village on marriage, while patrilineal households tend to be patrilocal (the wife moves to the husband's village).

[5] There are cases of men purchasing land in matrilineal communities, but this is overwhelmingly to give it to their daughters when they marry (Berge et al. 2014, Peters 2010).

[6] Although land is shared based on descent following divorce, consumption goods tend to be shared equally on divorce. Child custody tends to follow descent rules, so going to matrilineal women and patrilineal men.

[7] The prevalence of matriliny and patriliny by district is calculated based on the Living Standards Measurement Study data used in the empirical section of this paper. For the purposes of this map, in those villages where both types of descent are practised, half of the households are apportioned matrilineal descent while half are apportioned patrilineal descent. The figures are weighted based on the sampling strategy of the data (see footnote 27).

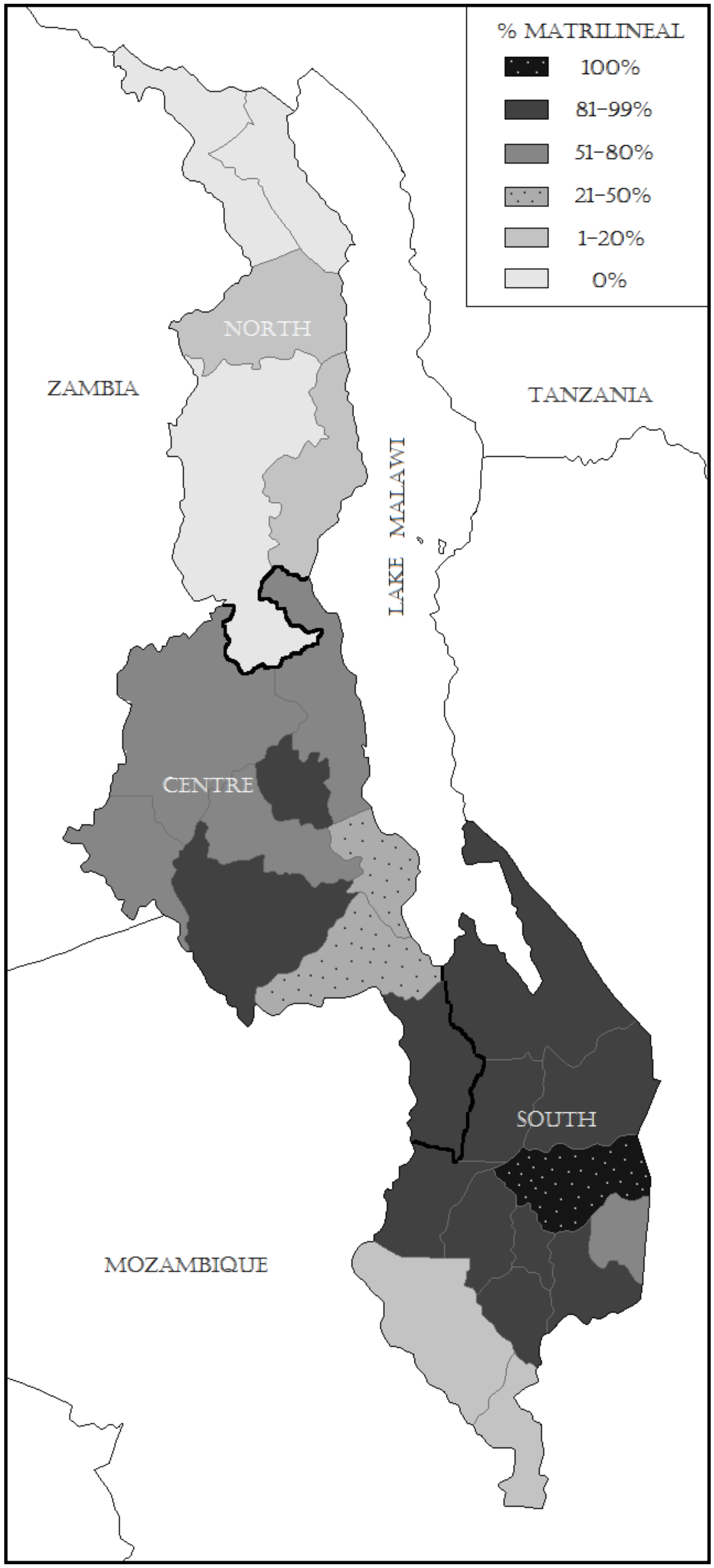

Figure 1: A map of Malawi depicting the prevalence of matriliny and patriliny by district.

people, while the Northern region is mostly patrilineal. This somewhat uneven dispersion of descent will be addressed in the robustness checks.

Table 1 describes the characteristics of matrilineal and patrilineal households. The average landholding size and household size are not significantly different across descent types, although patrilineal household heads are significantly better educated. Consistent with the anthropological literature, divorce rates are highest in matrilineal communities.[8] The table also shows that women own significantly more land and men own significantly less land, on average, in matrilineal compared to patrilineal households (p-values ≤ 0.001). Since the total amount of land owned by households is not significantly different across these descent types, this implies that women own a greater share of household land on average in matrilineal compared to patrilineal households, while the opposite is true for men.

Labor allocation in rural Malawi is affected by gender-based social norms. Almost all households derive a substantial amount of their income from agriculture, with women tending to engage in agricultural labor and performing many tasks on their own (Hirschmann and Vaughan 1983).[9,10] Men usually work both on the land and for wages.[11] It is rare for women to work for wages, unless they are unmarried (Spring 1995), so that men are predominantly responsible for providing the household's consumption goods (Schatz 2002). On the other hand, domestic labor is predominantly carried out by women (Spring 1995). These patterns are evident in Table 1. Also, patrilineal men spend more time on agricultural labor and less time on wage labor, on average, than matrilineal men; the wage labor difference is significant at the 1% level.[12] Women and men spend similar amounts of time on agricultural labor; the rest of women's time is devoted to domestic work.[13]

Matrilineal households are better off than patrilineal households in every region, in terms of real aggregate household expenditure (Table 1). In Malawi, the difference in mean expenditure between matrilineal and patrilineal households is 11% and statistically significant (p-value = 0.003).

[8] The divorce rate is measured at the district level. It is calculated from the full IHS sample and represents the proportion of household heads who report being separated or divorced. The figures are consistent with those in Reniers (2003), calculated from the 2001 Demographic and Health Survey of Malawi.

[9] This is different from the setting in Udry (1996), where men and women control separate plots.

[10] Maize is the most commonly farmed crop, followed by pigeonpea and tobacco (in terms of the number of households reporting that they farm it).

[11] Wage labor refers to any work for a salary, commission or in-kind payment, excluding agricultural activities on other farms. A typical task might be brick-laying.

[12] See Walther (2017) for a detailed analysis of how husbands and wives in Malawi allocate their time.

[13] Domestic labour is time spent fetching water and firewood. The questionnaire did not ask about more typical domestic tasks like cooking and cleaning. In addition, there is no data on leisure, which is why the total number of hours is not equal to the number of hours in a week.

Table 1: Summary statistics by descent

	Patrilineal		Matrilineal		Mixed		P-value Pat=Mat
	Mean	sd	Mean	sd	Mean	sd	
HH size	5.08	(2.14)	5.02	(1.94)	5.34	(2.18)	0.41
Age of head	41.36	(15.59)	39.99	(14.08)	42.29	(16.53)	0.00***
% Divorced	8.24	(2.73)	12.38	(3.19)	11.05	(3.55)	0.00***
% Heads with no education	70.59		76.08		68.90		0.01***
% Residing in Centre	33.86		46.50		47.05		0.01***
% Residing in South	24.08		53.40		42.20		0.00***
Land (acres)	2.13	(1.71)	2.06	(2.49)	2.33	(2.32)	0.41
Husband's land	1.06	(1.58)	0.78	(1.42)	1.17	(2.35)	0.00***
Wife's land	0.32	(0.89)	0.56	(1.15)	0.38	(0.80)	0.00***
Jointly owned land	0.28	(0.91)	0.34	(1.94)	0.35	(1.15)	0.27
Implied $\lambda^{\dagger}$	0.73		0.51		0.62		0.00***
Total labor, Husb.	21.08	(20.26)	22.50	(19.74)	18.78	(18.55)	0.15
Total labor, Wife	15.38	(16.57)	13.61	(14.10)	11.77	(13.07)	0.03**
Agric. labor, H	12.17	(14.07)	11.65	(12.54)	10.52	(13.07)	0.46
Agric. labor, W	11.80	(13.13)	10.87	(11.71)	9.62	(11.44)	0.19
Wage labor, H.	3.73	(13.04)	5.26	(14.69)	4.89	(14.28)	0.01***
Wage labor, W.	0.26	(2.96)	0.47	(4.35)	0.39	(3.51)	0.06*
Domestic labor, H.	0.62	(2.83)	0.84	(2.98)	0.59	(2.83)	0.05**
Domestic labor, W.	8.53	(7.12)	8.33	(6.91)	7.49	(7.30)	0.46
Expenditure, North	197.16	(182.52)	209.43	(129.74)	263.17	(340.86)	0.16
Expenditure, Centre	241.16	(162.34)	252.78	(195.97)	331.89	(299.70)	0.36
Expenditure, South	140.96	(104.83)	198.19	(168.18)	175.16	(120.31)	0.00***
Expenditure, All	198.53	(166.55)	223.59	(185.20)	258.36	(262.74)	0.00***
Number of observations	2472		4448		283		6920

This table reports mean (standard deviation). †Reported for households that own land. Labor hours are per week. Total labor consists of agricultural labor, wage labor, time spent running a business or helping with a business, and time spent working on others' farms. Domestic labor consists of time spent fetching water and firewood. For domestic labor, there is a reduced sample size of 2466 for patrilineal women, 2465 for patrilineal men, 4435 for matrilineal men and 282 for mixed communities men. Expenditure is in MWK. P-value is for the null hypothesis that the matrilineal and patrilineal group means are equal, excluding the mixed group.

3 Theoretical Framework

In order to determine whether household behavior in Malawi is efficient, I describe the canonical *collective model* of the household (Chiappori 1998, 1992) with and without market failures, and derive predictions on how labor supply and output relate to descent rules. I then describe alternative models and their implications for labor supply and output: the existence of transaction costs in the wage labor market, credit constraints for agricultural inputs, imperfect insurance, dynamic incentives, and, finally, a model of noncooperative decision making in labor supply.

3.1 The Collective Model with Market Failures

The collective model assumes that household decisions are made efficiently, so that allocations can be modelled as the result of maximising household welfare with Pareto weights on individual utilities. These Pareto weights represent the relative power of individuals in the decision-making process and are driven by *distribution factors*, which are variables that do not affect income or preferences but do affect outside options and bargaining power.

A household consists of a husband (a) and wife (b) who both enjoy consuming a vector of private goods x. Their utilities are $u^i(x^i)$ for $i = a, b$. The prices of private goods are a vector p.

Each household member spends n^i hours working for wages w^i and h^i hours working on the family land.[14] Agricultural labor yields output $AF(h)$, where A is a measure of agricultural productivity. This output can be sold to the market at price q. The household's income is then $y = w \cdot n + qAF(h)$. A parsimonious way of describing additional constraints that households may face is to assume that the household acts *as if* it faces household-specific shadow prices (Singh, Squire and Strauss 1986). In this case, the budget constraint has household-specific prices of wage labor, $\hat{w}$, and agricultural output, $\hat{q}$:

$$p \cdot \sum x^i = \hat{w} \cdot n + \hat{q}AF(h). \tag{1}$$

Normalizing total time to one, the time allocation constraint is

$$n^i + h^i = 1, \forall i. \tag{2}$$

The collective model of household choices is

$$\max_{\{x,h,n\}} \mu(z)u^a(x^a) + u^b(x^b) \text{ subject to (1) and (2),} \tag{3}$$

where $\mu(z)$ is the husband's Pareto weight and z is a vector of distribution factors that reflect bargaining power.

Following Chiappori (1997), a necessary condition for solving (3) is profit maximization by a

[14] I write $n = (n^a, n^b)$, $h = (h^a, h^b)$ and $w = (w^a, w^b)$ for the vectors of allocations and wages.

hypothetical "household firm" that produces agricultural output and hires labor:

$$\Pi = \max_h \hat{q}AF(h) - \hat{w} \cdot h. \tag{4}$$

Hence, optimal choices of agricultural labor h are determined by productivity and the household-specific price of agricultural products and wage:

$$\hat{q}A\frac{dF(h)}{dh} = \hat{w}. \tag{5}$$

When there are no additional constraints and markets are complete, $\hat{q} = q$ and $\hat{w} = w$, so that condition (5) simplifies to

$$qA\frac{dF(h)}{dh} = w. \tag{6}$$

When there are no market failures, the labor supply choice h is independent of the sharing rule μ and any distribution factors z.[15] A central empirical prediction of the collective model without market failures is that, *controlling for productivity and prices, descent systems will not affect the share of time spent on agricultural labor, nor the total output of the household.* Moreover, the model predicts that the share of each household member's time spent on agricultural labor will (i) increase with agricultural prices or productivities, and (ii) decrease with market wages.

A challenge in testing the prediction of the collective model that labor supply and output are independent of descent rules is that we cannot perfectly measure agricultural productivity or land quality. If there are residual (unobserved) productivity differences across descent systems, we might wrongly attribute resulting differences in labor allocations to descent itself, leading to a false rejection of efficiency. This issue can be addressed by conducting an additional test on overall levels of household consumption.[16] The collective model predicts that households in more productive regions dedicate more time to agricultural labor, and also enjoy a *higher* level of overall household consumption due to their superior productivity. In other words, in the presence of residual differences in agricultural productivity, the collective model predicts that *agricultural labor shares and overall consumption will be positively correlated across descent systems.*[17]

When there are market failures, condition (5) says that the household may supply more or less agricultural labor, as compared to under the optimality condition (6): the key quantity is the relative shadow price $\frac{\hat{w}}{\hat{q}}$, which determines whether there is any deviation from the unconstrained

[15] This result is very general; see Chiappori (1997) and Apps and Rees (1997).

[16] I assume that savings are negligible, so that output equals consumption. Brune, Giné, Goldberg and Yang (2016) study farmers in Malawi and find average savings of approximately 8.4 days worth of household expenditure.

[17] Note that these predictions are robust to introducing leisure in the model. Suppose that there are no market failures and individuals enjoy consuming goods x and leisure l, with utility $u^i(x^i, l^i)$ and time allocation constraint

$$n^i + h^i = 1 - l^i, \ \forall i.$$

The household firm's problem is unchanged, so it remains the case that agricultural labor choices h are fully determined by prices and productivity. The result generalises to different effort costs of wage and agricultural labour, but not if these effort costs also vary between patrilineal and matrilineal households.

optimum.[18] Any friction that constrains wage labor, n, will lead to $\frac{\hat{w}}{\hat{q}} < \frac{w}{q}$ and therefore an "oversupply" of agricultural labor. Any friction that constrains agricultural production will lead to $\frac{\hat{w}}{\hat{q}} > \frac{w}{q}$, and an "undersupply" of agricultural labor. These constraints also have implications for overall output: the presence of a (binding) constraint will always act to reduce overall output. The next section elaborates on several common market failures and their predictions for the correlation between descent systems, labor supply and output. I also analyze a model of noncooperative decision making in labor supply. As will be discussed in Section 5.1, the empirical results are consistent with the model of noncooperative decision making, and inconsistent with both the efficient collective model and with several common types of market failures.

3.2 Alternative Mechanisms

The collective model with household-specific shadow prices can be used to understand the implications of various market failures for labor supply and output.

1. **Transaction costs in the wage labor market**

The assumption of complete markets has been frequently rejected in the context of developing countries (Kevane 1996, Udry 1998, LaFave and Thomas 2016, although also see Pitt and Rosenzweig 1986). As an alternative, consider the role of transaction costs in the wage labor market. Assume a pecuniary loss τ per unit of wage labor supplied by the husband. This formulation captures direct costs such as bus fares, and can also represent a binding quantity constraint, such as the inability to work more than a given number of hours for wages. The latter interpretation follows if τ is a household-specific Lagrange multiplier on the quantity constraint.

The budget constraint with a transaction cost is

$$p \cdot \sum x^i \leq (w - \tau) \cdot n + qAF(h).$$

When this constraint binds, the household specific shadow wage is $\hat{w} = w - \tau$, which yields the household firm's first-order condition:

$$qA\frac{dF(h)}{dh} = w - \tau. \tag{7}$$

Therefore, households that face worse market failures (a higher τ) supply more agricultural labor and less wage labor. These households will also have lower consumption: using the binding

[18] Note that we are assuming no market for land, similar to Bardhan and Udry (1999). The effect of this is that separability between consumption and production breaks down, as households face two constraints. If they only faced one constraint (e.g. a land market existed but there was a binding constraint on the number of wage labor hours), then separability would hold, but the household's choice of agricultural and wage labor would still be affected by the constraint.

budget constraint, the value of total expenditure at the optimal allocation is

$$Y = (w - \tau) \cdot 1 + \max_h \Pi,$$

where $\Pi = qAF(h) - (w - \tau) \cdot h$. It is straightforward to show that $\frac{\partial Y}{\partial \tau} < 0$, and total income declines with transaction costs in the wage labor market. Thus, households that face worse wage labor transaction costs will supply more agricultural labor and consume less.

2. **Credit constraints for agricultural inputs**

Suppose that there is another input to agricultural production (e.g. fertilizer), which is needed in addition to labor to produce output. For simplicity, I assume that this input costs $\psi \cdot h$: the household pays for fertilizer per unit of labor supplied.[19] A higher ψ can capture agricultural frictions that raise costs (e.g. transport costs to the location where fertilizer is sold). As with wage labor transaction costs, we can also interpret ψ as a Lagrange multiplier on a constraint, where a higher ψ can capture tighter quantity constraints on agricultural inputs, or credit constraints for purchasing agricultural inputs. For example, for every unit of h the household needs one unit of fertilizer, which costs p_f, and it can only obtain at most B units of working credit to pay for this input. Then we have a quantity constraint $p_f h \leq B$ or $h \leq B/p_f$. Interpreting ψ as the Lagrange multiplier on this constraint, a higher ψ corresponds to a lower borrowing limit B.

Regardless of whether ψ is interpreted as a direct cost or as a Lagrange multiplier, it is straightforward to see that the household acts as if it faced the following modified budget constraint:

$$p \cdot \sum x^i \leq w \cdot n + qAF(h) - \psi \cdot h.$$

This, combined with $h + n = 1$, gives a shadow price of wage labor $\hat{w} = w + \psi$, which makes wage labor relatively more attractive. Households facing worse market failures in terms of credit for agricultural input (higher ψ) will supply less agricultural labor, more wage labor and consume less. This is a different pattern of labor supply from that predicted by wage labor transaction costs, which predicts less consumption and *more* agricultural labor among more constrained households.

3. **Imperfect insurance**

Suppose that agricultural production is risky and there is imperfect insurance available for this risk. In this situation, the household will demand an effective risk premium when investing in the risky production technology through its labor choice - in this case, agriculture. Heuristically, this would correspond to a household shadow price of agricultural output $\hat{q}$ that is effectively the true q minus a risk premium, and hence lower than the expected market price q. The effect is to reduce a household's agricultural labor supply. Overall output will also decline. For a formal discussion of this effect, see Bardhan and Udry (1999, chapter 2).[20]

[19] This perfect complementarity with labor simplifies the exposition but can be relaxed in a straightforward way.

[20] We can also introduce risk in wage labor: for example, there is uncertainty about the wage a person will be paid. For a risk averse household facing two sources of risk, it will prefer to invest in the technology with lower risk. It is

4. **Dynamic investment incentives and tenure insecurity**

Next, suppose that markets function well but there are dynamic investment incentives. In particular, agricultural labor today can increase the productivity of agricultural labor tomorrow (e.g. by increasing the productivity of the land). This model is derived formally in Online Appendix B. Households with a high future productivity return to today's agricultural labor will supply more agricultural labor in early life and less wage labor. A high future productivity return also raises lifetime income, since the investment opportunity raises the (maximized) present value of the firm's profits. Assuming that consumption in both periods is a normal good, and financial markets allow the smoothing of consumption, households with strong investment incentives in agriculture (motivated by future productivity increases) will supply more agricultural labor early on, and produce more throughout the lifecycle.[21,22]

A reinterpretation of this model is that land tenure is not secure, but security can be improved by investing in the land (as in Besley 1995). Households with a higher expropriation risk will supply more agricultural labor to prevent future loss of productivity, but they consume less overall because a higher expropriation risk increases losses all else equal, and reduces the present value of the household firm.

This latter model could be interpreted in terms of fallow periods: land is more productive at time 1 if left fallow (lower agricultural labor) at time 0. In this case, the optimal, profit maximizing choice is to leave land fallow and supply less agricultural labor in the first period. This in itself is not a constraint. Rather, differences between the labor supply and output of patrilineal and matrilineal households can arise if they face different constraints to fallowing. For example, if patrilineal households are unable to leave land fallow (e.g. if they face tenure insecurity), then they will supply more agricultural labor than matrilineal households and produce less output, given that fallowing is optimal.

5. **Noncooperative choices and limited commitment**

As an alternative model, suppose that markets are complete, but efficient household bargaining occurs *after* agricultural output and wage income has been earned. In an initial stage, the household members unilaterally choose their labor allocation. This setup describes a situation where it is not possible to make binding commitments about one's labor supply. Assume further that only the

plausible to assume that agricultural output is more uncertain than wages, so that wage labor will still be preferred over agricultural labor by households facing these two types of uncertainty. Only where wages are more uncertain than agricultural output, will the effect be to reduce wage labor and increase agricultural labor.

[21] The case where financial markets are imperfect and do not allow consumption smoothing is also discussed in Online Appendix B.

[22] Note that the opposite prediction holds if we assume productivity gains to wage labor. For example, higher wage labor may generate human capital that raises future wages. If this is the case, households with a higher human capital gain from wage labor will supply more wage labor and consume more overall. This effect seems less likely to apply in the Malawi context, where rural households tend to engage in low-skilled occupations such as brick-laying. In addition, if households face both types of incentives - an investment return to wage labor and to agricultural labor - then they will prefer the activity where the feedback effect is higher. This is likely to be agricultural labor.

husband makes a labor supply decision. This is justified by the empirical fact that women in Malawi engage in little to no wage labor; see Table 1.

At the bargaining stage, the household takes its income $y = wn + qAF(h)$ as given; n, h and w refer to the husband's allocation and wages. Since bargaining is efficient, the household solves

$$x^i = \arg\max_x \left\{u^i(x) \text{ subject to } p \cdot x = s^i(z)y\right\},$$

where z are distribution factors and s^i is the share of income allocated to member i, which is commensurate with i's bargaining power (and which satisfies $s^a(z) + s^b(z) = 1$). This is equivalent to the maximisation problem in (3) (see e.g. Browning, Chiappori and Weiss 2014).

Bargaining power depends on the incomes that spouses would enjoy outside of marriage. These are determined by the formal laws and social norms governing divorce. Upon divorce, the husband obtains a share $\alpha \in [0, 1]$ of household wage income, and a share $\lambda \in [0, 1]$ of agricultural income.

To formalize the effect of outside options on bargaining power, let $z = [\alpha(wn) + \lambda qAF(h)]/y$ denote the share of household income obtained by the husband in case of divorce, and assume that the sharing rule at the bargaining stage satisfies $s^a = \sigma(z)$ and $s^b = 1 - \sigma(z)$, where $d\sigma/dz > 0$. Relative income is commonly used as a distribution factor in the literature (e.g. Browning, Bourguignon, Chiappori and Lechene 1994, Hoddinott and Haddad 1995), justified by empirical results that reject income pooling (Lundberg, Pollak and Wales 1997, Thomas 1990). Divorce laws and control of land have also been used as distribution factors (Chiappori, Fortin and Lacroix 2002, and Udry 1996, respectively).[23]

The husband's indirect utility, as a function of bargaining power z and household income y, is therefore

$$V(y, z) = \max_x \{u^a(x) \text{ subject to } p \cdot x = \sigma(z)y\}.$$

At the labor allocation stage, he solves

$$\max_{h,n} \left\{V(y, z) \text{ subject to } y = wn + qAF(h),\ z = \frac{\alpha(wn) + \lambda qAF(h)}{wn + qAF(h)} \text{ and } h + n = 1\right\}.$$

The first-order condition for optimality[24] can be written as

$$\frac{dy}{dn} = \frac{dy}{dh} + y\left(\frac{dz}{dh} - \frac{dz}{dn}\right)\frac{\sigma'(z)}{\sigma(z)}. \tag{8}$$

The efficient choice is to equalize the marginal products of wage and agricultural labor: $dy/dn = dy/dh$, or $w = qA\frac{\partial F(h)}{\partial h}$, as in equation (6). In the current setting, however, agricultural labor yields an additional benefit for the husband if it increases his bargaining power by more than wage labor does. This effect is captured by the second term in (8), and it leads the husband to oversupply

[23] See the discussion on distribution factors in chapter 5 of Browning, Chiappori and Weiss 2014.

[24] Obtained by maximising $\sigma(z)y$ with respect to h and n subject to the constraint $h + n = 1$.

agricultural labor.[25]

The division of output upon divorce is now crucial for household efficiency. Evaluating dz/dh and dz/dn and substituting into (8), we have

$$w = qA\frac{dF(h)}{dh} + (\lambda - \alpha)\left[F(h) + n\frac{dF(h)}{dh}\right]\frac{qAw}{y}\frac{\sigma'(z)}{\sigma(z)}. \tag{9}$$

It is clear that the husband over-supplies agricultural labor if and only if $\lambda > \alpha$, because in this case $\frac{dy}{dh} < \frac{dy}{dn}$, so that a marginal reallocation from h to n would increase y. Further, the efficient choice maximises household output and therefore consumption, so that any deviation from the efficient choice results in lower overall consumption, even if one spouse obtains a higher share of it.

A central empirical prediction of this model is that inefficient choices can occur if post-divorce resource allocation of one type of income is not equal to post-divorce resource allocation of another type of income. In this case, labor allocation is skewed towards earning the type of income that most improves the spouse's outside option. This mechanism is distinct from the model of dynamic investment incentives, where agricultural labor today affects the productivity of agricultural labor tomorrow, rather than bargaining power.

In Malawi, the two key types of male labor are agricultural labor and wage labor (Table 1). Agricultural labor improves the value of land, both because of future crops that can be harvested, and because conservation efforts can reduce erosion and thus improve the fertility of the land. Therefore, in patrilineal households, where men keep most of the land on divorce, *higher levels of agricultural labor are expected, relative to matrilineal households, where men own a smaller share of the land*. These land shares can be seen in Table 1: λ is the share of household land owned by the husband, which is significantly higher in patrilineal, compared to matrilineal households. Consistent with this argument, men control a greater number of plots and more revenue from crop sales in patrilineal households than matrilineal households, while the opposite is true of women, who control a larger value of crop sales in matrilineal households (Table 10 in Online Appendix A).

With an additional assumption on how wage income is shared on divorce, the model also has empirical predictions regarding household consumption. Suppose that wage income is shared equally on divorce - this is not unreasonable, as recent judicial changes have resulted in courts ordering equal division of purchases such as movable property and personal belongings following divorce (Mwambene 2005). Using the average share of land owned by the husband in Table 1 as a measure of λ, greater inefficiency is expected for patrilineal households, because the wedge between α and λ is greater. This implies *lower household consumption for patrilineal than matrilineal households*.

[25] Note that this implicitly assumes that agricultural labour generates agricultural income (i.e. $\frac{dy}{dh} > 0$), and descent (λ) determines how agricultural income affects the outside option. The value of agricultural labor is in fact the value of future harvested crops. Clearly these are tied to the land. Agricultural labor can also raise the value of the land indirectly through soil conservation measures, for example. In fact, there is a substantial literature documenting that matrilineal men invest less in household land (Place and Otsuka 2001, Lovo 2016, Kishindo 2010).

3.3 Summary

The collective model with separation of consumption and production and no additional constraints predicts that households will maximize profits in production by setting the marginal product of their agricultural labor equal to the wage.

An alternative model is noncooperative decision making in labor supply with feedback to future bargaining power, which predicts that men who own their land (patrilineal) will tend to oversupply agricultural labor relative to men who do not (matrilineal), undersupply wage labor, and produce less overall for the household to consume or sell. There are two alternative mechanisms, driven by market failures, that generate similar predictions to noncooperative decision-making: transaction costs in the wage labor market and tenure inscurity. If patrilineal men face more stringent constraints in the wage labor market or higher tenure insecurity, they will tend to oversupply agricultural labor and generate less income overall.

The remaining mechanisms discussed above generate predictions that are at odds with noncooperative decision making, and with the empirical results in Section 5.1, which show that patrilineal men allocate more time to agricultural labor, less time to wage labor, and generate less income for household consumption. In order to show that the empirical findings are driven by noncooperative decision making and not by differences in wage labor costs, tenure insecurity or fallowing opportunities across patrilineal and matrilineal households, additional tests of these alternative mechanisms are provided in Section 6.

4 Data and Estimating Equations

The data are from the Malawi Third Integrated Household Survey (IHS 2013). I restrict the sample to rural and married households. Descent is identified based on the following question: "Do individuals in this community trace their descent through their father, their mother, or are both kinds of descent traced?" I define a household to be *patrilineal* if the answer is "father", *matrilineal* if the answer is "mother", and *mixed* if the answer is "both".[26]

Labor supply information is provided in the form of time allocation in the previous week, including agricultural work on household land and working for wages. In the main analysis, I focus on consumption rather than income. This is for two reasons: first, the consumption data I use are far richer than the income data, and second, consumption is less susceptible to shocks than income, hence painting a more accurate portrait of households' economic well-being (Deaton and

[26] Although identification of descent is effectively at the community level, this is unlikely to result in measurement error because of two reasons: first, the most common reason for migration is marriage, and second, marriage across descent types is extremely rare. In the IHS, approximately 50% of spouses live in the village of their birth, and of those that have moved, 45% report marriage as the reason, while the next most common reason is moving with parents, presumably when they were children. For these households, descent in the current village of residence is the same as descent at birth. For the remaining households, it could be that more productive spouses move from patrilineal to matrilineal villages. This possibility is addressed in the analysis of individual wages in Section 5.2, which shows that patrilineal men's predicted wages are higher than matrilineal men's predicted wages at all points in the distribution.

Zaidi 2002). All consumption expenditure is deflated by a temporal and spatial price index. I also report results on income to verify that they are consistent with the consumption results.

To evaluate the effect of descent on labor allocation, I estimate the following equation:

$$h_{i,c,d,r} = \gamma_0 + \gamma_1 P_{c,d,r} + \gamma_2 \ln w_{i,c,d,r} + \mathbf{G}'_{i,c,d,r}\boldsymbol{\gamma}_3 + \mathbf{X}'_{i,c,d,r}\boldsymbol{\gamma}_4 + \varepsilon_{i,c,d,r}. \tag{10}$$

I estimate this equation for five different dependent variables: weekly total hours of income-earning labor, agricultural hours, wage hours, the difference between agricultural and wage hours and their sum. The coefficient of interest in each case is γ_1. The unit of observation is the household i, and communities are indexed by c, districts by d and regions by r. $P_{k,d,r}$ is a dummy variable that equals one if the household's community is patrilineal and zero if it is not. I also include a dummy variable for mixed descent villages, so that the coefficient γ_1 captures the average difference between patrilineal and matrilineal households. I cluster all standard errors at the community level, weight the regressions based on the sampling strategy and take account of the fact that I am using a subpopulation of the full sample.[27]

I also include a vector of geographical controls, $\mathbf{G}_{i,c,d,r}$. In addition to several measures of soil quality at the household level, I include community-level measures of rainfall, temperature and greenness, which measures the onset and duration of spring. The intention is to control for characteristics that affect the productivity of agriculture and the suitability of the land for different crops, and that may also be correlated with descent. The vector $\mathbf{X}_{i,c,d,r}$ consists of additional individual-level, community-level, district-level and region-level covariates.[28,29]

This specification also controls for the logarithm of husbands' wages, $\ln w_{i,c,d,r}$. The observed wage may overestimate the underlying distribution of wage offers. I estimate a Heckman selection model (Heckman 1979) for observed wages, calculate the predicted wage for each husband in the sample and use this in place of the observed wage.[30]

[27] I cluster at the community level because while communities are selected randomly, the variable of interest (descent) is measured at the community level, which may induce correlation in errors between households in a given community. With regard to the use of weights, I follow the guidance in Deaton (1997, p. 72), which suggests the use of an 'auxiliary' regression to test whether slope parameters vary with weights, which is the case here.

[28] These are listed in the notes to each results table. Some of these - such as household composition and land owned - could be choice variables. Online Appendix A.3 reports the main estimates without these control variables, the omission of which has no impact on the estimated effect of descent on outcomes.

[29] Among other variables, this also includes the average crop choices of other households in the village. In fact, a regression of household crop choices on descent and control variables similar to equation (11) shows that patrilineal and matrilineal households do not differ significantly in their crop choices, except that patrilineal households are less likely to report tobacco as their main crop - see Online Appendix A.2.

[30] The exclusion variables should not affect the wage an individual receives but should affect the probability that an individual works in the wage sector. I use the number of acres of land inherited by the husband, the number inherited by the wife, their squares, the distance to the nearest bus stop and the fare to the district's government offices (*boma*), descent, religion and geographical variables such as soil quality and rainfall, as instruments for participation in wage labor. In a regression of log wage on covariates and these exclusion variables, they are not significant. All exclusion variables significantly predict wage participation in the selection equation. The results yield an estimate of $\rho = 0.40^{**}$, suggesting the presence of selection bias. Online Appendix A.3 reports the main estimates without controlling for the predicted wage; this does not change the estimated effect of descent on labor allocation.

Table 2: The estimated effect of descent on labor supply

Husband's Labor Supply	(1) Total	(2) Agricultural	(3) Wage	(4) Agric. -Wage	(5) Agric. +Wage
Patrilineal	0.097	1.453**	-1.386*	2.840**	0.067
	(1.065)	(0.682)	(0.831)	(1.141)	(1.005)
Geographical controls	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y
Number of observations	7203	7203	7203	7203	7203
Number of community clusters	628	628	628	628	628
R^2	0.138	0.177	0.184	0.200	0.153

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are the natural log of the husband's predicted wage from a Heckman selection model, acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

The estimating equation for consumption outcomes is

$$\ln C_{i,c,d,r} = \beta_0 + \beta_1 P_{c,d,r} + \mathbf{G}'_{i,c,d,r}\boldsymbol{\beta}_2 + \mathbf{X}'_{i,c,d,r}\boldsymbol{\beta}_3 + \varepsilon_{i,c,d,r}, \tag{11}$$

where I use the logarithm of various measures of household expenditure as the dependent variable, $C_{i,c,d,r}$. The coefficient of interest is β_1, which measures the percentage difference in household expenditure between patrilineal and matrilineal households.

5 Empirical Results

5.1 Key Results

The effect of descent on husbands' labor supply is reported in Table 2. The results are consistent with the noncooperative model, and inconsistent with the fully efficient collective model. Patrilineal men spend, on average, 1.45 hours more per week on agricultural labor and 1.39 hours less per week on wage labor, which represents a 12.5% increase and 26.3% reduction relative to baseline, respectively. These differences appear to be driven by substitution between wage and agricultural labor: we cannot reject that these coefficients are the same but opposite sign. Indeed, the sum of agriultural and wage labor hours is not significantly different across descent types (column (5)).[31]

[31] Sensitivity to the inclusion of controls is reported in Table 12 in Online Appendix A.

Table 3: The estimated effect of descent on consumption

	(1) Ln(exp)	(2) Ln(pc exp)	(3) Ln(equiv exp)	(4) Ln(purchase)	(5) Ln(public)	(6) Ln(private)
Patrilineal	-0.099***	-0.100***	-0.097***	-0.132***	-0.127***	-0.089***
	(0.031)	(0.032)	(0.031)	(0.036)	(0.031)	(0.034)
Geographical controls	Y	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y	Y
Number of observations	7203	7203	7203	7203	7203	7203
Number of community clusters	628	628	628	628	628	628
R^2	0.370	0.368	0.349	0.322	0.352	0.325

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

The effect of descent on household consumption is reported in Table 3. Regression (1) estimates the effect of patriliny on the logarithm of real household expenditure, which is the variable that was summarized in Table 1. As with labor supply, there is a significant difference in the consumption levels of patrilineal and matrilineal households. Patrilineal households have 9.9% lower household expenditure than matrilineal households, and this result is statisticaly significant. This finding suggests that patrilineal households make less efficient labor supply choices, resulting in lower overall consumption.[32]

These findings are robust to using different measures of consumption: patrilineal households have significantly lower per capita consumption (column (2)) and equivalent consumption (column (3)). The difference between matrilineal and patrilineal households' consumption from purchases is 13.2%, larger than the difference for all consumption (column (4)). This is interesting because the noncooperative model predicts that matrilineal husbands engage in more wage labor, which generates cash income. The difference in purchases is consistent with this hypothesis. Patrilineal households have lower private and public expenditure (columns (5) and (6)), but particularly public expenditure, which includes items such as durables that are typically shared equally on divorce.

The significant effect of descent on labor supply allocations and household consumption is inconsistent with the fully efficient collective model, which predicts that distribution factors should not matter for the efficient allocation of household production. Instead, these results are consis-

[32] Sensitivity to control variables is reported in Table 13 in Online Appendix A.

Table 4: Measures of wages and agricultural productivity

Labor type	Return (MWK per hour)			
	Means		Medians	
	Patrilineal	Matrilineal	Patrilineal	Matrilineal
Predicted Wage, husbands	76.96	75.99	58.82	52.50
Number of observations (N)	*2472*	*4448*	*2472*	*4448*
Average Product of Agricultural Labor†	60.12	60.34	36.17	39.74
N	*2386*	*4300*	*2386*	*4300*
MASAF Wage, males††	49.05	48.83	50	50
N	*2472*	*4448*	*2472*	*4448*
Ratio: Predicted Wage / APAL	11.11	5.57	1.43	1.30
N	*2002*	*3938*	*2002*	*3938*

†of household member. ††Hourly rates are obtained by dividing the daily rate by four (tasks typically take four hours; see Goldberg 2015).

tent with the noncooperative model, suggesting that individuals invest in their outside options to increase future bargaining power. Next, I explore the difference between wages and agricultural productivity to provide a further test of productive efficiency, and conduct a placebo test among households that own no land.

5.2 The Difference between Wages and Agricultural Productivity

Recall that equation (9) predicted a wedge between the marginal agricultural product and the wage that was increasing in $(\lambda - \alpha)$, suggesting that patrilineal men should have a bigger difference between the agricultural product and wage than matrilineal men. Table 4 reports the mean and median values of husbands' predicted wages from the Heckman selection model, as well as estimates of the average agricultural product (APAL); the last row shows the ratio of the predicted wage to the average agricultural product, and both the average and median ratios are higher for patrilineal than matrilineal men.[33] There is also a non-zero wedge between matrilineal men's wages and agricultural product, suggesting inefficient labor allocations among matrilineal households as well.[34]

The collective model predicts that households in more productive regions dedicate more time to agricultural labor, and also enjoy a *higher* level of overall household consumption due to their

[33] I assume that the average agricultural product is the same for all household members. This is a simplifying assumption that ensures identification of the agricultural product, because it is not possible to identify how much of consumption from own production came from the labor of each individual household member.

[34] To calculate the agricultural product, I divide the sum of the estimated value of consumption from own production, and agricultural sales revenue in the last year, by the number of hours of own-farm agricultural labor by all household members in the last year. As labor supply information is recorded for the past week, I multiply this by 52, but this is likely to be affected by seasonality. To overcome this problem, I calculate the median agricultural hours across households in each Traditional Authority area (TA) for each month (i.e. weekly hours multiplied by 4.3), on the condition that there are at least four households observed in every month of the year in that TA. I then calculate the annual agricultural hours for each TA as the total of the median hours in each month; this is used in place of the household's weekly hours.

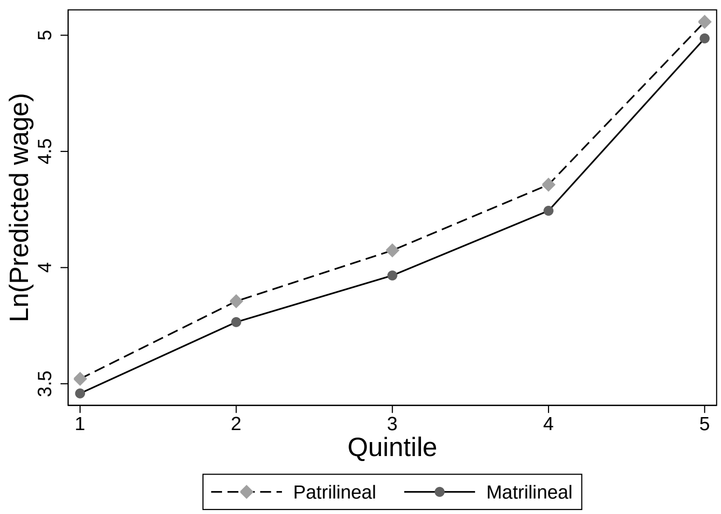

Figure 2: The average logarithm of the predicted wage of patrilineal and matrilineal husbands at each quintile.

superior productivity. Differences in agricultural productivity do not explain the key empirical results: patrilineal households have lower consumption, although they engage in more agricultural labor. Columns 3 and 4 in Table 4 show that the median agricultural product is lower in patrilineal than matrilineal households. This is in line with the finding that patrilineal households spend more time on agriculture than matrilineal households, hence lowering their agricultural productivity.[35]

Alternatively, suppose that matrilineal husbands have higher productivity in wage labor. Although the labor supply regressions control for the husband's predicted wage, we can exclude this mechanism more clearly by analyzing the predicted wage in Table 4. The estimates show that the median patrilineal wage is higher than the median matrilineal wage. Figure 2 is a plot of the natural log of husbands' wages: patrilineal husbands' average wages are higher than matrilineal husbands' average wages at every quintile. This contradicts the hypothesis that the results can be explained by higher wages of matrilineal husbands.[36] Table 4 also shows the median hourly wage for men paid by the Malawi Social Action Fund (MASAF) public works programme for comparison.[37] The MASAF wage shows that the estimates of the predicted wage are sensible: imputed wages are similar to an existing, observed wage that is a lower bound on what could be achieved in the labor market.

[35] Assuming that agricultural production exhibits diminishing marginal returns and that patrilineal and matrilineal households can be described by the same production function, then the average agricultural product can be used instead of the marginal agricultural product to compare this wedge across the two descent types. In this case the wedge will be a lower bound on the true wedge.

[36] This is also true when comparing observed wages, which are higher for patrilineal than matrilineal men.

[37] The MASAF programme offers a social safety net. It operates differently to employment guarantee schemes elsewhere, such as the National Rural Employment Guarantee of India, which sets wages above the market clearing wage.

Table 5: Consumption and labor supply in placebo group

	(1) Agricultural	(2) Wage	(3) Agric.-Wage	(4) Agric.+Wage	(5) Ln(exp)
Patrilineal	0.236	6.304	-6.068	6.540	-0.017
	(1.796)	(3.998)	(4.535)	(4.226)	(0.134)
Geographical controls	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y
Number of observations	422	422	422	422	422
Number of community clusters	191	191	191	191	191
R^2	0.419	0.497	0.509	0.456	0.637

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. These regressions exclude households who do not own any land. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are the natural log of the husband's predicted wage from a Heckman selection model (only in regressions (1) to (4)), acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

5.3 Placebo Group without Land Ownership

Next, I test whether the effects of descent are present in a placebo group with no land ownership by re-estimating the expenditure and labor supply regressions for this subsample (Table 5). The theory predicts that the estimated differences between patrilineal and matrilineal households are driven by incentives to invest in land, so that no differences should be observed between matrilineal and patrilineal households that do not own land. This is indeed the case: among households who own no land, there is no significant difference between patrilineal and matrilineal households in terms of expenditure and labor allocation. The magnitudes of the coefficients in regressions (1) and (2) are close to zero, while the coefficient in regression (3) is of the opposite sign to that observed in the baseline regressions.

5.4 Robustness Checks

5.4.1 Alternative Specifications

To check the robustness of the main results to alternative specifications, I re-estimate all labor supply equations using a Tobit model (Table 14 in Online Appendix A.4) and the effect of descent on the levels of each of the consumption categories in an OLS and Tobit model (Tables 15 and 16). The results are firmly robust to these alternative models. Next, I estimate the effect of descent on income in both an OLS regression and a Tobit model (Table 17).[38] I find that, consistent with the predictions of the noncooperative model, the income gap between patrilineal and matrilineal households is MWK 31012 ($43.30), which is approximately 36% of average income and not inconsistent with a 10% gap in consumption. I also estimate the effect of descent on husbands' wage earnings (Table 17), where I find that patrilineal husbands earn MWK 11875 ($16.40) less than matrilineal husbands, which represents a 13.7% reduction in baseline income, due to husbands' wage earnings. This is surprisingly close to the estimated 10% gap in consumption. Note that average income is far lower than average consumption, showing that income in this survey is underreported and hence less reliable than consumption in measuring household welfare.

5.4.2 Controlling for Observables and Accounting for Unobservables

The empirical results could be driven by omitted variables that are correlated with descent, consumption and labor supply. Online Appendix A.4 presents estimates of the main regression equations when controlling for additional observable variables. In particular, I consider further geographic measures such as GPS coordinates, plot-level soil quality and the exclusion of the Northern region, a measure of colonial infuence (distance to the nearest colonial railway station), ethnic group characteristics from the Ethnographic Atlas (Murdock 1967), ethnic group fixed effects proxied by language, and religion fixed effects (Tables 18-21).[39] In all these additional checks, the coefficient estimates on patriliny are unchanged from the baseline regressions.[40]

Although the results are robust to controlling for observables, there may be further unobservable factors that affect selection into descent type and economic choices that, if observed, would explain the results. To alleviate this concern, I adapt and implement the strategy proposed by Oster (2016) and Altonji, Elder and Taber (2005) to verify the robustness of the results to selection on unobservables. In particular, the method uses information from movement in estimated coefficients and movement in R^2 as controls are added to the regression to estimate the potential impact of controlling for unobservables, if they were in fact observable (see Online Appendix C for a detailed discussion). The results indicate that the coefficient estimates are robust to even the most conservative assumptions of selection on unobservables: selection on unobservables would have to be almost eleven times as strong as selection on observables to explain the effect of patriliny on wage labor hours, and almost four times as strong to explain the effect of patriliny on expenditure. Unobservables would have to be negatively correlated with observables to explain the estimated effect of patriliny on agricultural labor hours.

[38] Both income and wages are deflated by the same price index used to deflate the consumption aggregates. The construction of the income aggregate follows Hoddinott and Haddad (1995): it includes salaries, income from crop sales, profit from business and remittances from children and others.

[39] For the colonial railway stations, I use the station list on http://www.cear.mw and exclude stations built after Malawi achieved independent rule. I calculate the distance to the closest railway station for each village. The list of stations and their GPS coordinates are in Appendix E.

[40] Another alternative explanation is that more able patrilineal men migrate to matrilineal areas. However, marriages between matrilineal and patrilineal individuals appear rare - in the LSMS, village headmen were asked about the types of marriages observed in their village, where a mixed marriage was not listed as an option.

6 Alternative Mechanisms

The estimated negative effect of patriliny on consumption and wage hours, and positive effect on agricultural hours, is inconsistent with a fully efficient collective model, but consistent with an extension to the collective model in which there is limited commitment and noncooperative decision making in labor supply choices. In this Section, I show that alternative mechanisms cannot explain the main results. First, I focus on the alternative mechanisms modelled in Section 3.2 that predict a similar labor supply and output pattern to noncooperative decision making: a market failure via transaction costs in the wage labor market, and tenure insecurity and fallowing constraints. Second, I consider whether descent could be capturing rules other than land inheritance, such as marital residence, social norms about work, or political succession.

6.1 Transaction Costs in the Wage Labor Market

A potential alternative explanation for the finding that patrilineal husbands spend more time on agricultural labor and less time on wage labor is that there are transaction costs in the wage labor market, which affect patrilineal households more than matrilineal households. The presence of these transaction costs would also predict lower overall income and consumption in patrilineal households.

I test whether the availability of wage labor locally varies between patrilineal and matrilineal communities (Columns 1-3, Table 6). There is no difference in whether there is any wage employment in the village, and whether the public works program MASAF is present in the community. However, patrilineal households are 2.9 percentage points more likely to migrate looking for work, suggesting that there may be better employment opportunities elsewhere. Travelling to these locations may be costly. I compare the cost of travelling to employment opportunities between patrilineal and matrilineal households (Columns 4-10, Table 6). There is evidence that costs are higher for patrilineal households: the distance to the nearest government office (*boma*) and urban centre are significantly higher for patrilineal communities (9.1 and 35.6 kilometres respectively), and the fare is on average higher. There is no significant difference in the distance to the nearest bus stop, market, post office or telephone. This suggests that patrilineal households are further away from major amenities, but not any further away from minor amenities.

In order to assess whether these differences in labor costs can explain the labor allocation and consumption gap between patrilineal and matrilineal households, I control for the three measures of costs that are significantly different between patrilineal and matrilineal households in the main regressions: bus fare, distance to government office and distance to urban centre (regressions (1)-(3), (4)-(6) and (7)-(9) respectively, in Table 7). Some interesting patterns emerge. A higher bus fare and longer distance to a government office do predict lower wage labor, higher agricultural labor and lower expenditure, in a similar pattern to patriliny itself and consistent with the predictions of the model in Section 3.2. However, the presence of these transaction costs cannot explain the impact of patriliny on labor allocation and expenditure.

Further, the magnitude of the effect of these costs is smaller than the effect of patriliny. For example, Table 6 shows that the average difference in fare between patrilineal and matrilineal households is MWK 90.7. Multiplying this by the coefficients on bus fare in Table 7 predicts that patrilineal husbands spend 11 more minutes on agricultural work and 5.5 fewer minutes on wage work per week on average due to the difference in bus fare. The predicted gap in consumption is 0.9%. To the extent that these measures of wage labor transaction costs accurately capture the costs faced by these households - which seems likely given their significant impact on labor allocation that is consistent with theory - the evidence suggests that while patrilineal households do face higher wage labor market transaction costs, the magnitude of the estimated effect is much smaller than the estimated effect of patriliny, which is robust to controlling for these measures of labor market transaction costs.

6.2 Tenure Insecurity, Fallowing and Dynamic Investment Incentives

An alternative explanation for the findings in Section 5 is that patrilineal households face tenure insecurity, which forces them to overinvest in their agricultural land in order to retain rights over its use (as in, for example, Udry and Goldstein 2008). This tenure insecurity could plausibly lower their profit and therefore overall expenditure. Similarly, if fallowing is optimal but patrilineal households face constraints to fallowing, then they may engage in more agricultural labor and generate less output. There is no evidence of differences in tenure insecurity and fallowing between patrilineal and matrilineal households (Table 8). In particular, there is no estimated difference in the share of land that is insecure (defined as not inherited or not purchased with a title), the share of land that was left fallow in the last agricultural season, and no difference in behavior that could plausibly affect tenure security, such as the application of fertilizer, and planting with permanent crops.

Matrilineal households could have higher discount factors than patrilineal households, and so spend more today at the expense of saving for tomorrow, while allocating their time towards more immediate income-earning work, such as wage work. Column (6) in Table 8 shows that patrilineal households own significantly fewer livestock, a plausible measure of savings. Matrilineal household heads are also 8% more likely to say they are able to use their income to build their savings, and this difference is statistically significant at the 1% level. Thus, differences in discount factors are unlikely to explain the results.

Table 6: Measures of wage labor transaction costs

	(1) Migrate for work	(2) Any wage empl.	(3) MASAF program	(4) Fare to *boma*	(5) Dist. to *Boma*
Patrilineal	0.029*	0.050	0.007	90.739**	9.146***
	(0.017)	(0.067)	(0.051)	(41.823)	(3.420)
Number of observations	7180	7203	7203	7190	7191
Number of community clusters	628	628	628	628	628
R^2	0.210	0.214	0.222	0.361	0.418
	(6)	(7)	(8)	(9)	(10)
Distance to:	Daily market	Post office	Urban centre	Phone	Bus stop
Patrilineal	-1.351	1.461	35.557***	-1.349	1.567
	(1.018)	(1.782)	(12.961)	(1.489)	(1.532)
Number of observations	7191	7203	7190	7181	7203
Number of community clusters	628	628	628	628	628
R^2	0.246	0.161	0.450	0.223	0.193
Geographical controls	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variable Patrilineal in regressions where the dependent variables are whether it is typical for individuals to migrate for work in the community (column 1), whether any type of wage employment is listed as one of the main sources of employment for the community (column 2), whether a MASAF public works program operates in the community (column 3), the bus fare to the nearest government office (column 4) and distances to various amenities (columns 5 to 10). The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are the acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities (not for column 2), and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

Table 7: Controlling for wage labor transaction costs in the main estimates

	Agricultural	Wage	Ln(exp)
	(1)	(2)	(3)
Patrilineal	1.291*	-1.305	-0.093***
	(0.682)	(0.825)	(0.031)
Fare to *boma*	0.002**	-0.001*	-0.0001**
	(0.001)	(0.001)	(0.000)
Number of observations	7190	7190	7190
Number of community clusters	628	628	628
R^2	0.179	0.184	0.371
	(4)	(5)	(6)
Patrilineal	1.230*	-1.290	-0.094***
	(0.674)	(0.825)	(0.031)
Distance to *boma*	0.024***	-0.010	-0.001*
	(0.007)	(0.007)	(0.000)
Number of observations	7191	7191	7191
Number of community clusters	628	628	628
R^2	0.178	0.184	0.371
	(7)	(8)	(9)
Patrilineal	1.460**	-1.407*	-0.095***
	(0.689)	(0.849)	(0.032)
Distance to urban centre	-0.0002	0.0002	-0.0001
	(0.004)	(0.002)	(0.0001)
Number of observations	7190	7190	7190
Number of community clusters	628	628	628
R^2	0.177	0.184	0.371
Geographical controls	Y	Y	Y
Individual controls	Y	Y	Y
Community controls	Y	Y	Y

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variables Patrilineal, bus fare to the nearest government centre (boma), distance (km) to the nearest government centre (boma) and distance (km) to the nearest urban centre in regressions where the dependent variables are weekly hours of agricultural work (column 1), weekly hours of wage work (column 2) and log of household expenditure (column 3). The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are the natural log of the husband's predicted wage form a Heckman selection model (in columns 1 and 2 only), acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

Table 8: The estimated relationship between patriliny and measures of tenure insecurity and savings

	Share of land that is:					
	(1)	(2)	(3)	(4)	(5)	(6)
	Insecure	Fallow	w/ fertilizer	w/ perm. crops	# perm. crops/acre	# Livestock
Patrilineal	-0.019	-0.002	0.021	-0.002	4.465	-0.566*
	(0.018)	(0.007)	(0.014)	(0.011)	(4.093)	(0.334)
Geographical controls	Y	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y	Y
Number of observations	6781	6781	6781	6781	6781	7203
Number of community clusters	628	628	628	628	628	628
R^2	0.089	0.050	0.054	0.348	0.035	0.169

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variables Patrilineal in regressions where the dependent variables are the share of land that is not inherited or not owned with title (column 1), the share of land that was left fallow in the last rainy season (column 2), the share of land treated with some form of fertilizer (column 3), the share of land planted with trees or other permanent crops (column 4), total number of trees or permanent crops divided by land size (column 5) and number of livestock (column 6). The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are the acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

6.3 Rules of Descent

In this Section, I consider whether descent could be capturing rules other than land inheritance: marital residence, social norms or political succession.

6.3.1 Marital Residence

Kinship groups in Malawi have distinct patterns of marital residence, which are correlated with descent. In particular, patrilineal households tend to be patrilocal (where the wife moves to the husband's village after marriage), while matrilineal households tend to be matrilocal (where the husband moves to the wife's village). While acknowledging that marital residence is a choice, and hence endogenous to labor and expenditure outcomes, I explore the role of marital residence by controlling for whether a household is patrilocal or not in the main regressions (Table 9). Interestingly, patrilocality has a similar impact on men's labor allocation to patriliny, although the estimated effect is smaller. However, there is no correlation with total expenditure - suggesting that patrilocal households do not face additional constraints that would make them less efficient, as compared to matrilocal or neolocal households. The estimated effect of patriliny on expenditure and labor allocation is unchanged in these regressions.

6.3.2 Succession to Political Office

Adams (1999) argues that in addition to determining property inheritance, descent also determines succession to political office. To consider this mechanism, I exclude any household with a village headman and estimate the effect of descent on consumption and agricultural and work hours. The coefficients on patriliny in regressions (4)-(6) in Table 9 are similar to those estimated in the baseline regressions. To consider government roles more widely, I exclude all households with a member who works for the government (regressions (1)-(3) in Table 22, Online Appendix A.5), resulting in no significant change to the magnitudes of the main coefficients.

6.3.3 Social Norms

There may be social norms that have evolved so that patrilineal men are expected to specialize in agriculture. The strength of these social norms is likely to be increasing in the share of patrilineal households in the community. An indicative way of testing this hypothesis is to compare patrilineal households with households in mixed villages that are both patrilineal and matrilineal. Households in mixed villages should behave like an attenuated version of patrilineal households - with weaker enforcement of the social norm. Regressions (4)-(6) in Table 22, Online Appendix A.5, display the main results from Table 2 and also the coefficient on the dummy variable for households in mixed villages, which is a control variable in all regressions. Households in mixed villages do not appear to be significantly different from patrilineal households in terms of wage labor hours, but engage in significantly lower agricultural hours ($p < 0.05$). This pattern is not consistent with the idea that patrilineal villages are a version of mixed villages with more enforced social norms.

Table 9: Controlling for marital residence and accounting for succession to political office

				HHs without village headman		
	(1) Agric.	(2) Wage	(3) Ln(exp)	(4) Agric.	(5) Wage	(6) Ln(exp)
Patrilineal	1.463**	-1.396*	-0.099***	1.484**	-1.387*	-0.098***
	(0.678)	(0.830)	(0.031)	(0.685)	(0.827)	(0.031)
Patrilocal	0.776*	-0.794**	0.009			
	(0.463)	(0.403)	(0.020)			
Geographical controls	Y	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y	Y
Number of observations	7203	7203	7203	7178	7178	7178
Number of community clusters	628	628	628	628	628	628
R^2	0.178	0.184	0.370	0.178	0.186	0.371

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variables Patrilineal and Patrilocal (defined as the husband living in his birth village and the wife reporting that she moved to this village for marriage), in regressions where the dependent variables are weekly hours of agricultural work (column 1), weekly hours of wage work (column 2) and log of household expenditure (column 3). Columns (4)-(6) do not include households that report have a village headman in the family. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are the natural log of the husband's predicted wage from a Heckman selection model (only in regressions (1), (2), (4) and (5)), acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

7 Conclusion

In this paper, I propose and implement a new test of production efficiency in the household, that also tests whether inefficiency is driven by limited commitment. I extend the collective model to allow a noncooperative first stage, which results from limited commitment in labor allocation. Labor supply affects future bargaining power because it determines the value of future outside options. The model predicts that individuals spend more time on the type of labor that most improves their outside option. This results in lower overall consumption available for sharing in the second period.

I test for production efficiency in the household by exploiting predetermined variation in descent in Malawi, which governs land rights. I find that patrilineal men spend more time on agricultural labor, less time on wage labor and generate less consumption overall, compared to matrilineal men. The outside options of patrilineal men are increasing in the value of their land, so this finding is consistent with the limited commitment collective model, where individuals invest in their outside options to raise future bargaining power. The empirical results are robust to a wide variety of checks, and are not explained by alternative mechanisms such as wage labor transaction costs, dynamic investment choices or tenure insecurity.

The results in this paper suggest that there may be inefficiencies in how resources are allocated across time within households. This relates to the literature on limited commitment and dynamic models of the household, with growing evidence that efficiency is more difficult to achieve in dynamic than static settings (Chiappori and Mazzocco 2017, Mazzocco 2007, Robinson 2012, Dubois and Ligon 2011).

This paper rejects production efficiency in the context of the collective model, and so is coherent with similar results in other papers, mostly in developing countries. As consumption efficiency is often not rejected in the literature, this suggests that there may be more serious constraints to achieving production efficiency, and that these two measures of efficiency should be considered separately, as in Rangel and Thomas (2012). More generally, the findings demonstrate that the size of the household 'pie' may not be invariant to spouses' outside options, and noncooperative decisions can have a negative impact on household welfare.

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Appendix for Online Publication
Noncooperative Decision Making in the Household: Evidence from Malawi
Selma Walther

A Additional results tables

A.1 Control of crop sales

Table 10: Control of plots and crop sales by spouses

	(1)	(2)	(3)	(4)
	# Plots controlled by:		Value of crop sales controlled by:	
	Woman	Man	Woman	Man
Patrilineal	-0.006	0.059***	-142.717**	2299.801*
	(0.010)	(0.022)	(67.030)	(1187.322)
Geographical controls	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y
Community controls	Y	Y	Y	Y
Number of observations	7203	7203	7203	7203
Number of community clusters	628	628	628	628
R^2	0.034	0.091	0.021	0.056

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variable Patrilineal in regressions where the dependent variables are the number of plots controlled only by the wife or by the husband (columns 1 and 2 respectively) and the total value of crop sales controlled only by the wife or husband (columns 3 and 4 respectively). The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Appendix D. The individual controls are the acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

A.2 Crop choices

Table 11: The estimated effect of descent on main crop choice

	(1)	(2)	(3)	(4)	(5)
			Main crop is:		
	Maize	Tobacco	Groundnut	Rice	Other
Patrilineal	-0.010	-0.027***	-0.011	0.008	0.009
	(0.011)	(0.010)	(0.015)	(0.005)	(0.028)
Geographical controls	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y
Number of observations	7203	7203	7203	7203	7203
Number of community clusters	628	628	628	628	628
R^2	0.186	0.372	0.219	0.372	0.225

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variable Patrilineal in regressions where the dependent variables are indicator variables for whether maize, tobacco, groundnut, rice, or another crop are the household's main crop, defined as covering the largest planted area of all crops that the household grows. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Appendix D. The individual controls are the acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

A.3 Sensitivity to controls

Table 12: Sensitivity to controls: Labor supply

Estimated coefficient on Patrilineal	(1)	(2)	(3)
1. Agricultural	0.937	1.449**	1.453**
	(0.620)	(0.698)	(0.682)
2. Wage	-1.594***	-1.400*	-1.386*
	(0.572)	(0.829)	(0.831)
3. Wage - Agric.	2.532***	2.849**	2.840**
	(0.927)	(1.147)	(1.141)
4. Wage + Agric.	-0.657	0.049	0.067
	(0.749)	(1.016)	(1.005)
Basic controls	Y	Y	Y
Geographical controls	N	Y	Y
Community controls	N	Y	Y
Household controls	N	N	Y
Predicted wage	Y	Y	N
Number of observations	7203	7203	7203
Number of community clusters	628	628	628

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variable Patrilineal in regressions where the dependent variables are husbands' agricultural labour (row 1), wage labour (row 2), the difference between wage and agricultural labour (row 3) and the sum of wage and agricultural labour (row 4). The basic controls are the household head's age, age squared, education level, log predicted wage from the Heckman model, and dummy variables for the interview month and year. Column (2) adds a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, the district-level divorce rate, the distance to the nearest road and the proportion of households that farm maize, tobacco, groundnut, rice and mango, and geographical controls, including temperature, rainfall, greenness and soil quality, which are listed in Appendix D, as well as dummy variables for the Southern and Central regions. Column (3) drops the predicted wage, and adds household composition, amount of land owned, and the gender of the household head.

Table 13: Sensitivity to controls: Consumption

	(1)	(2)
	Ln (real expenditure)	
Patrilineal	-0.141***	-0.095***
	(0.033)	(0.033)
Basic controls	Y	Y
Geographical controls	N	Y
Community controls	N	Y
Household controls	N	N
Number of observations	7203	7203
Number of community clusters	628	628
R^2	0.145	0.274

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. The basic controls are the household head's age, age squared, education level, and dummy variables for the interview month and year. Column (2) adds a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, the district-level divorce rate, the distance to the nearest road and the proportion of households that farm maize, tobacco, groundnut, rice and mango, and geographical controls, including temperature, rainfall, greenness and soil quality, which are listed in Appendix D, as well as dummy variables for the Southern and Central regions.

A.4 Robustness checks

Table 14: Tobit model of labor supply

	(1) Total	(2) Agricultural	(3) Wage	(4) Agric. - Wage	(5) Agric. + Wage
Patrilineal	-0.054	1.529***	-0.489	1.826**	-0.077
	(0.967)	(0.526)	(0.477)	(0.734)	(0.897)
Geographical controls	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y
Number of observations	7203	7203	7203	7203	7203
Number of community clusters	628	628	628	628	628

This table reports the marginal effects at means from a Tobit model. Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Appendix D. The individual controls are the natural log of the husband's predicted wage from a Heckman selection model, acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

Table 15: Consumption in levels (OLS)

	(1) Exp.	(2) Pc exp.	(3) Equiv. exp.	(4) Purchases	(5) Public exp.	(6) Private exp.
Patrilineal	-24.653***	-4.669**	-4.921**	-26.909***	-9.777***	-14.875**
	(9.326)	(1.893)	(2.110)	(8.881)	(3.635)	(6.530)
Geographical controls	Y	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y	Y
Number of community clusters	628	628	628	628	628	628
Number of observations	7203	7203	7203	7203	7203	7203
R^2	0.318	0.310	0.304	0.286	0.239	0.296

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. The dependent variables are measured in local currency ('000s Malawi Kwacha). The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Appendix D. The individual controls are the acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

Table 16: Consumption in levels (Tobit)

	(1) Exp.	(2) Pc exp.	(3) Equiv. exp.	(4) Purchases	(5) Public exp.	(6) Private exp.
Patrilineal	-22.703***	-4.361**	-4.632**	-22.985***	-7.734***	-13.849**
	(8.439)	(1.752)	(1.970)	(7.356)	(2.780)	(6.042)
Geographical controls	Y	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y	Y
Number of community clusters	628	628	628	628	628	628
Number of observations	7203	7203	7203	7203	7203	7203

This table reports marginal effects at means from a Tobit model. Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. The dependent variables are measured in local currency ('000s Malawi Kwacha). The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Appendix D. The individual controls are the acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

Table 17: Income and husband's earnings in levels

	OLS		Tobit model	
	(1) Income	(2) Husband's earnings	(3) Income	(4) Husband's earnings
Patrilineal	-31.012**	-11.875***	-18.325**	-4.204*
	(12.648)	(4.038)	(7.598)	(2.394)
Geographical controls	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y
Community controls	Y	Y	Y	Y
Number of community clusters	628	628	628	628
Number of observations	7203	7203	7203	7203
R^2	0.146	0.341	N/A	N/A

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. The dependent variables are measured in local currency ('000s Malawi Kwacha). Regressions (1) and (2) estimate Ordinary Least Squares, while regressions (3) and (4) report the marginal effects at means of a Tobit model. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Appendix D. The individual controls are the acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

Table 18: Controlling for observables in labor supply regressions

Estimated coefficient on Patrilineal	(1)	(2)	(3)	(4)	(5)
1. Agricultural	1.560**	1.183*	1.457**	1.473**	1.457**
	(0.701)	(0.706)	(0.692)	(0.679)	(0.687)
2. Wage	-1.529*	-1.179	-1.535*	-1.394*	-1.342
	(0.874)	(0.814)	(0.883)	(0.830)	(0.839)
3. Wage - Agric.	3.089***	2.362**	2.992**	2.867**	2.799**
	(1.195)	(1.160)	(1.201)	(1.136)	(1.153)
4. Wage + Agric.	0.030	0.004	-0.077	0.079	0.115
	(1.040)	(0.988)	(1.037)	(1.005)	(1.011)
Geographical controls	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y
GPS	Y	N	N	N	N
Plot quality	N	Y	N	N	N
Railway distance	N	N	N	Y	N
Tribes	N	N	N	N	Y
Number of observations	7203	6781	5882	7203	7203
Number of community clusters	628	624	518	579	628

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variable Patrilineal in regressions where the dependent variables are husbands' agricultural labour (row 1), wage labour (row 2), the difference between wage and agricultural labour (row 3) and the sum of wage and agricultural labour (row 4). Compared to the baseline regressions in Table 2, regression (1) adds GPS co-ordinates, (2) adds plot quality, plot erosion and plot slope, (3) restricts the sample to the Southern and Central regions, (4) adds distance to nearest colonial railway station, and (5) adds language dummy variables. (2) has a reduced sample size due to missing plot quality or colonial information for some households. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are the natural log of the husband's predicted wage form a Heckman selection model, acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

Table 19: Controlling for observables in the consumption regression

	(1)	(2)	(3)	(4)	(5)
			Ln(expenditure)		
Patrilineal	-0.098***	-0.092***	-0.088***	-0.100***	-0.094***
	(0.032)	(0.030)	(0.033)	(0.031)	(0.031)
Geographical controls	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y
GPS	Y	N	N	N	N
Plot quality	N	Y	N	N	N
Railway distance	N	N	N	Y	N
Tribes	N	N	N	N	Y
Number of observations	7203	6781	5882	7203	7203
Number of community clusters	628	624	518	579	628
R^2	0.374	0.368	0.366	0.371	0.373

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. Compared to the baseline regression (1) in Table 3, regression (1) adds GPS co-ordinates, (2) adds plot quality, plot erosion and plot slope, (3) restricts the sample to the Southern and Central regions, (4) adds distance to nearest colonial railway station, and (5) adds language dummy variables. (2) has a reduced sample size due to missing plot quality or colonial information for some households. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are the acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

Table 20: Controlling for observables: Labor supply

Estimated coefficient on Patrilineal	(1)	(2)	(3)	(4)
1. Agricultural	1.176*	1.796**	1.726**	1.724**
	(0.707)	(0.780)	(0.762)	(0.676)
2. Wage	-1.072	-1.386*	-1.374*	-1.453*
	(0.808)	(0.831)	(0.832)	(0.822)
3. Wage - Agric.	2.248*	3.182**	3.100**	3.177***
	(1.159)	(1.242)	(1.225)	(1.119)
4. Wage + Agric.	0.104	0.410	0.353	0.271
	(0.981)	(1.026)	(1.022)	(1.007)
Geographical controls	Y	Y	Y	Y
Community controls	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y
Number of community clusters	624	607	607	628
Number of observations	6781	5946	5946	7203

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variable Patrilineal in regressions where the dependent variables are husbands' agricultural labour (row 1), wage labour (row 2), the difference between wage and agricultural labour (row 3) and the sum of wage and agricultural labour (row 4). Regression (1) repeats the estimation equations in Appendix D for the subsample with information on plot quality. Using dummy variables, regression (2) controls for the major crop type (v29) and predominant form of animal husbandry (v40) from the Murdoch atlas. Regression (3) controls for the class structure (v66) and marital structure (v9) from the Murdoch atlas. Regression (4) controls for the predominant religion practised in the village. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Table 23. The individual controls are the log of the husband's predicted wage from a Heckman selection model, acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

Table 21: Controlling for observables: Consumption

	(1)	(2)	(3)	(4)
	Ln (real expenditure)			
Patrilineal	-0.081***	-0.089***	-0.090***	-0.107***
	(0.030)	(0.034)	(0.034)	(0.032)
Geographical controls	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y
Community controls	Y	Y	Y	Y
Number of community clusters	624	607	607	628
Number of observations	6781	5946	5946	7203
R^2	0.364	0.355	0.355	0.372

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. Regression (1) repeats the estimation equation (1) in Table 3 for the subsample with information on plot quality. Using dummy variables, regression (2) controls for the major crop type (v29) and predominant form of animal husbandry (v40) from the Murdoch atlas. Regression (3) controls for the class structure (v66) and marital structure (v9) from the Murdoch atlas. Regression (4) controls for the predominant religion practised in the village. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Appendix D. The individual controls are the acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

A.5 Alternative mechanisms

Table 22: Controlling for succession to political office

	HHs without government workers					
	(1)	(2)	(3)	(4)	(5)	(6)
	Agric.	Wage	Ln(exp)	Agric.	Wage	Ln(exp)
Patrilineal	1.451**	-1.317	-0.100***	1.453**	-1.386*	-0.099***
	(0.683)	(0.814)	(0.032)	(0.682)	(0.831)	(0.031)
Mixed lineage				-1.056	-1.225	-0.027
				(0.901)	(1.226)	(0.072)
Geographical controls	Y	Y	Y	Y	Y	Y
Individual controls	Y	Y	Y	Y	Y	Y
Community controls	Y	Y	Y	Y	Y	Y
Number of observations	7136	7136	7136	7203	7203	7203
Number of community clusters	628	628	628	628	628	628
R^2	0.177	0.185	0.367	0.177	0.184	0.370

Standard errors are clustered by community and reported in parentheses. *** denotes significance at 1% level, ** at 5% level and * at 10% level. This table reports the value of the coefficient on the variables Patrilineal and Mixed lineage (villages that have both patrilineal and matrilineal households), in regressions where the dependent variables are weekly hours of agricultural work (column 1), weekly hours of wage work (column 2) and log of household expenditure (column 3). Columns (4)-(6) do not include households that report have any government workers in the family. The geographical controls are temperature, rainfall, greenness and soil quality, which are listed in Online Appendix D. The individual controls are the natural log of the husband's predicted wage from a Heckman selection model (only in regressions (1), (2), (4) and (5)), acres of land farmed, the head's age, age squared, education level and gender, the number of male children, female children, male adults, female adults, male elderly and female elderly in the household, dummy variables measuring the month and year of the interview, and the household's distance to the nearest road. The community controls are a dummy variable for the existence of a women's group, the presence of immigrants, the presence of wage or business labour opportunities, and the proportion of households that farm maize, tobacco, groundnut, rice and mango. All regressions also include dummy variables for the Southern and Central regions and the district-level divorce rate.

B Dynamic investment incentives

Let us assume two periods, where household member i has lifetime utility $U(x_0^i, x_1^i)$: for example, $U(x_0^i, x_1^i) = u(x_0^i) + \beta u(x_1^i)$, where x_t^i is $i's$ consumption in period t.

With access to financial markets with an interest rate of r, we solve a standard (collective) intertemporal consumption problem, maximizing utility subject to a lifetime budget constraint where bargaining power does not change over time:

$$\max \mu(z) U^a(x_0^a, x_1^a) + U^b(x_0^b, x_1^b)$$

subject to

$$\sum_t \frac{1}{(1+r)^t} \left(p_t \cdot \sum x_t^i \right) \leq \sum_t \frac{1}{(1+r)^t} \left(w_t \cdot n_t + q_t A_t F(h_t) \right),$$

$$h_t^i + n_t^i = 1, \forall i, t.$$

To model the feedback between agricultural labor today and productivity tomorrow, assume that

$$A_1 = A_0 + \kappa \cdot h_0. \tag{12}$$

In this case, period 0 labor h_0 plays a dual role: it is productive at date 0, and is also an investment in future productivity. The strength of this effect on productivity is captured by κ. As complete markets apply, the household firm maximizes the present value of profits:

$$\max_{h_0, h_1} \Pi = \sum_t \frac{1}{(1+r)^t} \left(q_t A_t F(h_t) - w_t \cdot h_t \right)$$

subject to (12). The first-order conditions are

$$q_0 A_0 \frac{dF(h_0)}{dh_0} + \kappa \frac{1}{1+r} q_1 F(h_1) = w_0, \tag{13}$$

$$q_1 A_1 \frac{dF(h_1)}{dh_1} = w_1.$$

Therefore, the effective household shadow price of wage labor early in life is

$$\hat{w}_0 = w_0 - \kappa \frac{1}{1+r} q_1 F(h_1) < w_0.$$

Households with high κ will supply more agricultural labor in early life and less wage labor. As a high κ raises the (maximized) present value of the firm's profits, then these households will also have higher lifetime income.

Imperfect financial markets

The above example is solved with the existence of financial markets that allow consumption smoothing over the lifecycle. Let us now sketch the case without financial markets, where agricultural labor in the first period, h_0, raises future productivity, A_1. The incentive to invest in land early on clearly remains, but now this could come at the cost of reduced early consumption if the household cannot borrow to smooth consumption over the lifecycle. However, overall, the option to increase future productivity via agricultural labor must increase the household's (discounted) lifetime income, and therefore its (discounted) lifetime consumption. Thus, average consumption over the lifecycle is still higher, even if it cannot be smoothed. When analyzing the consumption of a cross-section of young and old households, empirically, this model does not predict lower *average* consumption in the sample, unless the sample contains more young than old households. In particular, in order to generate the same predictions as the noncooperative model, the patrilineal sample would need to be on average younger than the matrilineal sample. However, the main findings are estimated on a cross-section of households of all ages. The average age of the household head in the sample is not significantly diferent between patrilineal and matrilineal households, and the standard deviation is also similar. This means that any differences between early life and late life consumption driven by dynamic investment choices should be balanced in the sample, yielding no effect on average consumption (contrary to the main findings).

C Robustness to selection on unobservables

I adapt and implement the strategy proposed by Oster (2016) and Altonji, Elder and Taber (2005) to verify the robustness of the results to selection on unobservables. The method proceeds in three steps:

1. Record the impact of controlling for observable variables on the coefficient of interest. I use the coefficients in Tables 2 and 3. Also required is a regression with a sparse set of individual controls that are hypothesised not to be related to unobservables; I estimate regressions with dummy variables for patriliny, mixed community, the age, age squared and education level of the household head.

2. Quantify selection on unobservables. In the simple case with dependent variable y, one observable control multiplied by its true coefficient X and a linear combination of unobservable controls multiplied by their true coefficients captured by vector Z, we write

$$\delta = \frac{Cov(y, Z)}{Var(Z)} / \frac{Cov(y, X)}{Var(X)}.$$

   Intuitively, the bias introduced by omitting unobservables is δ times the bias introduced by omitting observables; the former is measured in step 1. In practice, I implement Oster's general estimator for multiple observable controls (see Oster 2016). To quantify selection, I find the coefficient of proportionality δ that would produce a coefficient of zero on patriliny.

3. Construct set estimates for the coefficient of interest that are robust to selection: assuming that the R^2 in a regression with all unobservables could be at most $R_{\max}$, the coefficient is

bounded on one side by the estimate with observable controls, and on the other side by a bias-adjusted effect that assumes $\delta = 1$.

I carry out these steps for the regressions on log household expenditure and husband's labor supply.[41] Figures 3, 4 and 5 plot the set estimates of the coefficient on patriliny for the regressions on husband's agricultural hours, husband's wage hours, and log household expenditure, respectively, as a function of $R_{\max}$. Oster (2016) argues that assuming $R_{\max} < 1$ is usually justified, e.g. due to measurement error, and suggests that as a rule of thumb, $R_{\max} = 1.3 * R^2_{full}$, where R^2_{full} is the achieved R^2 in the regression with observable controls (as in Tables 2 and 3).

The results indicate that the coefficient estimates are robust. Figure 3 shows that, for the effect of patriliny on agricultural hours, the identified coefficient set moves away from zero as $R_{\max}$ increases. This is because the addition of controls moves the coefficient on patriliny away from zero, as seen in Table 12. The identified coefficient set at $R_{\max} = 1.3 * R^2_{full}$ is $[1.453, 1.790]$, or an increase of $12.5 - 15.4\%$ compared to baseline. The identified set for the coefficient on patriliny in the wage regression does not include zero until $R_{\max}$ exceeds 0.85, and the estimated bounds on patriliny in the wage regression with $R_{\max} = 1.3 * R^2_{full}$ are $[-1.385, -1.270]$, implying a reduction of $24.1 - 26.5\%$ in the wage hours of patrilineal husbands. The set estimate of the coefficient on expenditure in Figure 5 does not contain zero until $R_{\max}$ exceeds 0.85. For $R_{\max} = 1.3 * R^2_{full}$, the estimated bounds on patriliny are $[-0.099, -0.0764]$, implying a consumption wedge of between 7.6% and 9.9%. Thus, in both the expenditure and wage regressions, the required $R_{\max}$ for the identified set to include zero is greater than the recommended $1.3 * R^2_{full}$. Similar fan charts for the regressions on Agriculture - Wage hours and Agriculture + Wage hours are shown in Figures 6 and 7.

Turning to the coefficient of proportionality, a value of $\delta > 1$ implies a robust result: especially in survey data, where questions and control variables are not chosen at random, unobservable variables are unlikely to carry more explanatory power than observables (Altonji et al. 2005). Note that a negative value of δ implies that controlling for observables increases the value of the coefficient of interest away from zero, so that unobservables would have to be related to the variable of interest in the opposite direction to observables. This is the case here for all outcomes except expenditure and wage hours.

Figure 8 plots the value of δ, the coefficient of proportionality, for different values of $R_{\max}$, for those regressions where δ is positive. The figure shows that δ exceeds one for both coefficients for most values of $R_{\max}$. Taking as a benchmark the values of $R_{\max} = 1.3 * R^2_{full}$, the estimated coefficient of proportionality is 10.81 for the wage regression and 3.94 for the expenditure regression. Note that this is for a model that already controls for a rich set of observable measures of geography, so that selection on unobservables would have to be almost *eleven times as strong* as selection on observables such as soil quality, rainfall, plot erosion and temperature to explain the effect of patriliny on wage labor hours, and almost *four times as strong* to explain the effect of patriliny on

[41] I adapt Oster's code to survey data. The adapted Stata code and instructions can be found at http://selmawalther.weebly.com.

expenditure.

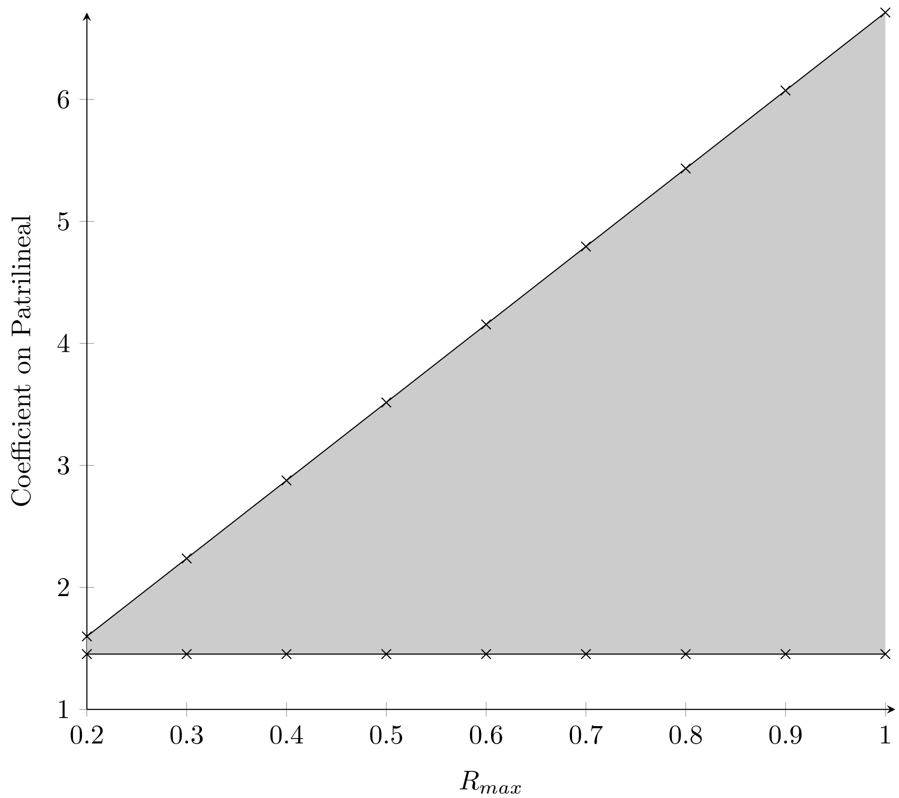

Figure 3: Estimated bounds on the coefficient on patriliny in a regression of husband's agricultural labor supply on controls.

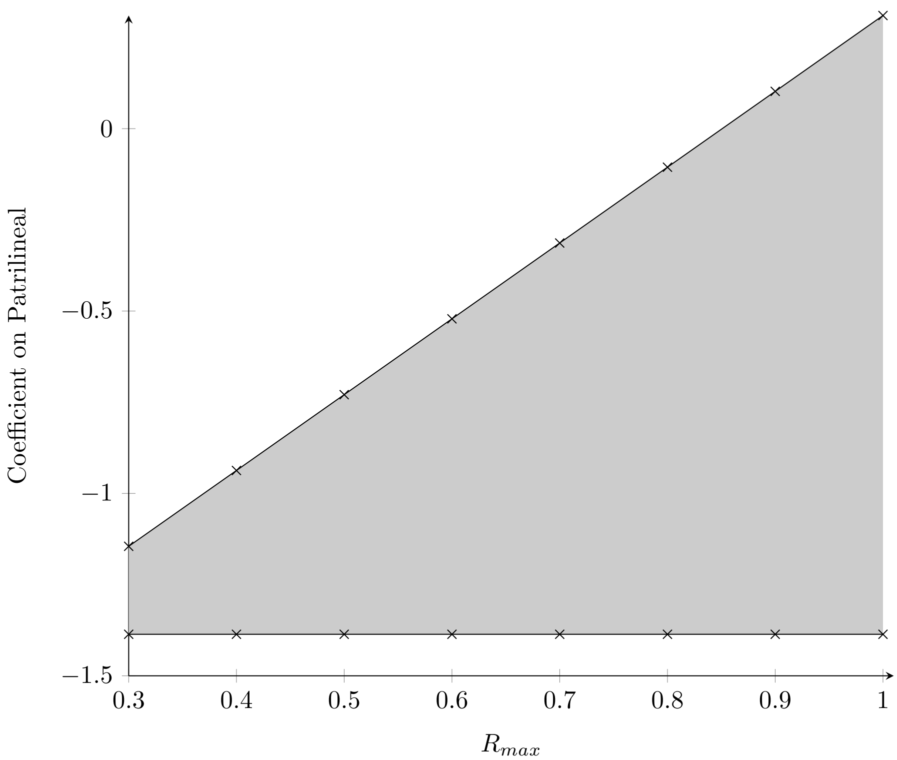

Figure 4: Estimated bounds on the coefficient on patriliny in a regression of husband's wage labor hours on controls.

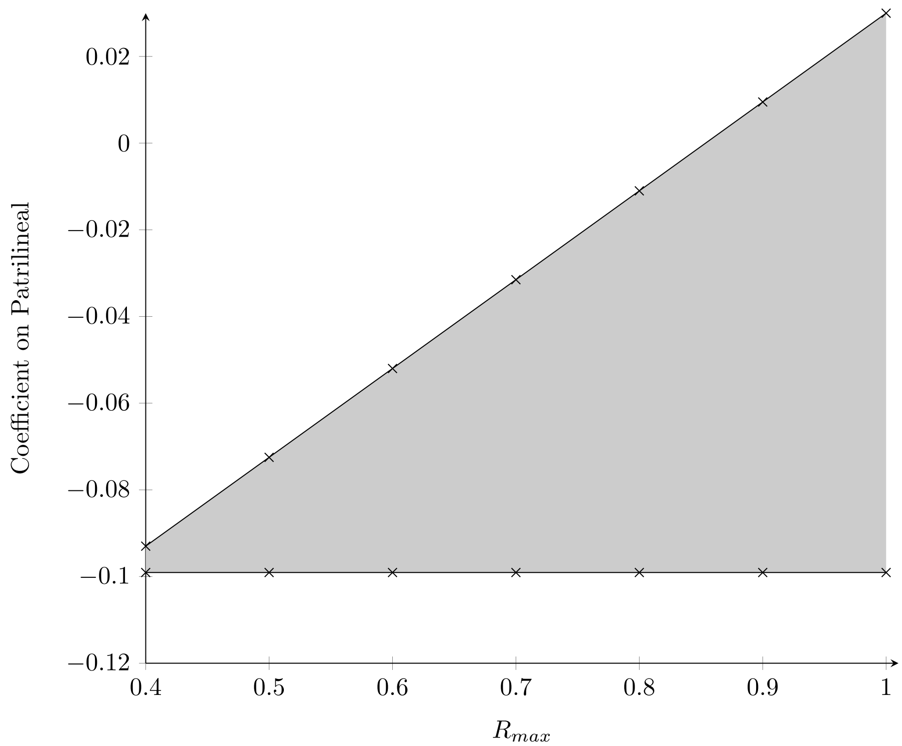

Figure 5: Estimated bounds on the coefficient on patriliny in a regression of log of household expenditure on controls.

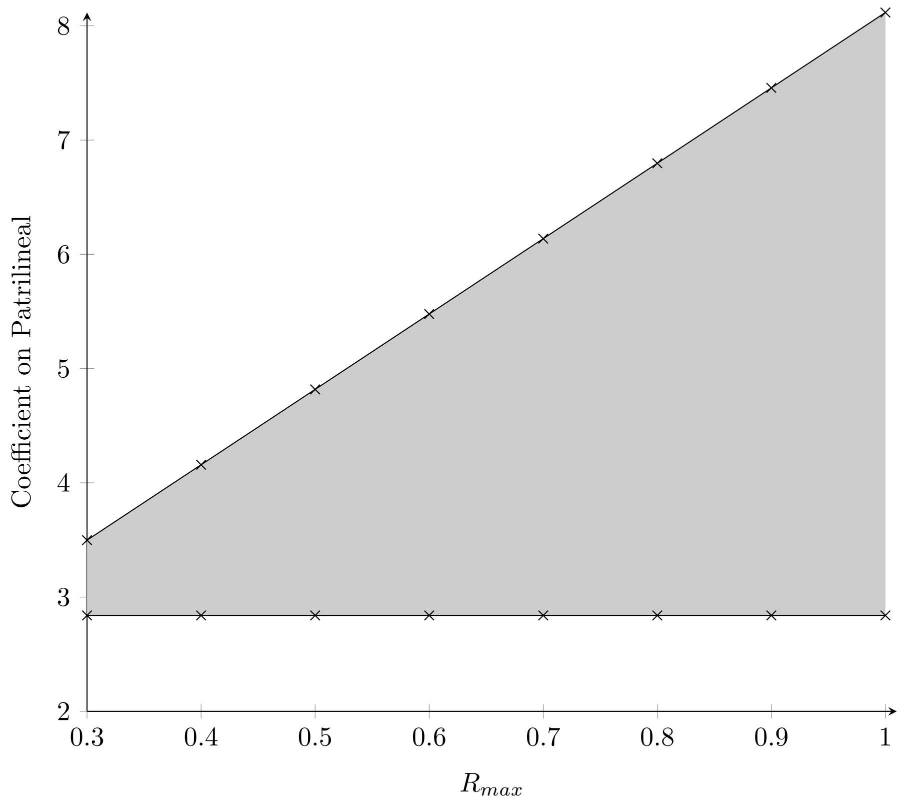

Figure 6: Estimated bounds on the coefficient on patriliny in a regression of husband's agricultural - wage labor hours on controls.

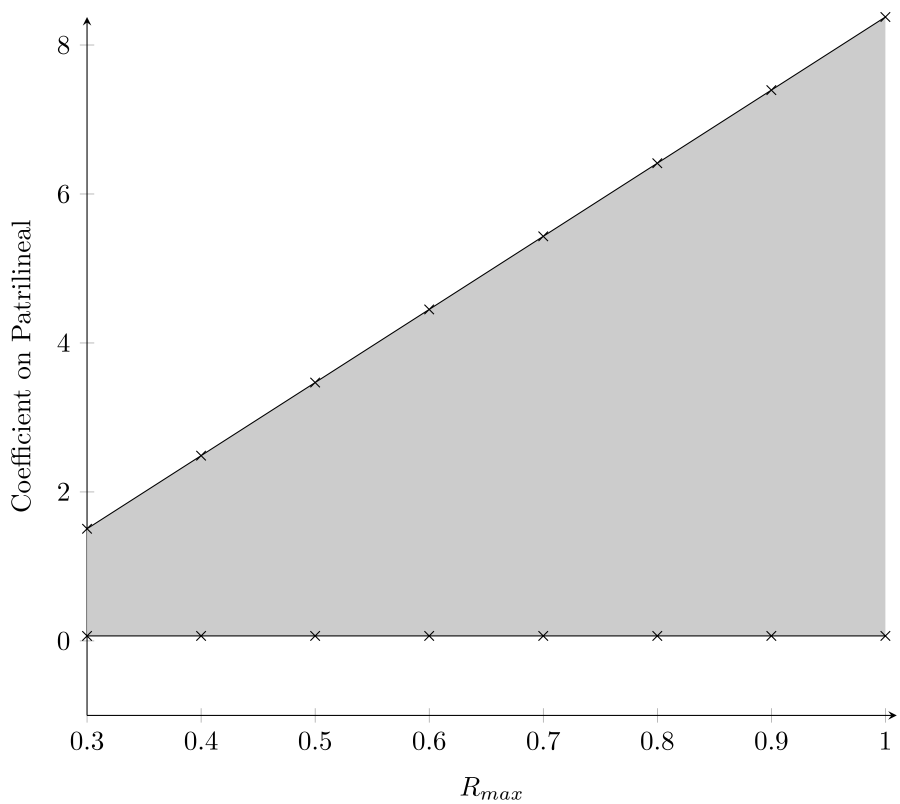

Figure 7: Estimated bounds on the coefficient on patriliny in a regression of husband's agricultural + wage labor hours on controls.

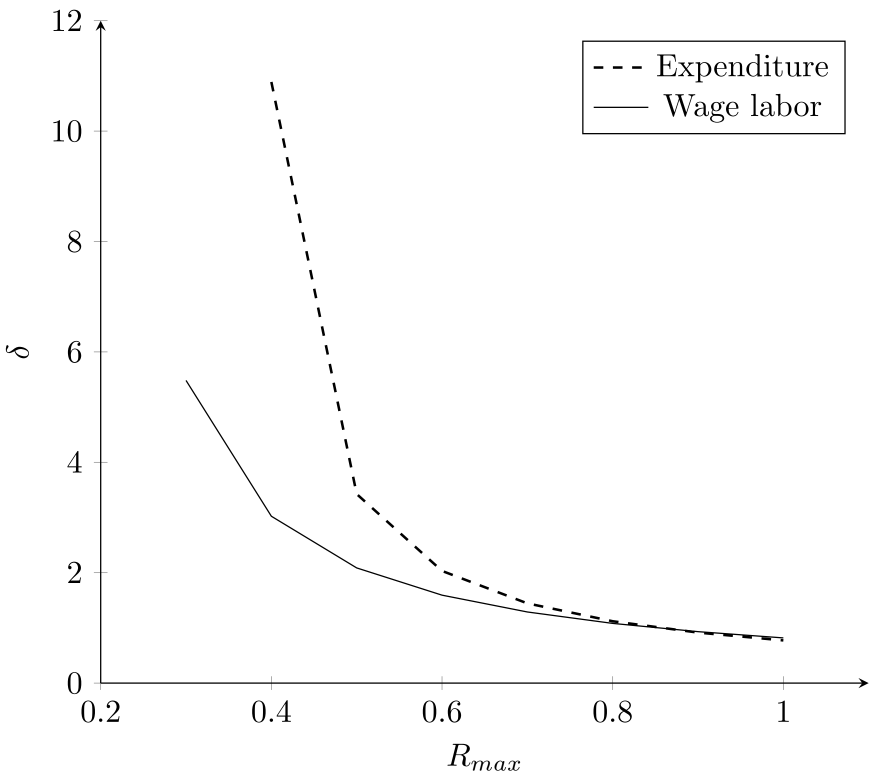

Figure 8: The estimated δ (ratio of selection on unobservables to selection on observables) required to explain the coefficient on patriliny as being driven by unobservables, as $R_{\max}$ increases, for log of household expenditure and wage labor hours. The lowest possible $R_{\max}$ is that achieved in the regression with all observable controls, which is why there is no estimated δ for expenditure for low values of $R_{\max}$. The $R_{\max}$ when $\delta = 1$ is 0.854 for expenditure and 0.848 for wage hours.

D Geographical variables

Table 23 lists the geographical variables included in the regressions.

Table 23: Geographical variables

Category	Variable type	Level	Reference period	Description
Temperature	Continuous	Community	1960-1990	Average daily range: mean of max. temp.- min. temp.
Temperature	Continuous	Community	1960-1990	Temperature seasonality: standard deviation of monthly climatology
Temperature	Continuous	Community	1960-1990	Minimum temperature of coldest month
Temperature	Continuous	Community	1960-1990	Average temperature of wettest quarter
Rainfall	Continuous	Community	2008-2009, 2009-2010	Average 12-month total rainfall
Rainfall	Continuous	Community	2008-2009, 2009-2010	Average total rainfall in wettest quarter
Rainfall	Continuous	Community	2008-2009, 2009-2010	Average start of wettest quarter in dekads, from July onwards
Greenness	Continuous	District	2008-2009, 2009-2010	Total change in greenness within the primary growing season
Greenness	Continuous	District	2008-2009, 2009-2010	Onset of greenness increase in day of year, starting July 1st
Greenness	Continuous	District	2008-2009, 2009-2010	Onset of greenness decrease in day of year, starting July 1st
Soil quality	Indicator	Household	N/A	Nutrient availability: 7 categories defining extent of constraint
Soil quality	Indicator	Household	N/A	Rooting conditions: 7 categories defining extent of constraint
Soil quality	Indicator	Household	N/A	Excess salts: 7 categories defining extent of constraint

E GPS Coordinates of pre-Independence Railway Stations

Railway station	Latitude	Longitude
Limbe	-15.8084	35.0574
Malabvi	-15.8403	35.1316
Nansadi	-15.8833	35.2
Makandi	-15.9333	35.2333
Luchenza	-16.0101	35.3082
Khonjeni	-16.1233	35.2423
Makapwa	-16.3333	35.2833
Sandama	-16.2073	35.2952
Chipho	-16.2893	35.2952
Thekerani	-16.3424	35.0994
Thukuta	-16.0686	34.8666
Sankhulani	-16.2325	35.2847
Osiyana	-16.4790	35.1885
Makhanga	-15.5408	35.7939
Blantyre	-15.7879	35.0159
South Lunzu	-15.6527	35.0195
Chilaweni	-15.2768	35.7189
Maleule	-15.6445	35.0567
Lirangwe	-15.5333	35.0167
Namatunu	-15.4	35.05
Gwaza	-14.8785	34.8114
Shire North	-15.2980	35.0799
Utale	-15.1667	35.05
Nkaya	-15.1282	35.0298
Bazale	-15.0167	34.9833
Rivirivi	-15.0167	34.9667
Balaka	-14.9870	34.9575
Faringdone	-14.8318	34.8670
Bilila	-14.8167	34.8333
Chinyama	-13.0167	33.6833
Lambulira	-15.4833	35.3
Mphonde	-16.55	34.9

These coordinates were obtained from the following sources: Geographic.org, Openstreetmap.org and Latlong.net. The GPS coordinates for Thukuta station are the GPS coordinates of Mfera Health Centre, which is the closest location with available GPS coordinates.