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Gender differences in the relationship between land ownership and managerial rights: Implications for intrahousehold farm labor allocation

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ABSTRACT

Recent research has increased interest in the intersection of land tenure and gender roles in African agriculture. While formalization of land ownership has been found to have important gender impacts, time use and management remain critical to both the productivity of agricultural operations as well as the welfare of household members. Thus, it is important to understand how gender intersects with the relationship between the ownership and operation of plots. We use plot level data from nationally representative household surveys in Ethiopia and Malawi to characterize the structure (sole male; sole female; or joint) and domain (plot ownership; plot management; or output management) of control over land in each household. We then answer the following research questions: 1) are there any gender gaps in the degrees of the concordance among different domains of controls? and 2) how does the structure of ownership and managerial rights affect labor allocations on plots? We find that for both males and females, sole managerial rights are most likely to occur in plots owned exclusively by either gender. However, on jointly owned plots, instances of sole planting rights are almost exclusively male. We also find that while females supply more of their own labor to plots they control, the pattern of own-gender bias in labor allocation varies with each structure-domain combination. The heterogeneity suggests gender inequality analyses related to land rights are sensitive to the choice of domain of control.

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1. Introduction

Against a backdrop of broad land tenure changes in Sub-Saharan Africa (SSA), international development institutions continue to target reforms that provide women access to ownership and control over land.[1] Many of these reforms focus on formalizing customary or neo-customary tenure systems, which have potentially critical consequences for gender gaps (Boone, 2019). Formalization efforts explicitly focused on promoting legal rights for women could potentially foster a more gender egalitarian land distribution, while registration processes that disfavor or ignore women's rights may exacerbate existing inequalities.[2] Recent evaluations of tenure system in Ethiopia (Holden, Deininger, & Ghebru, 2011), Rwanda (Ali, Deininger, & Goldstein, 2014), and Benin (Goldstein, Houngbedji, Kondylis, O'Sullivan, & Selod, 2018) all suggest that basic certification schemes have strengthened the tenure security of women, though productive impacts have been modest.

At the same time, the development of the Women's Empowerment in Agriculture Index suggests renewed attention to female autonomy in agricultural production more broadly. However, despite growing evidence for a strong and positive relationship between women's land right and outcomes like gender equality, consumption and food security (Meinzen-Dick, Quisumbing, Doss, & Theis, 2017), discussion is lacking on the interface between female land ownership and the gendered distribution of managerial and output rights. These issues are critical for understanding how systematic changes in land tenure are likely to impact key intrahousehold allocative efficiency and productivity challenges that have been a traditional focus of agricultural economists (e.g. Udry, 1996).

In this paper, we investigate the role of gender in the relationship between land ownership and managerial rights, and its implication for intrahousehold farm labor allocation in Ethiopia and Malawi. We have two overarching objectives: a) to characterize the interrelationship of ownership, management and output rights among different genders, and b) to estimate the relationship

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[1] In a 2013 report, the United Nations (UN) acknowledged women's land rights as an essential human right necessary to improve the food security and sustainable development (United Nations. Office of the High Commissioner for Human Rights and Women, U.N., 2013, 2013).

[2] Our focus here is on gender, though Boone (2019) notes the ambiguous effect of land formalization on inequality extends to ethnic and class differences, as well.

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between the intrahousehold distribution of these rights and the within-household labor allocation to plots.

As Doss, Kovarik, Peterman, Quisumbing, and van den Bold (2015) notes, much of the rhetoric on women's land rights lack a basic, descriptive empirical foundation. By pursuing our first objective, with an eye toward elucidating potential gender disparities, we aim to fill the evidence gap on the within household distribution of land rights across different domains of control. With the notable exception of Twyman, Useche, and Deere (2015), who focus on female land ownership and plot management decisions, systematic empirical evidence is lacking on how agricultural land ownership maps to managerial rights, and the extent to which the relationship depends on gender. We aim to fill the gap in the literature by exploring gender differences in the relationship across land ownership and plot managerial rights within households.

Throughout the paper, we focus on three "domains" – plot ownership measured by the right to sell, right to make planting decisions, and right to make decisions on outputs from the plot – and three "structures" of control – male sole, female sole, and joint. We use the term, "domains" of controls, to refer to ownership and managerial rights and the term, "structures" of controls, to refer how ownership and managerial rights are distributed to household members. Using this framework and data from nationally representative household surveys in Ethiopia and Malawi, we address the following research questions: 1) are there any gender gaps in the degrees of the concordance among different domains of controls? and 2) how does the structure of ownership and managerial rights affect labor allocations on plots? Though we find a high degree of gender symmetry in the relationship between land ownership and managerial rights, the evidence suggests that the concept of 'jointness' is not fully egalitarian. On jointly owned plots, female (but not male) sole management over planting is almost non-existent, and joint management is overall more likely to occur on solely female-owned plots relative to solely male-owned plots. We also find that while females supply more of their own labor to plots they control, the pattern of own-gender bias in labor allocation varies with each structure-domain combination.

The remainder of the paper consists of the following sections. First, we describe the literature, highlight our contribution, and provide the institutional background. We then illustrate our dataset and the variables we use and show the patterns of ownership and managerial rights of the plots in our sample across gender followed by the analysis on how the structure of ownership and managerial rights affect labor allocations on plots**.** We then summarize and discuss our finding and conclude with limitations and suggestions for future research.

2. Literature review: gender, land rights and management and labor allocation

Studies of gender and agricultural labor typically utilize household level information, which neglects within-household plot-level ownership variation. We depart from recent contributions to understanding female land rights—including Doss (2001), Doss et al. (2015), Twyman et al. (2015), De la O Campos, Covarrubias, and Patron (2016), and Wineman and Liverpool-Tasie (2017)—by focusing solely on households with both male and female adults. As a result, our paper is relevant to gender-based issues in agriculture specifically in environments in which women are engaged in joint economic decisions with men. The dynamics governing the *intrahousehold* distribution of land rights and management may be distinct from general patterns. Indeed, if single sex female-headed households are only households that are gaining female control over land, overall national trends could hypothetically indicate positive signals of land egalitarianism even as women living with men are deprived of land.

We also contribute to the literature of intrahousehold farm labor allocation by providing a discussion of the effect of land ownership and managerial rights on intrahousehold farm labor allocation. Previous studies indicate that the assignment of land ownership or managerial rights affects household production (e.g. Quisumbing & Maluccio, 2003; Doss, 2006; Place, 2009; De la O Campos et al., 2016). Building upon our discussion on how land ownership and managerial rights are gender-specifically interlinked, we provide important findings on how these interlinkages affect intrahousehold farm labor allocation. Labor represents a vitally important input for several reasons; not only is it a key factor of agricultural production, but it also directly affects the welfare of household members and is inextricably linked with issues of autonomy, empowerment, and bargaining power.

Our study also connects to a vast literature on land rights, gender, and the agricultural household.[3] Of particular relevance is recent work that has carefully considered the importance of different indicators of gender and land ownership. De la O Campos et al. (2016) show that the agricultural productivity gap across gender depends on the choice of the gender indicator on who has the rights to plots, and Doss et al. (2015) and Twyman et al. (2015) emphasize the importance of understanding the meaning of various measures of ownership and control of plots in the context of gender inequality.[4] These studies find that plot ownership by women does not guarantee managerial rights to women. Such findings again highlight the importance of investigating the interlinkage across various measures of ownership and managerial rights. We contribute to the literature by providing empirical evidence on the gender gap in this interlinkage.

The efficiency of intrahousehold labor allocation has been investigated by several previous studies. For example, Udry (1996), Goldstein and Udry (2008) and Andrews, Golan, and Lay (2014) reject Pareto efficiency within the household, in part due to labor and land market failures. Walther (2018) demonstrates that insecure tenure can cause non-cooperative decision making within the household in Malawi. Although we do not provide an explicit discussion of intrahousehold decision making and Pareto efficiency of labor uses, we contribute to this literature by providing empirical evidence on how ownership and control of plots affect labor use and find suggestive evidence of labor allocation inefficiencies.

3. Institutional background

Land tenure institutions vary considerably between different countries, and often within countries (Fenske, 2011). The settings of our study, Ethiopia and Malawi, likewise encompass divergent and diverse land tenure systems. Under a backdrop of increasing land scarcity, Ethiopia and Malawi have developed their own institutions governing land and property rights based on their political and social backgrounds.

In Ethiopia, sweeping land reform in 1975 nationalized land and restricted transactions (Holden & Otsuka, 2014). The reforms restricted farmers to usufructuary rights, and converted large swaths of commercial farms to egalitarian smallholders (Kebede, 2008). The 1995 Federal Constitution affirms that land is owned

[3] Land rights have been examined by number of previous studies to assess the impact of having secure land rights on agricultural investment and thus, productivity (e.g. Dillon & Voena, 2018; Deininger et al., 2017; Goldstein & Udry, 2008; Besley, 1995). Measures of "land rights" differ among the previous studies: transfer rights (Besley, 1995), land title ownership (Goldstein & Udry, 2008), inheritance rights (Dillon & Voena, 2018), and land market participation (Deininger et al., 2017).

[4] Similarly, Peterman et al. (2015) and Seymour and Peterman (2018) show that common indicators of gender and household decision making are sensitive to aggregation and construction differences and their interpretation is highly context dependent.

by the State while farmers have right to inherit their land only to their family. Although a 2005 proclamation eased the restriction on land rentals, land still cannot be formally transacted (Tigistu, 2011; Deininger, Ali, Holden, & Zevenbergen, 2008; Kosec, Ghebru, Holtemeyer, Mueller, & Schmidt, 2017). Nevertheless, land can be bequeathed to others, and the regulation of transactions differs by region. Thus, a substantial portion of farmers reports sales rights on their land.

Deininger, Xia, and Holden (2017) describe Malawi's land tenure system as "dualistic": smallholders farm food crops in a customary system traditionally characterized by egalitarian access and diverse inheritance systems, while commercial crops (usually tobacco) are farmed in a formal, private system.[5] Faced with increasing land scarcity and conflict, land tenure reform has become a perennial public policy issue in Malawi. While a National Land Policy proposal has existed for over a decade, implementation of national reforms has been slow.

Considerable variability exists within customary land tenure systems in Malawi, particularly in relation to matrilineal versus patrilineal inheritance, as well as land transaction practices (Holden, Kaarhus, and Lunduka, 2006; Berge, Kambewa, Munthali, & Wiig, 2014.). However, despite these differences, land transactions appear to have been increasing since the 1990s (Peters & Kambewa, 2007). These transactions are not explicitly state-sanctioned, but have evolved such that "customary land continues to be regarded as a resource with use but *also exchange values*" (Jimu, 2012; emphasis added). Thus, sales rights are a meaningful measure of land ownership, though security of tenure remains a significant concern for many smallholders (Deininger, Savastano, & Xia, 2017).

4. Data and descriptive statistics

We use nationally representative survey data from the World Bank's Living Standard Measurement Study – Integrated Survey on Agriculture (LSMS-ISA) program. We combine data from two recent rounds of household surveys in Ethiopia and Malawi, which are 2013–2014 and 2015–2016 Ethiopia Rural Socioeconomic Surveys, 2013 Malawi Integrated Household Panel Survey and 2016–2017 Malawi Fourth Integrated Household Survey. We use the two recent rounds because they include questions that consistently measure the ownership and managerial rights of surveyed plots.[6]

The LSMS-ISA program supports Sub-Saharan African countries to implement nationally representative household surveys with a focus on agriculture. Typically, these surveys collect data on the demographics, education, health, and employment of households, as well as plot-level information on input use, cultivation, production, and the identity of managers and owners (Palacios-Lopez, Christiaensen, & Kilic, 2017).

Since our objective is to understand intra-household dynamics of farm ownership, managerial rights and labor allocation, we restrict our sample to the cultivated plots (fields) in households with at least one adult male and one adult female. Accordingly, female-headed households with no adult male between 15 and 64 years old or male-headed households with no adult female are excluded in our analysis. We also restrict our sample to plots where each domain of controls is assigned to at least one individual in the household. Consequently, we exclude 38.98% and 58.73% of the cultivated plots from Ethiopia and Malawi.

Ownership of a plot can be defined in several ways (De Janvry, Emerick, Gonzalez-Navarro, & Sadoulet, 2015; Doss et al., 2015; Fenske, 2011). In the household surveys we use, there are questions distinguishing the identity of the holder of the plot, the title-holder of the plot, and who has the right to sell the plot. Since the definition of *holder* may be subjective, and the meaning of plot certification may be ambiguous, we identify the plot owner based on the response to the question, "who has the right to sell the plot?".[7] This is similar to Besley (1995) where the self-reported transfer rights are used as the key measure of land rights. While the right to alienate land may be distinct from ownership, it consistently identifies the individual with the most senior or exclusive exchange value right to the land.[8]

Table 1
Shares of cultivated plots by structure and domain of controls.

Ethiopia (n = 27,322)	Male only	Female only	Joint
Right to sell (%)	16.94	7.90	75.16
Plant decision (%)	22.49	2.77	74.75
Output decision (%)	8.58	9.73	81.70
Malawi (n = 2,276)	**Male only**	**Female only**	**Joint**
Right to sell (%)	38.09	38.18	23.73
Plant decision (%)	11.95	12.92	75.13
Output decision (%)	18.32	17.31	64.37

Sources: World Bank Living Standard Measurement Survey (LSMS) – Integrated Survey on Agriculture (ISA).
Notes: Each row sums up to 100%.

Table 1 reports the shares of the cultivated plots by structure and by domain of controls. We focus on three structures—male sole, female sole, and joint—and three domains— rights to sell, rights on planting decision, and rights on output. Table 1 shows that about three-fourth of plots in Ethiopia are jointly owned and jointly managed for planting decisions. The share of the plots with outputs jointly managed is above 80%. Within the plots with sole control by one household member, the shares of male sole and female sole are similar for the output management domain, but the share of male sole is greater for the other two domains. In Malawi, the share of plots that are solely owned is much higher than Ethiopia. Similar to Ethiopia, managerial rights are likely to be shared between males and females. However, there is no gender gap in sole ownership or management in Malawi.

Table 2 reports descriptive statistics of the key variables we utilize to explain intrahousehold dynamics of land ownership, managerial rights and labor inputs. Except the labor days variables, these are the control variables that we include in the regression equations in the later sections. Household characteristics are similar across different ownership domains except the gender of the household head. As expected, we observe that sole ownership of females occur more often in female-headed households. The proportion of the female-solely-owned plots from female-headed households is higher in Ethiopia compared to Malawi.

Plot-level variables are more heterogeneous across the different structures of ownership and vary across countries. In general, plot

[5] Private land is distributed between freehold and 'estate' or converted customary land. Jere (2012) estimates that as of 1998, customary land comprised 65 percent of total land area in Malawi.

[6] We choose to use the most recent two rounds from each country to maximize statistical power and capture recent social and economic phenomena. Unfortunately, other waves do not contain sufficient information on the variables required for our analysis.

[7] A possible alternative is to use "documented ownership (title-holder)". However, we believe that using this variable is less practical in our context since only 3% of the plots in Malawi data are certified and have information on who is the title-holder.

[8] Our definition is not intended to suggest the concept of ownership cannot exist without alienation, but to focus on a well-defined sample of plots with a clear criterion for ownership. Because we exclude plots where no household member has a sale right—either solely or jointly—we do not consider plots in which households have embedded ownership rights while alienation rights are vested exclusively with a community or political institution. Such arrangements can occur in customary tenure systems, in particular.

Table 2
Descriptive statistics of key variables by ownership structure.

Ownership structure	Ethiopia (n = 27,322)			Malawi (n = 2,276)		
	Male only	Female only	Joint	Male only	Female only	Joint
Household characteristics						
Head is female (yes = 1, no = 0)	0.02	0.75	0.06	0.01	0.29	0.14
	(0.136)	(0.432)	(0.233)	(0.117)	(0.456)	(0.344)
Head' age	45.62	49.97	46.67	43.26	43.66	44.66
	(13.577)	(11.523)	(12.648)	(12.506)	(12.517)	(12.204)
Head' education level	2.00	0.89	2.04	7.18	6.99	7.09
	(3.159)	(2.371)	(3.098)	(3.280)	(3.717)	(3.506)
Reside in rural (yes = 1, no = 0)	0.99	0.96	0.97	0.94	0.88	0.93
	(0.121)	(0.205)	(0.158)	(0.233)	(0.322)	(0.256)
Distance to road (km)	13.86	12.81	14.00	9.91	9.61	9.22
	(15.184)	(14.173)	(14.603)	(10.127)	(10.107)	(9.815)
Plot characteristics						
Plot size (acre)	0.346	0.386	0.441	1.417	0.887	1.427
	(0.833)	(2.652)	(2.551)	(3.938)	(0.789)	(1.960)
Grow only cereals (yes = 1, no = 0)	0.486	0.459	0.477	0.439	0.369	0.430
	(0.500)	(0.498)	(0.499)	(0.497)	(0.483)	(0.495)
Use organic fertilizer (%)	0.315	0.348	0.336	0.143	0.234	0.157
	(0.464)	(0.476)	(0.473)	(0.350)	(0.423)	(0.365)
Inorganic fertilizer use (kg)	9.268	8.619	20.905	63.302	37.964	44.074
	(139.20)	(87.275)	(263.03)	(306.13)	(69.249)	(61.284)
Average male's labor days	12.494	2.899	12.186	26.932	19.319	24.222
	(17.095)	(11.611)	(17.547)	(21.315)	(20.716)	(20.310)
Average female's labor days	4.726	7.611	5.989	27.253	28.965	28.172
	(9.821)	(12.247)	(12.328)	(21.993)	(24.951)	(21.974)
Other household member's labor days	6.096	13.255	7.312	19.141	20.918	23.678
	(12.919)	(19.248)	(15.569)	(28.977)	(29.154)	(29.545)
Hired labor days	1.793	1.696	1.561	3.541	3.207	3.243
	(6.792)	(5.033)	(7.414)	(9.084)	(7.881)	(7.831)
Number of observations	4,628	2,158	20,536	867	869	540

Sources: World Bank Living Standard Measurement Survey (LSMS) – Integrated Survey on Agriculture (ISA).
Notes: Standard deviations are in parentheses. Ownership is determined by the household member identified as having the right to sell the given plot. All plots with no ownership, no planting decision maker or no output decision maker from the household are excluded.

sizes are smaller in Ethiopia than Malawi. In Ethiopia, plot sizes are relatively similar across male-owned, female-owned, and jointly owned plots. In Malawi, female-owned plots are about 35% smaller than other plots.

Notable differences in agricultural inputs emerge across ownership structures. The amount of inorganic fertilizer used in female-owned plots is smaller than other plots, though per acre rates are similar in Malawi. The patterns in labor inputs are less clear. Male labor days are lower in female-owned plots but female labor and labor from other family member are greater in female-owned. In Section 5, we systematically investigate labor allocation across structures and domains of control in the sample plots.

5. The relationship between land ownership and managerial rights

We first explore how the different structures—male sole, female sole, and joint—and domains of controls— rights to sell, rights to make planting decisions, and rights on outputs —are correlated with each other. Our objective in this section is to explore whether having ownership of a plot leads to other managerial rights (i.e. planting or output control) and whether gender differences arise in the relationship between ownership and managerial rights.

Fig. 1 presents the shares of plots with gender-specific managerial rights by ownership structure. While high shares of joint management are present, we observe gender-specific concordance for both managerial rights and differences in the degrees of gender-specific concordance between males and females across the two managerial right domains. In nearly every male owned plot, either the male makes the planting decision (39%) or it is joint (60%). In female owned plots, female sole management over planting is prevalent (27%), but not to the same extent as for males. In jointly owned plots, joint management of planting predominates (80%), but sole management on these plots is not egalitarian. Male sole management occurs in 19% of jointly owned plots, though female ownership is almost non-existent, with the gender gap driven by observations from Ethiopia (see online Appendix A1.2).

Overall, females have substantially more sole decision making around outputs than for planting across all structures of control. In fact, females are more likely to solely manage outputs on female-owned plots than males on male-owned plots. Similar patterns arise in the shares of the plots in each domain-by-structure combination, which we present in the online appendix.

We formally assess the correlation across ownership and the two managerial rights with regression analyses. For plot j, in household k, in round t, we estimate the following equation:

$$DM_{jkt} = \alpha_0 + \alpha_1 F_{jkt} + \alpha_2 J_{jkt} + \Gamma X_{jkt} + u_k + v_t + \varepsilon_{jkt} \quad (1)$$

where DM_{jkt} is the indicator variable for various structures and managerial rights combinations. The indicator variable, F_{jkt}, indicates whether female has the sole right to sell plot j or not, J_{jkt} indicates whether plot j is jointly owned or not, X_{jkt} is a vector of plot and household characteristics and u_k and v_t are households and rounds fixed effects.[9] We separately estimate six equations with six different dependent variables: female solely, male solely, and

[9] The omitted variable bias occurs when a) we leave out relevant explanatory variables that affect the dependent variable, and b) the left-out explanatory variables are correlated with the key explanatory variables and thus, our concern is leaving out the variables that satisfy the both conditions. We suspect that household characteristics such as the characteristics of the head of the household and accessibility would affect both who is the owner and who manages for the plots we are analyzing, and other time-invariant household characteristics are captured by the household fixed effects. We believe that plot characteristics such as input uses and crop choices have similar concerns and thus include them in the regressions.

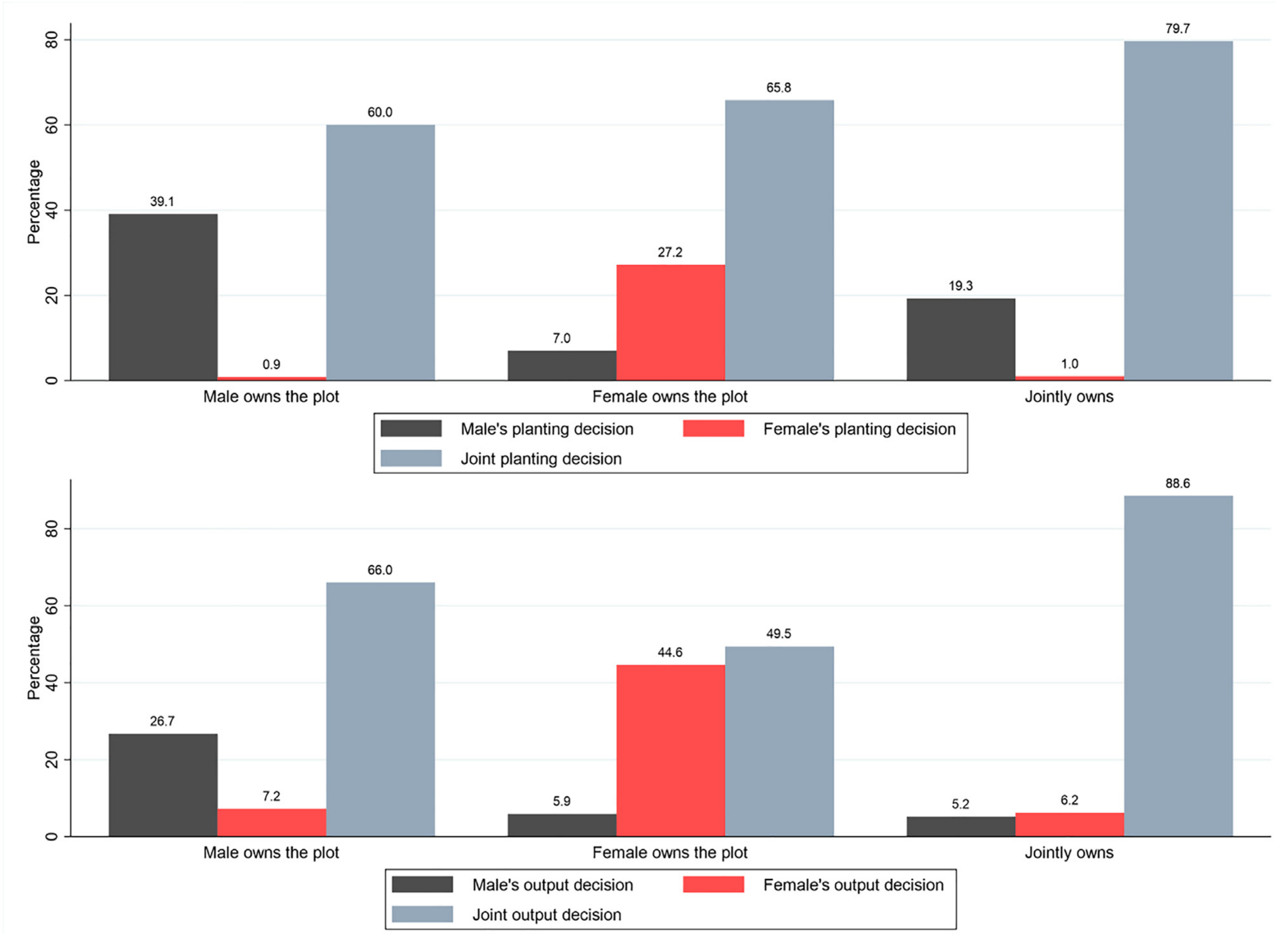

Fig. 1. Percentage of plots with gender-specific managerial rights by ownership structure. Sources: World Bank Living Standard Measurement Survey (LSMS) – Integrated Survey on Agriculture (ISA).

joint planting decisions, and male's sole right, female's sole right and joint right on outputs. To incorporate fixed effects, we use a linear probability model for Eq. (1).[10]

Table 3 reports the estimation results.[11] The first three columns report results for the equations in which the dependent variable refers to planting decisions, and the next three columns report estimates of the rights to manage outputs. As expected, we observe strong degrees of gender-specific concordance. Female-owned plots are much more likely to be managed by females compared to jointly owned plots. In columns (1) and (4), we find that the coefficients of the female sole ownership variable are positive and statistically significant whereas the coefficients of the joint ownership variable are either insignificant or negative. We reject both the null hypotheses, $\alpha_{11} - \alpha_{21} = 0$ and $\alpha_{14} - \alpha_{24} = 0$, which we report in the online appendix (Table A2). This indicates that the likelihood that a plot is solely managed by a female is statistically larger in female-owned plots compared to jointly owned plots. Similarly, male-owned plots are more likely to be managed by males compared to jointly owned plots (i.e. the negatives of α_{23} and α_{26} are positive and significant).

We test whether these gender-specific concordances are stronger for males than females by re-estimating the six equations jointly within a Seemingly Unrelated Regression (SUR) framework and conducting cross-equation hypothesis tests. Specifically, we test the null hypotheses that $(-\alpha_{22}) - (\alpha_{11} - \alpha_{21}) = 0$ and $(-\alpha_{25}) - (\alpha_{14} - \alpha_{24}) = 0$. These test that the likelihood of a male-owned plot being managed by males and the likelihood of a female-owned plots being managed by females—relative to jointly owned plots—is equal. Although the relative magnitudes are larger for male-owned plots, we fail to reject the null hypothesis for both planting and output management (see Table A2).

There are also similarities across gender in the relative distribution of sole rights on non-concordant plots. The likelihood that females (males) engage in sole management decisions on plots owned by males (females) is similar to the likelihood on jointly owned plots. The coefficients α_{21} and α_{24} are statistically insignificant, indicating that sole female planting and output decision in jointly owned plots are statistically indistinguishable compared to those for male-owned plots. We execute a similar test for males. In column (2), we find that the coefficient of the female ownership variable (α_{12}) is more negative than the coefficient of the joint

[10] Since the dependent variables are binary variables, one can argue that it is important to incorporate the nonlinearity and models such as logit or probit are more appropriate. However, in such models, incorporating fixed effects leads to inconsistency of the estimates (i.e. incidental parameter problem) and obtaining proper standard errors is also challenging. While we keep the linear probability model as our main specification, we provide the results from probit model with correlated random effects and conditional logit fixed effects model in the online appendix. The probit correlated random effects model and conditional logit fixed effects model are alternative ways to control for unobservable time-invariant household-level heterogeneity (Frederiksen, Honoré, & Hu, 2007; Magnac, 2004; Wooldridge, 2009). The results remain robust in general.

[11] We also provide country-specific estimation results of Eq. (1) in the online appendix. The key results remain robust with smaller statistical power in the Malawi-only sample.

Table 3
Likelihood of ownership leading to managerial rights.

	(1) Female's planting decision	(2) Male's planting decision	(3) Joint planting decision	(4) Female's right on outputs	(5) Male's right on outputs	(6) Joint right on outputs
Female solely has right to sell (α_{1i})	0.048	−0.130	0.081	0.084	−0.156	0.072
	(0.023)**	(0.045)***	(0.050)	(0.028)***	(0.028)***	(0.039)*
Joint right to sell (α_{2i})	0.002	−0.095	0.093	−0.012	−0.155	0.167
	(0.003)	(0.034)***	(0.034)***	(0.009)	(0.022)***	(0.024)***
Head is female (Γ_1)	0.252	−0.243	−0.009	0.333	−0.052	−0.281
	(0.068)***	(0.076)***	(0.106)	(0.077)***	(0.042)	(0.073)***
Head's age (Γ_2)	0.000	0.000	−0.000	−0.000	0.003	−0.003
	(0.001)	(0.003)	(0.003)	(0.001)	(0.002)	(0.003)
Head's education years (Γ_3)	0.003	−0.011	0.007	0.004	−0.001	−0.003
	(0.002)	(0.008)	(0.009)	(0.003)	(0.005)	(0.006)
Plot size (acre) (Γ_4)	−0.000	0.000	−0.000	−0.005	0.002	0.003
	(0.000)	(0.003)	(0.003)	(0.001)***	(0.001)	(0.001)**
Plot size sq. (acre) (Γ_5)	0.000	−0.000	0.000	0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)**
Cultivate cereals only (Γ_6)	−0.003	−0.005	0.008	−0.044	0.008	0.036
	(0.001)***	(0.004)	(0.004)**	(0.004)***	(0.003)**	(0.004)***
Organic fertilizer usage (Γ_7)	0.004	−0.019	0.015	0.043	−0.023	−0.020
	(0.003)	(0.007)***	(0.007)**	(0.005)***	(0.005)***	(0.006)***
Fertilizer use (100 kg) (Γ_8)	0.000	0.002	−0.003	−0.003	0.002	0.000
	(0.000)	(0.001)	(0.001)*	(0.001)***	(0.001)	(0.002)
Distance to road (km) (Γ_9)	0.018	−0.113	0.095	0.020	−0.011	−0.009
	(0.020)	(0.064)*	(0.068)	(0.030)	(0.025)	(0.039)
F-statistic	2.60***	3.42***	1.98**	19.66***	7.28***	13.28***
N	29,598	29,598	29,598	29,598	29,598	29,598

Note: ***p < 0.01 **p < 0.05 *p < 0.10.
All six equations are estimated with household and round fixed effects. Note that subscript i in coefficient α_{1i} and α_{2i} indicates column number where $i = 1, \cdots 6$. Standard errors are clustered at household level.

ownership variable (α_{22}), but we fail to reject the null hypothesis, $\alpha_{12} - \alpha_{22} = 0$. Thus, the likelihood of a plot to be solely managed by males is statistically indistinguishable in jointly owned plots versus female-owned plots. The likelihoods of males having sole rights on outputs between female-owned and jointly owned plots is even closer in magnitude, and we fail to reject the null hypothesis, $\alpha_{15} - \alpha_{25} = 0$ (see Table A2 in the online appendix for the hypothesis testing results).

Despite these similarities across genders, we find suggestive evidence that female-owned plots are more likely to be jointly managed compared to male-owned plots. The coefficients for both planting decisions (α_{13}) and output decision (α_{16}) are positive, though the former is marginally insignificant and the latter significant only at the 10 percent level. Though imprecise, the direction of the estimates indicates that men are more likely to join in the managerial decisions in female-owned plots than women are to participate in such decisions in male-owned plots.

Overall, we find strong evidence of gender-specific concordance across different domains of control. Despite a high degree of symmetry between males and females in the relative concordance levels, our findings hint at a gender gap in the concept of "jointness". Joint management is more commonly associated with female-owned plots than male-owned plots, and instances of sole planting rights on jointly-owned plots are almost exclusively male. While the patterns are in general similar across the two countries, we do see a notable difference in how land ownership maps to joint output rights. In Ethiopia, male-owned plots are significantly less likely to have joint output rights, but in Malawi we find no statistical differences in their occurrence across male, female and jointly owned plots (Tables A4.1 and A4.2).

6. The relationship between the gender structure of control over land and labor allocation

In this section, we explore how each domain-by-structure combination is correlated with the labor input of the primary adult male, female, other household members and hired labors. Particularly, we focus on investigating the presence of gender-specific concordances in labor allocations and whether the degree of the concordance differs between males and females.[12]

Fig. 2 shows the distribution of male and female labor inputs across plots with different domains and structures of controls. Gender-specific concordances are reflected in both male and female labor distributions in all domains. In both male and female labor distributions, we observe greater densities around zero in plots owned or managed by their opposite gender and greater densities around positive values in plots owned or managed by themselves. We also see that both male and female labor follow similar distributions in male-controlled or jointly-controlled plots. That suggests that the concept of "jointness" is closer to male-control than female-control in the context of labor allocations.

Similar to the previous section, we formally assess the gender-specific concordance in labor allocation by estimating the following equation:

$$Y^i_{jkt} = \beta^i_0 + \beta^i_1 FS_{jkt} + \beta^i_2 FP_{jkt} + \beta^i_3 FO_{jkt} + \beta^i_4 JS_{jkt} + \beta^i_5 JP_{jkt} + \beta^i_6 JO_{jkt} + \Gamma^i X_{jkt} + u^i_k + \theta^i_t + \varepsilon^i_{jkt} \tag{2}$$

For each of the four categories of labor, primary adult male, female, other household members, and hired, Y^i_{jkt} represents labor days provided in plot j in household k in time t. Accordingly, $i = m, f, o, h$ which indicates male, female, other household members, and hired persons. For each domain of control (ownership, planting, output), a plot is categorized as under female control, joint control, or male control. Accordingly, female and joint ownerships are denoted by the dummy variables FS_{jkt}, and JS_{jkt}, female planting decision and joint planting decision are denoted by FP_{jkt} and JP_{jkt}, and female output decision and joint output decision are denoted by FO_{jkt} and JO_{jkt}.

[12] Unlike Palacios-Lopez et al. (2017), our analysis focuses on plot level, as opposed to household level, relationships between gendered labor allocation and land ownership.

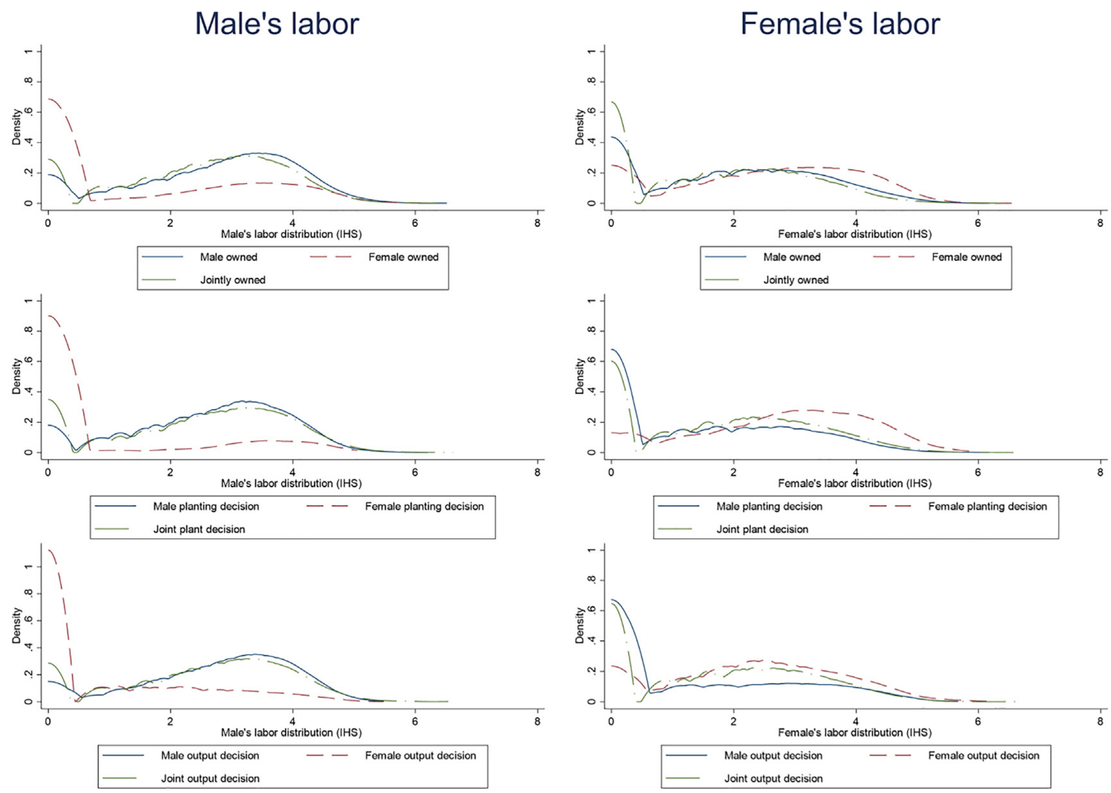

Fig. 2. Labor distributions by domain and structure of controls. Source: World Bank Living Standard Measurement Survey (LSMS) – Integrated Survey on Agriculture (ISA). Note: In each domain of control, the density of the inverse hyperbolic sin (IHS) of either male or female labor is plotted for each structure of control subsample.

Male sole control is the omitted category. The vector, X_{jkt}, consists of the control variables listed in Table 2.[13]

Household fixed effects are denoted by u_k^i, which controls for time invariant household characteristics that might impact labor allocation. Because plots cannot be tracked across rounds, the parameters are identified by within household variation both across and between rounds. We also include a time fixed effect θ_t^i to control for generic differences between rounds. Finally, we also estimate a specification that includes interaction terms across domains for each structure to exam whether any synergy effect exists. We jointly estimate four labor allocation equations (male, female, other household member, and hired labor equations) via Seemingly Unrelated Regression (SUR) to control for possible correlation in error terms across equations.

In Table 4, we report the estimation results on the relationship between labor allocation and domains and structures of controls of the plots. Columns (1) through (4) are estimated using the pooled sample and columns (5) through (12) reports the results from country-specific regressions. In every specification, the estimated coefficients of our variables of interest should be interpreted relative to the omitted group of sole male control. We also provide various within equation hypothesis testing results in the online appendix (Table A5).

First, every domain of control exhibits some degree of gender-specific concordance in the relationship between labor allocation and the structure of control. Females supply more labor to plots on which they have a sole right to sell, a sole right to make planting decisions, and a sole right on outputs (β_1^f, β_2^f, and β_3^f). On female-controlled plots, males generally supply less labor (β_2^m and β_3^m). While the general direction remains consistent across the pooled sample, Ethiopia, and Malawi, the pattern is less strong in Malawi. In that country, only female sole right to make planting decisions has a statically significant effect on labor (negative for male labor days and positive for female labor days).

Second, the magnitude of the gender-specific concordance varies across the *domain* of control. Own-gender effects on labor are greater for managerial rights than for ownership. Specifically, in the pooled sample, output decisions have the highest own-labor effects, with females supplying 78 percent more labor on plots where they solely control the output decisions, relative to plots where males solely control the output. For planting decisions, the same effect is less than half (40 percent). Sole female control of the right to sell a plot has the smallest impact on relative female labor supply, with an increase of just 18 percent over sole male control (not significant at the five percent level). The relative reduction in male labor on solely female controlled plots is also largest for the output decision domain (-80 percent), followed by planting decisions (-52 percent). For the right-to-sell domain, the coefficient is small and not significant. The same pattern also appears in the Ethiopia-only sample, though for Malawi, as described above, the coefficients are only significant for the female sole right to make planting decisions.

Third, jointly controlled domains (β_4^i, β_5^i, and β_6^i) do not have the same relationship with labor allocation as either solely female or male-controlled domains and the relationship also differs across countries. In the pooled and Ethiopia samples, we find greater labor allocations of male, female, and other household members and less hired labor in jointly owned plots compared to those in male owned plots. We also observe less male labor in plots with joint planting decisions compared to those with a male sole planting right and greater labor allocations from female and other household members in plots with joint output decisions compared to those with the male sole output rights. In Malawi, the only sta-

[13] Similar to Eq. (1), we include the household and plot characteristics and the household and round fixed effects to mitigate potential omitted variable bias.

Table 4
The influence of structure and domain of control on plot level labor inputs.

	Pooled sample				Ethiopia only				Malawi only			
	(1) Male' labor days	(2) Female's labor days	(3) Other HH labor days	(4) Hired labor days	(5) Male' labor days	(6) Female's labor days	(7) Other HH labor days	(8) Hired labor days	(9) Male' labor days	(10) Female's labor days	(11) Other HH labor days	(12) Hired labor days
Head is female (Γ_1^i)	−1.209	−0.175	0.152	0.066	−1.514	−0.165	0.089	−0.062	−0.451	−0.056	0.154	0.461
	(0.253)***	(0.185)	(0.205)	(0.105)	(0.284)***	(0.230)	(0.215)	(0.121)	(0.370)	(0.245)	(0.547)	(0.220)**
Head's age (Γ_2^i)	−0.016	−0.003	0.018	−0.007	−0.020	−0.002	0.014	−0.009	0.013	−0.008	0.056	−0.007
	(0.005)***	(0.005)	(0.007)***	(0.005)	(0.005)***	(0.005)	(0.007)**	(0.005)*	(0.013)	(0.009)	(0.017)***	(0.010)
Head's education years (Γ_3^i)	−0.007	−0.036	−0.033	−0.002	−0.005	−0.040	−0.034	−0.019	−0.039	−0.013	−0.026	0.034
	(0.012)	(0.014)***	(0.019)*	(0.011)	(0.014)	(0.017)**	(0.021)	(0.012)	(0.020)**	(0.016)	(0.038)	(0.024)
Plot size (acre) (Γ_4^i)	0.094	−0.002	0.073	0.122	0.095	−0.009	0.076	0.125	0.103	0.134	0.011	0.199
	(0.018)***	(0.009)	(0.015)***	(0.022)***	(0.019)***	(0.008)	(0.016)***	(0.023)***	(0.036)***	(0.043)***	(0.053)	(0.038)***
Plot size sq. (acre) (Γ_5^i)	−0.001	0.000	−0.000	−0.001	−0.001	0.000	−0.000	−0.001	−0.001	−0.001	−0.000	−0.002
	(0.000)***	(0.000)	(0.000)***	(0.000)***	(0.000)***	(0.000)	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)	(0.000)***
Cultivate cereals only (Γ_6^i)	0.643	0.137	0.487	0.363	0.686	0.158	0.517	0.388	−0.128	−0.161	−0.072	−0.071
	(0.019)***	(0.022)***	(0.021)***	(0.015)***	(0.020)***	(0.023)***	(0.021)***	(0.015)***	(0.059)**	(0.051)***	(0.069)	(0.057)
Organic fertilizer usage (Γ_7^i)	−0.175	0.296	−0.160	−0.193	−0.178	0.301	−0.166	−0.196	0.139	0.191	0.139	0.054
	(0.022)***	(0.023)***	(0.024)***	(0.016)***	(0.023)***	(0.024)***	(0.025)***	(0.017)***	(0.083)*	(0.075)**	(0.103)	(0.078)
Fertilizer use (100 kg) (Γ_8^i)	0.012	0.002	0.008	0.009	0.011	0.002	0.009	0.008	0.031	0.011	−0.014	0.033
	(0.004)***	(0.003)	(0.005)*	(0.004)**	(0.004)***	(0.003)	(0.005)**	(0.004)*	(0.011)***	(0.021)	(0.027)	(0.013)**
Distance to road (km) (Γ_9^i)	0.090	−0.022	0.124	0.094	0.115	−0.015	0.279	0.153	−0.008	−0.015	−0.191	−0.152
	(0.094)	(0.103)	(0.159)	(0.070)	(0.107)	(0.137)	(0.167)*	(0.076)**	(0.129)	(0.101)	(0.250)	(0.137)
Female' sole selling right (β_1^i)	0.052	0.174	0.307	−0.059	0.077	0.204	0.322	−0.089	−0.116	0.018	0.095	−0.002
	(0.080)	(0.091)*	(0.097)***	(0.069)	(0.095)	(0.111)*	(0.111)***	(0.079)	(0.135)	(0.116)	(0.199)	(0.134)
Female's sole planting decision (β_2^i)	−0.498	0.397	−0.014	0.046	−0.536	0.440	−0.119	−0.006	−0.464	0.643	0.248	0.064
	(0.124)***	(0.123)***	(0.146)	(0.065)	(0.141)***	(0.148)***	(0.167)	(0.071)	(0.277)*	(0.220)***	(0.329)	(0.181)
Female's sole output decision (β_3^i)	−0.775	0.776	−0.128	−0.268	−0.789	0.823	−0.110	−0.272	−0.271	0.113	−0.164	0.164
	(0.066)***	(0.061)***	(0.069)*	(0.045)***	(0.069)***	(0.065)***	(0.070)	(0.047)***	(0.220)	(0.177)	(0.296)	(0.178)
Joint selling right (β_4^i)	0.101	0.104	0.146	−0.107	0.093	0.107	0.150	−0.128	0.046	−0.020	−0.015	−0.111
	(0.049)**	(0.055)*	(0.064)**	(0.038)***	(0.052)*	(0.059)*	(0.067)**	(0.040)***	(0.119)	(0.114)	(0.201)	(0.110)
Joint planting decision (β_5^i)	−0.139	0.002	0.055	0.003	−0.147	−0.008	0.053	0.005	0.059	0.343	0.015	0.012
	(0.043)***	(0.045)	(0.051)	(0.028)	(0.044)***	(0.046)	(0.052)	(0.028)	(0.156)	(0.137)**	(0.222)	(0.170)
Joint output decision (β_6^i)	−0.085	0.342	0.106	−0.056	−0.080	0.370	0.124	−0.036	−0.099	0.087	−0.147	−0.017
	(0.055)	(0.050)***	(0.059)*	(0.039)	(0.059)	(0.054)***	(0.061)**	(0.041)	(0.120)	(0.123)	(0.207)	(0.129)
F-statistic	320.10***	57.30***	126.11***	193.23***	328.80***	56.28***	130.88***	201.46***	9.41***	8.62***	7.41***	16.32***
N	29,598	29,598	29,598	29,598	27,322	27,322	27,322	27,322	2,276	2,276	2,276	2,276

Note: ***p < 0.01 **p < 0.05 *p < 0.10. Dependent variables are transformed using the inverse hyperbolic sine (IHS). Household and round fixed effects are included in the estimation. The superscript i in each coefficient represents the person who provides labor input where $i = m, f, o, h$ for male, female, other household members, and hired. Standard error is clustered at household level.

Table 5
Cross-equation hypothesis testing results.

	Null Hypothesis	Description of Null Hypothesis	Result	Decision
Pooled	$(-\beta_4^m) - \left(\beta_1^f - \beta_4^f\right) = 0$ (Ownership)	Relative to jointly controlled plots, additional male labor inputs in male-controlled plots and additional female labor inputs in female-controlled plots are identical	−0.171 (0.097)*	Reject
	$(-\beta_5^m) - \left(\beta_2^f - \beta_5^f\right) = 0$ (Planting)		−0.256 (0.126)**	Reject
	$(-\beta_6^m) - (\beta_3^f - \beta_6^f) = 0$ (Output)		−0.349 (0.074)***	Reject
Ethiopia	$(-\beta_4^m) - \left(\beta_1^f - \beta_4^f\right) = 0$ (Ownership)		−0.190 (0.116)*	Reject
	$(-\beta_5^m) - \left(\beta_2^f - \beta_5^f\right) = 0$ (Planting)		−0.302 (0.152)**	Reject
	$(-\beta_6^m) - (\beta_3^f - \beta_6^f) = 0$ (Output)		−0.373 (0.078)***	Reject
Malawi	$(-\beta_4^m) - \left(\beta_1^f - \beta_4^f\right) = 0$ (Ownership)		−0.084 (0.127)	Fail to reject
	$(-\beta_5^m) - \left(\beta_2^f - \beta_5^f\right) = 0$ (Planting)		−0.359 (0.209)*	Reject
	$(-\beta_6^m) - (\beta_3^f - \beta_6^f) = 0$ (Output)		0.073 (0.186)	Fail to reject

Note: ***p < 0.01 **p < 0.05 *p < 0.10. The subscript $1 \sim 6$ in each coefficient represents female sole ownership, female sole planting decision, female sole output decision, joint ownership, joint planting decision, and joint output decision. The superscript in each coefficient represent 'm' for 'male's labor', 'f' for 'female's labor', 'o' for 'other household members' labor', and 'h' for 'hired labor'.

tistically significant jointly controlled domain is the right to make planting decisions, which is associated with higher female labor.

Finally, plots where women have either the sole right to sell or sole control over output are supplied with less hired labor in Ethiopia. Relative to plots where men have sole control over sales, when women have sole land sale control there are 9 percent fewer hired labor days. For sole female output decisions, there are 27 percent less hired labor days, while for sole female planting decisions the relationship is null. Thus, even though sales rights have the weakest correlation with the gendered allocation of household labor, hired labor input use remains significantly reduced for sole female control of this domain. We also observe that hired labor in female-controlled plots is either statistically not different from those in jointly controlled plots or lower (Within equations test results (3) in Table A5.1). In the Malawi-only sample, hired labor inputs was not statistically linked to the domain or structure of plot control.

Table 5 presents cross-equation hypothesis testing results. Utilizing the SUR estimation, we test whether the degrees of gender-specific concordances are stronger in male-controlled domains compared to female-controlled domains. The first set of hypotheses in Table 5 tests whether the degree of gender concordance is equal between for males or females (i.e. effect of male control on male labor vs. female control on female labor). In all domains for the pooled sample and the Ethiopia-only sample, we reject the null of equality and find that the degree of gender-specific concordance is greater in female-controlled plots. For the Malawi-only sample, we only reject the null for the planting decision domain.

7. Summary of empirical findings and discussion

In this paper, we explore the role of gender in the relationship between land ownership and managerial rights, and its implication for intrahousehold farm labor allocation. We find that both females and males are more likely to report control over the management of plots on which they claim exclusive transaction rights. We also find suggestive evidence of disadvantages faced by women in the concept of 'jointness', both in terms of joint management and joint ownership. The former is more likely to occur on solely female owned plots than male owned plots, and the latter is more likely to entail male sole planting decisions than female sole planting decisions.

The empirical patterns derived from the analysis of labor allocation suggest several important implications. First, our finding on the gender-specific concordance in the relationship between labor allocation and the structure of control is consistent with previous studies that document intrahousehold inefficiencies in agricultural investment.[14] For the patterns observed here to derive from an efficient allocation of labor, there would need to be a fairly distinct form of sex-disaggregated comparative advantage for management and labor activities.

Second, the fact that labor allocations patterns differ across domains of land control suggests that the choice of variable in defining gendered control over agricultural activity is likely important when analyzing production and input use questions. The sensitivity of our results to the precise domain (land sales, planting, output) echoes not only De la O Campos et al. (2016), who find similar sensitivity in analyzing productivity in Uganda, but also several other studies, such as Peterman, Schwab, Roy, Hidrobo, and Gilligan (2015) and Seymour and Peterman (2018), which find that measures of women's bargaining power are dependent on how common decision-making questions are constructed, aggregated and interpreted.

By implication, research on the relationship between plot ownership, gender and agricultural labor may not generalize across different definitions of "ownership". Andrews, Golan, and Lay (2014), for example, demonstrate intrahousehold inefficiencies in labor allocations between plots and crops in Uganda, though that finding may be an artifact of defining plot ownership based on output control. Not only do we find that the labor allocations are sensitive to the precise domain, but we also find the linkage across different domains is heterogenous between males and females.

Third, the weaker gender pattern in labor allocation on joint plots is consistent with other studies suggesting such plots do not suffer from the same incentive problems facing plots under the control of a single household member (Andrews et al., 2014; Kazianga & Wahhaj, 2013).

Finally, in both Malawi and Ethiopia, the gender balance of labor followed the gender identity of management rights more strongly than ownership rights. However, in Ethiopia, the gender of the output decision maker matters most for labor allocation, while in Malawi it is the gender of the planting decision maker. If the compensation for agricultural labor is embedded in realizing

[14] This literature has a long tradition since Udry (1996).

the gains from output, the pattern in Ethiopia may simply reflect the implied incentive structure. Household members work relatively more on plots where they can control the output and enjoy the returns on production. The difference in Malawi may owe to the presence of tobacco, whose labor requirements are four times greater than maize, the most common alternative (Negri & Porto, 2016). In our data, the results similarly suggest that in Malawi, but not Ethiopia, cereal cultivation is associated with significantly less labor use. As a consequence of the greater labor variability of crop choice in Malawi, planting decision power may be more closely tied to labor allocation.

8. Concluding remarks

Our empirical findings suggest that control over the various domains of agricultural production influence labor use on corresponding plots. However, an alternative possibility is that the responses to questions of land control are themselves endogenous to labor supply. If that is the case, the implied direction of causality is reversed: the assignment of 'control' over a given plot is determined by the ultimate labor allocation outcome.

The possibility of reverse causality in the relationship between labor allocation by gender and the structure of control is supported by the pattern of results across domains. Own-gender effects are strongest for measures of managerial control—output and planting decisions—and weakest for measures of ownership (i.e. right to sell). Because the right to sell land requires sanction external to the household, it is least susceptible to this form of reporting endogeneity. On the other hand, managerial decisions are fully determined within the household, and therefore most able to endogenously respond to labor allocation outcomes. That codetermination may be particularly acute for households where some members migrate, as even temporary relocations represent allocation decisions of both labor and managerial rights by default. The high correlation we find between reports of female managerial input and female labor provision on a given plot are consistent with the findings of Twyman et al. (2015) in a very different context, Ecuador, which further suggests the possibility of a persistent pattern in survey response. If managerial responses are indeed endogenous, they call into question studies that rely on such demarcations for efficiency tests. Disentangling the direction of the causality is difficult, but one potential avenue is to collect both pre and post cropping season data on domains of control paired with an exogenous shock to labor allocation. Future progress in understanding and improving these measures would be a crucial contribution to the literature on gender and agriculture.

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Appendix A. Supplementary Material

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