Multidimensionality of Land Ownership among Men and Women in Sub-Saharan Africa

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Abstract

Across Sub-Saharan African countries with customary tenure systems and low levels of documented land ownership, there are limited nationally representative insights on men and women landowners' rights over land. Variations in institutions and norms governing land ownership further complicate cross-country comparisons. Using machine learning techniques and nationally representative, intrahousehold survey data elicited in private from men and women on their ownership of assets, this paper creates unique profiles of landowners in Ethiopia, Malawi, and Tanzania, anchored in a range of constructs related to self-reported rights and control over land parcels. The analysis reveals a high degree of cross-country consistency in the new insights. Landowners, particularly women, often do not have full rights and decision-making power over land. Multiple correspondence analysis demonstrates that transfer rights (rights to bequeath, sell, rent out, and use as collateral) contribute the most to the variation in the composition of the constructs related to rights and control over land. Hierarchical clustering shows that landowners can effectively be clustered into three categories: (1) owners with mostly exclusive transfer rights, (2) owners with mostly joint transfer rights, and (3) owners with no/limited transfer rights. Owners with transfer rights tend to have all other rights and measures of control. Women are overrepresented in the cluster of landowners with no/limited transfer rights, and in moving from the cluster with mostly joint transfer rights to the one with mostly exclusive transfer rights, the increase in the share of individuals not needing permission to exercise any right is considerably greater among women than men.

Multidimensionality of Land Ownership among Men and Women in Sub-Saharan Africa

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JEL Codes: C81, C83, J16, Q15.

Keywords: Land Rights, Gender, Household Surveys, Machine Learning, Clustering, Malawi, Ethiopia, Tanzania, Sub-Saharan Africa.

1. Introduction

Land is a primary factor of agricultural production and land ownership has the potential to enhance welfare of households and individuals through multiple channels, including increasing access to liquidity through land rental and sales (Holden et al., 2011; Deininger et al., 2009); providing access to credit through the use of land as collateral (Zhang et al., 2020); and enhancing the wealth of future generations through land bequests (Wineman and Liverpool-Tasie, 2019). Research has also demonstrated the links between land ownership and greater socioeconomic status and participation in intrahousehold decision-making (Kishindo, 2010; Wiig, 2013). The empirical evidence on the impacts of land ownership on development outcomes has, however, revealed context-specificity in the resulting impacts,[2] and of particular importance to this paper, the literature has fallen short of providing representative insights regarding the profiles of the general population of landowners in low-income countries, specifically those in Sub-Saharan Africa that rely heavily on customary tenure systems. There are at least two reasons for the latter.

First, the research has disproportionately focused on a particular definition of ownership: whether individuals are documented owners[3] or reported owners.[4] *Documented land ownership* is a relatively uncommon event in much of Sub-Saharan Africa where customary tenure systems continue to exert significant influence on individuals' use and ownership of land (Chauveau et al., 2007; Doss et al., 2014; Chimhowu, 2019) and many countries face a common struggle in integrating contemporary statutory laws with customary laws (Berge et al., 2014; Ayano, 2018; Dancer, 2017). In customary tenure systems, individuals' *reported land ownership* can entail different sets of rights across localities and population groups, including men versus women; multiple people can be assigned different rights for the same parcel of land; and the scope of individuals' land rights can evolve over time (Ayano, 2018; Witten, 2007). As such, simply knowing reported landowners without information regarding their land rights can underlie

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[2] Carter and Olinto (2003) discuss how the links between land ownership and access credit depend on landholding size and Higgins et al. (2018) argue that land ownership interventions should ensure that lending institutions in targeted localities would have services to help support these objectives. Besley and Burgess (2000) examine different land reforms across stats in India — including policies conferring ownership on tenants after certain periods of time — and find that poverty reduction stemming from specific land reforms depends on the distribution of landownership and local incentives. The links between women's land ownership and intra-household bargaining power and empowerment also vary across countries, depending on local context and other economic opportunities (Meinzen-Dick et al., 2019). Yokying and Lambrecht (2019) discuss, in a study from northern Ghana, how substantial gender gaps continue to persist among landowners in terms of decision-making over cultivation and the use of earnings. Nuances of ownership, including the security of property rights, and joint versus exclusive ownership, also matter in understanding the links between land ownership and development outcomes (Kilic et al., 2021a; Place et al., 1994).

[3] Documented owners are individuals who can claim ownership of an asset through the use of a document that is recognized by the government of that country and that lists the individual as an owner of the specific asset. For land, the type of documentation conferring ownership (and the associated rights) will vary according to the laws and tenure systems in a given country (United Nations, 2019).

[4] Reported owners are individuals who consider themselves to be owners of an asset, irrespective of whether they possess documented ownership of the asset. "Reported ownership measures people's self-perceptions about their ownership status, it need not—and cannot—be objectively verified." (United Nations, 2019: 16)

misleading insights regarding the profiles of landowners and gender differences in land rights in a given country.[5]

In fact, Slavchevska et al. (2021) show how different land rights, such as rights to sell, rent, or bequeath, do not necessarily overlap in Sub-Saharan Africa, and should not be used interchangeably. Relatedly, Kilic et al. (2021b) document that having rights to bequeath and sell land - but not rights to rent out or use as collateral - is significantly linked with investment and cash crop adoption in Malawi, with especially important effects for women. Individuals who are joint owners of the same parcel may also have different decision-making roles as it relates to crop choice, timing of cultivation and input use (Acosta et al., 2020; Twyman et al., 2015). Thus, land ownership should be understood as multidimensional and as a bundle consisting of rights and decision-making in customary tenure systems. In fact, the idea that property ownership contains a bundle of rights has been widely acknowledged in economics (Demsetz, 1967; Alchian and Demsetz, 1973; Schaleger and Ostrom, 1992; and Sikor et al., 2017).

The second reason for the knowledge gaps regarding the profiles of landowners in low-income countries is the fact that the available evidence has been informed by data collected in small-scale studies and the representative insights on land ownership and rights in customary tenure systems have been out of reach due to the gaps in the availability and quality of individual disaggregated survey data. Even if landowners and right holders are individuals, nationally representative survey data on landownership has traditionally been collected at the household-level. And even when the surveys attempted to identify sole or joint landowners were identified within households (and often for each parcel owned by any household member), there have been two major deficiencies in large-scale survey data collection: (a) surveys have not systematically sought to identify exclusive and joint holders of specific rights, alongside reported and documented owners, and (b) individual household members have not been interviewed personally and it has been commonplace for self-identified most knowledgeable household members to identify intra-household landowners and right holders, which resulted in biased measurements of men's and women's land ownership and rights (Kilic et al. 2021b).

Against this background, the first contribution of our paper is to provide cross-country, nationally representative insights regarding land rights among men and women in Sub-Saharan Africa, with a focus on non-residential (primarily agricultural) landowners. The analysis is informed by the nationally-representative household surveys that have been conducted in Ethiopia, Malawi, and Tanzania over the period of 2016-2020 and that have interviewed adult household members in private and collected self-reported, parcel-level information on each respondent's *reported*, *documented,* and *economic*[6] ownership of land, as well as his/her right to invest in, use as collateral, rent out, bequeath, and sell that piece of land. Across these different ownership and rights constructs, respondents were asked whether they had exclusive ownership and rights or held them jointly with other individuals. Additionally, respondents were asked to identify individuals

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[5] Doss et al. (2015) provide a discussion on the nuances of landownership measures and their importance for gender-disaggregated statistics on land.

[6] Economic owners are individuals that report themselves as having control over the proceeds of a land sale in the hypothetical event that a given parcel would be sold.

they need *permission* from before exercising their land rights and the degree of tenure security over the land. Finally, each respondent was asked whether he/she had any *decision-making power* over planting time and crop choice on each parcel. These surveys have been conducted under the World Bank Living Standards Measurement Study-Plus (LSMS+) program,[7] using cross-country comparable survey methods and tools, and in accordance with the international guidelines (United Nations, 2019) for individual-disaggregated survey data collection on asset ownership and control.[8] Compared to the work by Slavchevska et al. (2021) based on household survey data on land ownership and rights as reported by most knowledgeable household members, our analysis relies on self-reported survey data and a wider range of land ownership and rights constructs.

The second contribution of our paper is to introduce the use of unsupervised machine learning (ML) techniques in the analysis of high-dimensional survey data on land ownership and rights – elicited from individuals, at the parcel-level, and based on survey questions on a range of constructs related to self-reported rights to and control over land. The cross-country comparability in questionnaires and respondent selection protocols permits a robust analysis of how machine learning techniques perform in different countries with different institutions and norms around land ownership and rights. The unsupervised ML algorithms are useful for analyzing data without a definite label – in our case, the true "land ownership" type or label is unknown to the researcher. We use multiple correspondence analysis (MCA) and hierarchical clustering to understand how much certain land rights variables matter in distinguishing between different types of reported ownership. Once clusters of different types of reported ownership are identified based on self-reported land rights, we conduct additional analyses that profile landowners within each cluster and across countries as a function of their individual and household attributes. Our methods facilitate a more convenient and data-driven, as opposed to subjective, profiling of landowners based on their self-reported rights (the latter of which often involves, for example, picking one or two rights or decision-making roles to reflect nuances of ownership).

On the whole, the findings show a high degree of consistency across Ethiopia, Malawi, and Tanzania. Despite self-reporting themselves as owners, survey respondents often do not have full rights and decision-making power over their land parcels. There are significant gender gaps in land rights among landowners, in favor of men. Using MCA, we calculate a measure of variance that distinguishes landowners based on the composition of self-reported rights and control over land. Among different land rights and control variables across countries, transfer rights consistently contribute most to this variance. Hierarchical clustering further demonstrates that landowners can effectively be clustered into three categories: (1) owners with mostly exclusive transfer rights, (2) owners with mostly joint transfer rights, and (3) owners who claimed to not have transfer rights or only a limited number of them. Women are over-represented in the cluster of landowners without or with limited transfer rights, and in moving from the cluster with mostly joint transfer rights to

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[7] Please visit www.worldbank.org/lsmsplus for more information on the LSMS+ program. LSMS+ supported surveys over the period of 2016-2021 did collect self-reported, intra-household information on individuals' ownership of and rights to a broad range of physical and financial assets, beyond land.
[8] Compared to the work of Slavchevska et al. (2021), who used household survey data on land ownership and rights as reported by most knowledgeable household members.

the one with mostly exclusive transfer rights, the increase in the share of individuals not needing permission to exercise any right is much greater among women than men.

Moreover, the cluster definitions are robust to feeding into the algorithm a larger or a smaller set of ownership, rights, and decision-making variables. The profiles of owners across the clusters indicate that owners who have transfer rights tend to have other decision-making and rights. These findings, together with the MCA results, imply that household survey questions on land rights can be trimmed down to only include those on transfer rights, without any loss in our ability to cluster landowners. Documented ownership (whose incidence is very low in the three countries) or economic ownership do not appear to be influential in determining rights and decision-making in our sample. This finding is also consistent with the findings of Doss et al. (2014) who have shown that having a land title in Uganda did not guarantee other land rights.

Furthermore, the differentiation of exclusive versus joint ownership and rights variables as part of the hierarchical clustering exercise creates more variation in clusters relative to simpler approaches (as expected) but results in clusters that are much more consistent across countries, which eases cross-country comparisons. This finding reveals not only the importance of eliciting self-reported data on exclusive versus joint ownership and rights arrangements, but also the utility of machine learning techniques in accommodating the high-dimensional survey data and efficiently creating clusters of landowners that facilitate cross-country comparable profiling, particularly across contexts with significant variation in institutions and norms governing land ownership.

The profiling of landowners based on the clustering results provides an entryway to explore further gaps in our knowledge of landownership.[9] In later sections, we analyze gender differences in ownership bundles; the rigidity of bundles (defined as the variation in bundles within a cluster) across countries; how ownership bundles interact with permission structures and decision making; and whether individuals with land use rights are different from landowners in terms of their rights bundles (in a subset of countries where information on land rights are collected also for individuals with land use rights).

The paper is structured as follows. Section 2 of the paper provides a description of the data followed by a discussion of methodology and clustering results in Section 3. Section 4 discusses the variation within a cluster and cross-country differences. With the resulting landowner clusters, Section 5 analyzes each clusters' overall level of ownership, decision-making, and permission status in detail when it comes to their land. Section 6 discusses further sensitivity analysis and Section 7 concludes.

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[9] The importance of transfer rights in distinguishing landowners points to the need of further research on how behavior and outcomes may change depending on whether the landowner has the ability to transfer or not. While the investigation of this research question is outside the scope of this paper, Deininger and Jin (2006) have found that the ability to transfer land, more so than tenure security, provide higher incentive for landowners to invest in their land.

2. LSMS+: Land Rights and Decision-Making Measures in Defining Ownership

2.1 Multidimensionality of Ownership

This paper uses three nationally representative, multi-topic household surveys supported by the LSMS+ program, namely the Tanzania National Panel Survey (NPS4 2018/2019), Ethiopia Socioeconomic Survey (ESS4 2018/2019), and the Malawi Integrated Household Panel Survey (IHPS 2016). The LSMS+ modules on asset ownership and rights are comparable across countries and were administered directly to all household members 18 and older on different asset classes, including ownership and rights to residential and non-residential land (Hasanbasri et al., 2021).[10] A specific emphasis of the survey data collection was on self-reporting and interviewing respondents privately — and hence conducting interviews within the household simultaneously, when possible.[11]

This paper focuses on characterizing landowners' rights and decision-making over non-residential land parcels. A respondent is defined as the reported landowner if they answer upfront that he/she owns the parcel. A *parcel* is defined as a continuous piece of land which can have more than one parcel. Parcels were first identified and rostered through the household questionnaire and then carried forward to individual interviews. Non-residential land in these contexts is mainly used for agriculture. In Ethiopia, for example, 87 percent of non-residential parcels have been used in agriculture in the last 12 months.[12]

Rights and decision-making questions were asked directly to individuals who reported themselves as owners or as individuals with use rights on the land. Since the paper aims to analyze rights associated with ownership, we restrict our sample to those who report themselves as landowners. Later in the paper, however, we address sensitivity of our findings to the inclusion of non-owners with use rights (which is only possible to do in Ethiopia and Tanzania). Most individuals who provided answers on rights and decision making were owners instead of users of land.

For each parcel, respondents are asked about different types of ownership (reported, economic, and documented); rights (to sell, bequeath, use as collateral, rent out, and make improvements/invest); as well as decision-making in the case of agricultural parcels.[13] A detailed list of land rights and ownership variables in the LSMS+ surveys, as well as additional decision-making variables, are presented in Table 1. All countries had the same questionnaire structure and implementation, except for Ethiopia where the right to sell was not asked because land is legally

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[10] Other types of assets were also covered, including financial accounts, and mobile phones. Ownership of livestock was covered in Ethiopia.

[11] The module on land specifically covers all land owned or accessed via use rights and follows the recommendations of FAO, World Bank and UN Habitat (2019).

[12] Ethiopia and Malawi looked at all non-residential land used for agriculture. Tanzania was not restricted to agricultural use only due to missing data on current use.

[13] Along with rights/ownership, respondents reported on how each parcel was acquired; identified the individuals from whom the asset was inherited or received as a gift, as applicable; and provided the current hypothetical sales value for each asset (and the construction costs specifically for the dwelling) and limited information on their knowledge of asset transactions in their communities.

owned by the state and is prohibited to be sold.[14] The scope of rights included in the questionnaire was influenced by Schlager and Ostrom's (1992) theoretical framework which focuses, in the context of natural resources, on issues related to access, withdrawal, management, exclusion and alienation while defining a bundle of rights.

Table 1: LSMS+ Survey Questions on Rights and Decision-Making

Rights over land parcels:

1) **Sell:** Are you among the individuals who have the right to sell the land, even if you need permission or consent from someone else?

2) **Bequeath:** Are you among the individuals who have the right to bequeath the land, even if you need permission or consent from someone else?

3) **Collateral:** Are you among the individuals who have the right to use land as collateral, even if you need permission or consent from someone else?

4) **Rent:** Are you among the individuals who have the right to rent out the land, even if you need permission or consent from someone else?

5) **Improvement**: Are you among the individuals who have the right to make improvements/invest in the land, even if you need permission or consent from someone else?

Additional ownership and decision-making variables:

1) **Documented ownership**: Is your name among the names listed as owners on the document for this land?

2) **Economic ownership**: If the parcel were to be sold today, would you be among the individuals that would decide how the money would be used**?**

3) **Parcel decision-making:** Are you among the decision-makers about the parcel, regarding the timing of crop activities, crop choice, and input use?

Notes: In Ethiopia, the question on selling right was not asked. Questions were asked to individuals who report themselves as the owner or have use rights. In Malawi, questions were asked only to owners.

Additionally, the LSMS+ modules further asked landowners to identify whether ownership is joint or exclusive, and separately whether permission is needed to exercise rights. Up to three household members and two non-household members can be listed who share ownership/give permission. The design and implementation of these modules therefore acknowledges that there are varying

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[14] Ethiopia's constitution established that the right to ownership of land belongs "exclusively to the State and the peoples of Ethiopia." Individuals have the right to use land allocated to them; however, they do not have the right to sell the land. Additional background information on land tenure in Ethiopia can be found in Crewett et al. (2008a), Crewett et al. (2008b), and Dokken (2015).

degrees of ownership which has implication on how decisions are made and bargaining power (Doss et al., 2020; Doss et al., 2011).[15]

One could argue that these variables can already be categorized into bundles of rights depending on the question of interest. Under the Evidence and Data for Gender Equality (EDGE) initiative, for example, the United Nations has emphasized the concept of *SDG ownership*: having either documented ownership, right to bequest, or right to sell.[16] Under Schlager and Ostrom's (1992) classification, on the other hand, rights are designated into three categories: management, alienation, and exclusion. Management rights are related to patterns of use and ability to improve on the land. For example, decision-making and improvement rights over land in the LSMS+ survey modules can be classified into the management category. Exclusion rights are those related to determining who has access or the ability to transfer land, while alienation rights relate to whether the land can be sold or rented. Economic ownership measure, as captured in the LSMS+ survey modules, does not fit into this standard classification. However, economic ownership is still of interest because it provides a more tangible idea of who would receive the valuation of the land when a land transfer occurs. Documented ownership, on the other hand, might increase the land's ability to be transferred or used as collateral as well as an official recognition that would improve its tenure security (see, for example, Sitko et al., 2014; Jacoby and Minten, 2007). Our methodology will help us analyze whether we empirically see these theoretical bundles and categorization in the data. We can contrast how these bundles compare with what the owners view as enough rights to report themselves as landowners.

2.2 What Do the Data Tell Us about Ownership?

Table 2 presents the share of individuals owning non-residential (primarily agricultural) land across the three countries. About a third or more of rural men and women own non-residential land, with a slightly higher share of men than women owning land. While urban respondents are less likely to own non-residential land, the shares are still substantial in urban Malawi and Tanzania — spanning about 19 percent of urban women and men in Tanzania, and 14 and 10 percent of women and men, respectively, in Malawi. Reported ownership masks exclusive and joint ownership which varies by country context. For example, Ethiopia's reported owners are more likely to be joint owners while Tanzania and Malawi have a more equal distribution among the two types of owners.

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[15] A number of papers have discussed the effects of joint ownership and joint titling of land on welfare measures (Wiig, 2013; Newman et al., 2015; Kabumbuli, 2016; Agarwal, 2003).
[16] This is related to the Sustainable Development Goals (SDGs); guidelines can be accessed at https://unstats.un.org/edge/publications/docs/Guidelines_final.pdf

Table 2: Share of Non-Residential Landowners Across Countries

		Ethiopia		Tanzania		Malawi	
		Urban	Rural	Urban	Rural	Urban	Rural
Share of individual landowners							
Men	Reported owner	0.08*	0.33***	0.19	0.37	0.10***	0.30**
	Exclusive owner	0.02	0.06	0.07	0.20	0.04**	0.15***
	Joint owner	0.06	0.29***	0.13	0.20	0.06	0.17
Women	Reported owner	0.06*	0.30***	0.19	0.33	0.14***	0.36**
	Exclusive owner	0.01	0.05	0.08	0.16	0.07**	0.21***
	Joint owner	0.05	0.25***	0.11	0.19	0.07	0.17
Share of household with any land		0.09	0.44	0.23	0.55	0.19	0.50
# of obs (landowner + non-landowners)		8073	7315	1199	1785	1307	3428
# of obs (households)		3655	3115	502	683	649	1799

Notes: Landowners are individuals who self-report as the owner of the land. Significant difference across men and women (conducted within urban and rural areas) are indicated by asterisks: ***p<0.01, **p<0.05, *p<0.1. Some individuals have both exclusive and joint ownership of land which resulted in a higher share of combined exclusive and joint owners relative to reported owners.

Within the sample of non-residential landowners, Figures 1 and 2 illustrate that despite self-reporting as an owner, respondents often do not have full rights and decision-making power over their land parcels. Figure 1 reports the distribution of rights and decision-making variables among landowners across the three countries. Figure 2 shows the number of rights held per parcel by landowners (an individual can own multiple parcels). Consistent with the findings of Slavchevska et. al. (2021), rights tend to not overlap with each other. In Tanzania, for example, the majority of landowners (53 percent) do not have the right to bequeath, while in Malawi, 52 percent of landowners do not have the right to use their land as collateral. Across countries, men are more likely to have these rights than women.

Across countries, less than half of landowners reported having all rights, with the exception of Ethiopia, with men more likely to than women to hold all rights. Figure 2 focuses specifically on rights to bequeath, sell, rent, improve, and use as collateral and reported the number of rights a landowner holds. In Ethiopia, most landowners have all four rights (right to sell is not allowed by the state), covering nearly three-quarters of landowners. In Tanzania and Malawi, on the other hand, more than half of landowners do not have all rights to land.

Additional differences arise with documented ownership (Figure 1), which is about 80 percent among landowners in Ethiopia, but significantly more limited in Malawi and Tanzania. Starting in 1996, Ethiopia pursued a land certification program which is one of the most ambitious among Sub-Saharan Countries. Holden et al. (2011) discuss how the land certification program helped enhance rental land market participation in Ethiopia. Women landowners were especially affected by the certification program. Since men tend to be the ones who cultivate land, women have less

land tenure security than men in Ethiopia. In Tanzania, documentation remains rare despite the 1999 Village Land Act which recognizes customary land rights through the Customary Right of Occupancy (Kironde, 2009; Fairley, 2013). This, however, has not prevented the buying and selling of lands through informal means (Kironde, 1995).

Figure 1: Incidence of Non-Residential Parcel-Specific Rights, Ownership and Decision-Making Measures, by Gender of Self-Reported Landowner
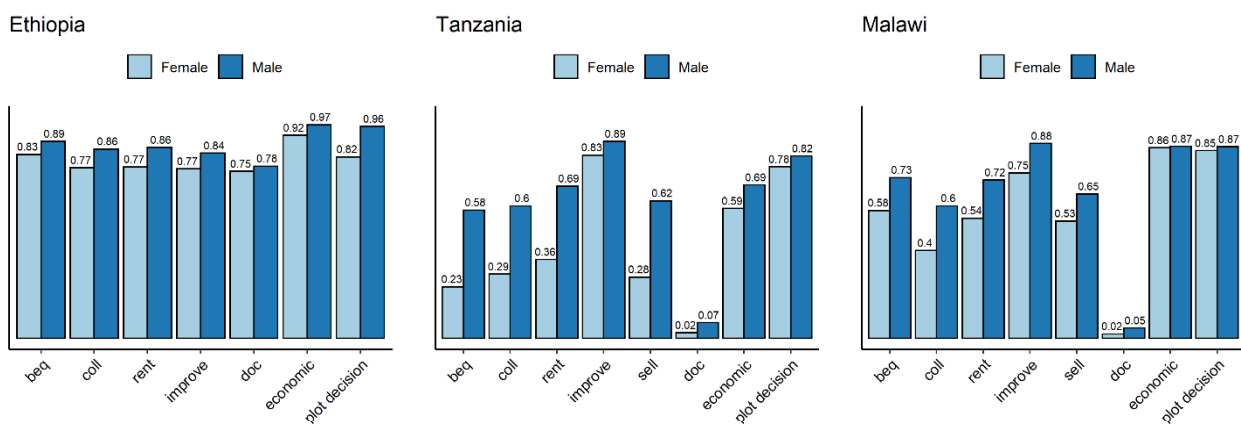
Notes: The figure illustrates proportions of male and female non-residential landowners who hold specific rights or decision-making role for a piece of land. The unit here is an individual-parcel level observation since a landowner may own multiple parcels and have unique rights associated with the parcel. Landowners are those who self-reported as the owner of the land. For Malawi, there is a statistically significant difference across gender for all variables except for plot decision and economic. For Ethiopia, only document ownership is not statistically different by gender. For Tanzania, only plot decision is not statistically different by gender.

While gender gaps are prevalent across countries for different aspects of land ownership and rights, gaps vary by type of right and ownership, and tend to be the widest in Tanzania. In Tanzania, statutory law has emphasized equal rights to land for both men and women. The state prohibits discriminatory acts that deny women land rights under customary law. Spouses also are not allowed to sell land without the consent of the other. In practice, however, discriminatory practices may still occur under customary law, and substantial gender gaps in land ownership and rights persist (Chan et al., 2016; Slavchevska et al., 2021; Dancer, 2017; Hasanbasri et al., 2021). Overall, Figure 1 shows that about 58 percent of men landowners in Tanzania claimed having rights to bequeath land, compared to 23 percent of women landowners. Rights to improve land, on the other hand, are held by over 80 percent of men and women, with narrower gender gaps for economic ownership and parcel decision-making as well.

**Figure 2: Distribution of Number of Non-Residential Parcel-Specific Rights
Held by Self-Reported Landowner, Broken Down by Gender of Self-Reported Landowner**
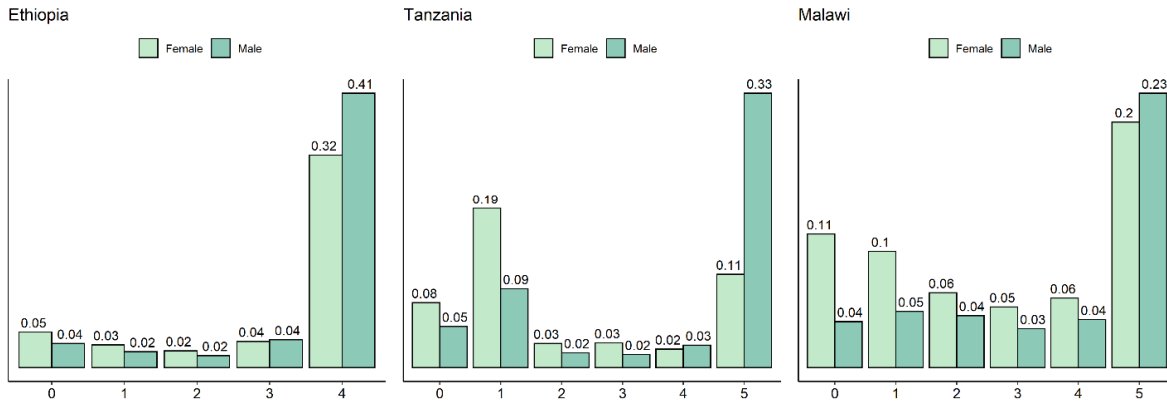
Notes: The figure illustrates proportions of male and female non-residential landowners who hold a specific number of rights for a piece of land. The unit here is an individual-parcel level observation since a landowner may own multiple parcels and have unique rights associated with the parcel. Landowners are those who self-reported as the owner of the land. For Ethiopia, only four rights are available since landowners are not allowed to sell according to state law.

In Malawi, similar tensions exist between statutory and customary law. The National Land Policy, for example, introduced the concept of equal rights to inheritance for men and women while the status quo relied on lineage-based tenure systems in matrilineal and patrilineal regions (Berge et al., 2014; Tschirhart et al., 2018). At the local level, whether norms are matrilineal (more common in Central and Southern Malawi) or patrilineal (more common in Northern Malawi) have a bearing on individuals' land rights (a relatively understudied research topic according to Berge et al., 2014), and land is often not sold outside the family lineage (Berge et al., 2014). Within matrilineal marriages, women are therefore more likely to own land, as reflected in Table 3 and Figure 3. Figure 3 does show, however, that even among owners in matrilineal marriages, men continue to have higher share of rights and decision-making — although the gender disparities are smaller than in patrilineal marriages.

Table 3: Share of Non-Residential Landowners Across Countries

		Matrilineal Marriages		Patrilineal Marriages	
		Urban	Rural	Urban	Rural
Share of individual landowners					
Men	Reported owner	0.13	0.32***	0.18	0.44***
	Exclusive owner	0.08	0.16***	0.04	0.27***
	Joint owner	0.05	0.19	0.15	0.21
Women	Reported owner	0.17	0.50***	0.17	0.32***
	Exclusive owner	0.11	0.35***	0.05	0.12***
	Joint owner	0.06	0.19	0.12	0.22
# of Observations (Married Landowners)		459	1350	376	1085

Notes: The analysis is conducted at the individual-level. Statistically significant gender differences are highlighted in red. Significant difference across men and women (conducted within urban and rural areas) are indicated by asterisks: ***p<0.01, **p<0.05, *p<0.1.

Figure 3: Incidence of Non-Residential Parcel-Specific Rights, Ownership and Decision-Making Measures, by Gender of Married, Self-Reported Landowner and Marriage Type
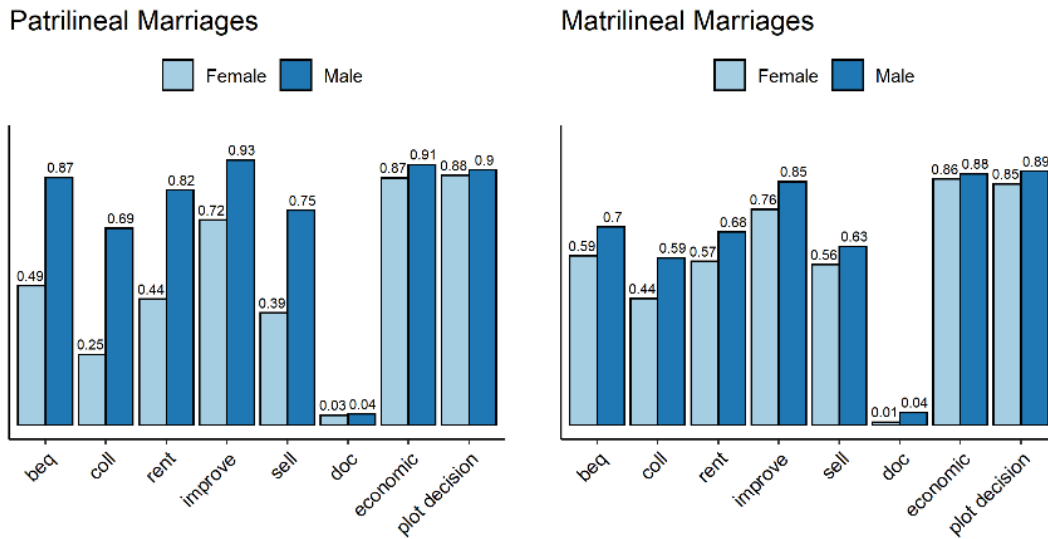
Notes: The figure illustrates proportions of male and female non-residential landowners who hold a specific number of rights for a piece of land. The unit here is an individual-parcel level observation since a landowner may own multiple parcels and have unique rights associated with the parcel. Landowners are those who self-reported as the owner of the land. Only married landowners and associated parcels are used.

By covering different categories of ownership and rights, the LSMS+ survey modules help shed light on the multidimensionality of land ownership and rights. The figures above highlight the difficulty of subjectively choosing which rights one should focus on, especially in Tanzania and Malawi where land variables are less likely equally held among landowners. Using all the variables for an analysis may not be ideal since there could be a lot of correlation between variables. On the other hand, choosing one variable as a proxy for property rights is also problematic since it is

unclear what exactly one is measuring with the proxy. To achieve a more objective categorization, this paper uses a clustering exercise to find which variables differentiate landowners the most with the aim of finding an aggregate categorization of ownership.

3. Methodology

In this section, we briefly discuss the two main methodologies used in this paper: Multiple Correspondence Analysis (MCA) and Hierarchical Clustering with Principal Components (HCPC).[17]

3.1 Multiple Correspondence Analysis Using Land Rights Data

Factor Analysis methods, such as Principal Component Analysis (PCA) and MCA are dimensionality reduction techniques. These methods can be used in exploratory data analysis to identify important patterns in the data, particularly when there are a large number of correlated variables. MCA is an extension of PCA that is used when all variables are categorical with multiple levels without necessarily an order. The discussion below will focus solely on MCA given the type of data that we use.

Factor analysis methods have a long history of being used in other disciplines (Abdi and Williams, 2010) and in a number of economic studies to reduce the dimensionality of data. In labor economics, a single measure of skill can be derived using PCA when multiple skill variables are available (see Autor et al., 2003; Antonovics and Golan, 2012). In the macro literature, factor analysis is useful since multiple economic measures are highly correlated. Gregory and Head (1999) used dynamic factor analysis to find a single measure of common economic activity among G7 countries. Factor analysis can also be used in modeling asset returns and economic forecasting (for example Ludvigson and Ng, 2009). In the development context, PCA has been used to create a wealth index. The Demographic and Health Survey (DHS) uses PCA on household durables data to create a single wealth index measure separately for urban and rural households. Most studies that use PCA typically assign the first principal component as the index measure that summarizes the data.

For our purposes, MCA helps in better understanding land ownership in two ways. First, we are able to analyze which variables (based on their variance) distinguish different types of right bundles/profiles. Second, since MCA provides a transformation of the data from categorical to continuous variables, we can use the continuous variables for the hierarchical clustering method that will categorize individuals into groups with a similar rights profile. Common clustering methods, such as hierarchical clustering and k-means clustering, rely on continuous variables instead of categorical.

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[17] For a more theoretical discussion on these methodologies, please refer to Abdi and Valentin (2007), Husson et al. (2017) and Pagès (2014).

MCA receives an input of variables and then constructs a number of components (also known as factors or dimensions). These components correspond to the eigenvectors of the variables' correlation matrix and are ordered based on which component contains the most variance to the least. Each component/dimension summarizes x% of the total differences in information, this is analogous to each dimension containing x% the total variance seen in the original data.

Following the notation from Pagès (2014), one can calculate the differences between two individuals i and j as

$$d^2(i,j) = \sum_k \frac{p_k}{J}\left(x_{ik} - x_{jk}\right)^2$$

such that $x_{ik} = \frac{y_{ik}}{p_k}$ where p_k is the proportion of individuals belonging to category k in variable j. J denotes the number of variables while K is the number of categories.

A measure of distance can also be calculated between an individual and an average individual (called the individual at the center of gravity G_I). By summing up all the distances between the individual and G_I, we have calculated the total variance or total inertia.

$$Total\ Inertia\ \left(\frac{N_I}{G_I}\right) = \sum_i p_i\, d^2(i, G_i) = \frac{K}{J} - 1$$

where p_i is the weight of an individual if available, otherwise is constant across individuals.

In our data sets, there are thousands of parcel-individual level observations. Analyzing how different these observations are with each other is not very useful. The total variance, however, can also be expressed in terms of the sum of distances between different categories, called the duality principle. The variance of category k can be written as,

$$Var(k) = \sum_i p_i \left(\frac{y_{ik}}{p_k} - 1\right)^2 = \frac{1}{p_k} - 1$$

3.1.1. MCA Results: Ethiopia

We continue the discussion by focusing on the correlation between variables and the principal components (dimensions), as provided by MCA. The principal components are newly created variables that are a mixture of linear combinations of the original variables. The first dimension is the axis that explains the most variance in the data, followed by the second axis which is orthogonal to the first dimension, and so on. Figure 4 below presents the MCA results for Ethiopia using all land ownership variables. The first dimension is the x-axis and explains 28.3 percent of the total variance, while the second dimension is the y-axis and explains 26.2 percent of the total variance. To understand how landowners differ by combinations of rights and land ownership bundles, we need to understand which variables are contributing the most to the variance in the data.

The graph on the left of Figure 4 plots the categories with respect to the first and second dimensions. Categories that are correlated with each other are closer in proximities and categories that are opposite to each other are negatively correlated. The newly created principal components are not always interpretable. In our case, however, there seems to be a clear pattern that characterizes the first and the second dimensions. The second dimension differentiates landowners by whether they own or not own most rights. Joint and exclusive categories lie below 0 in the y-axis. The x-axis then separates joint ownership and exclusive ownership. Figure 4 shows that landowners typically fall in one of three categories: "mostly joint," "mostly exclusive," or "not hold," the latter of which refers to not holding most or all rights.

Figure 4 also color codes the categories based on their cosine-squared, a measure indicating the importance of a given dimension for the category. For a particular category, adding up the cosine-squared of every dimension will sum up to 1. The category "bequeath-not hold" for example has a high cosine-squared of approximately 0.8 for dimension 1 and 2 as shown in the left graph of Figure 4. This indicates "bequeath-not hold" is well represented in the first two dimensions but not necessarily in the other dimensions. Categories related to economic ownership, parcel decision-making, and documented ownership show a lower cosine-squared for the first two dimensions.

The graph on the right of Figure 4 reports how much a variable contributes to the variance in each dimension. Rights to use as collateral, rent out, bequeath, and improve are the variables that are contributing the most to both dimensions. Since the two dimensions explain 54.5 percent of the variation in the data, this shows that the transfer rights variables are key drivers of this variation.

Figure 4: MCA Results for Ethiopia using All Land Ownership Variables
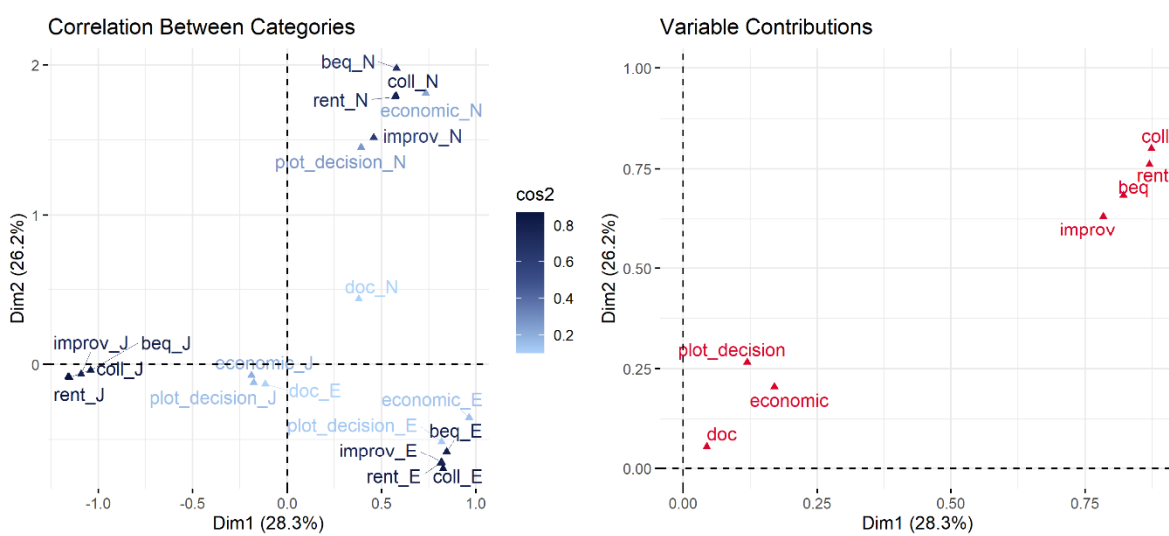
Do parcel decision-making, economic ownership and documented ownership matter at all for explaining the rest of the variance? Upon further investigation, parcel decision-making and

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economic ownership do have a greater contribution to dimensions 3 and 4, while documented ownership seems to mostly contribute to dimensions 4 and 5. These latter dimensions, however, explain a lesser portion of the total variance as seen in the scree plot in Figure 5 below. Dimension 5, for example, only explains 6.6 percent of the total variance which are being driven by document ownership.

Figure 5: Ethiopia MCA All Land Variables Scree Plot
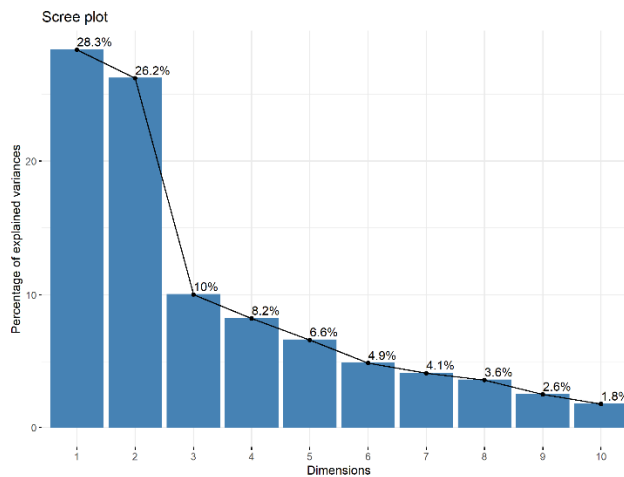
Notes: The scree plot explains the percentage variance explained by each dimension. The MCA conducted uses all land related ownership variables.

The MCA results for Ethiopia highlight a few key findings with respect to land ownership variables. First, there is a key separation between transfer rights (bequeath, collateral, rent) and the rest of the variables, namely economic ownership, document ownership, decision-making.[18] Second, rights variables are highly correlated with each other. In the case of Ethiopia, all contribute approximately the same amount to the first two dimensions of the MCA. Having one of these rights makes one very likely to receive all of these rights jointly or exclusively.

3.1.2. MCA Results: Tanzania and Malawi

The findings for Tanzania and Malawi, shown in Figure 6 and Figure 7, are similar to the results for Ethiopia. Documented ownership, which was quite low in both countries, was not included in the MCA analysis.[19] The figures still exhibit the separation of rights and decision-making variables. One exception is for improvement rights, which do not contribute as much as the other rights in both Tanzania and Malawi. As compared to other rights variables, in Tanzania, the

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[18] In Ethiopia, the right to improve does follows a similar pattern as transfer rights. However, this pattern is only observed in Ethiopia. Separating the right to improve from transfer rights is consistent with the results of other countries and does not change the results for Ethiopia in future analysis.

[19] MCA is quite sensitive to very low proportions.

contribution of improvement rights on the two dimensions is similar to contributions of parcel decision making and economic ownership. Not all rights variables necessarily exhibit similar patterns.

Figure 6: MCA Results for Malawi using All Land Ownership Variables
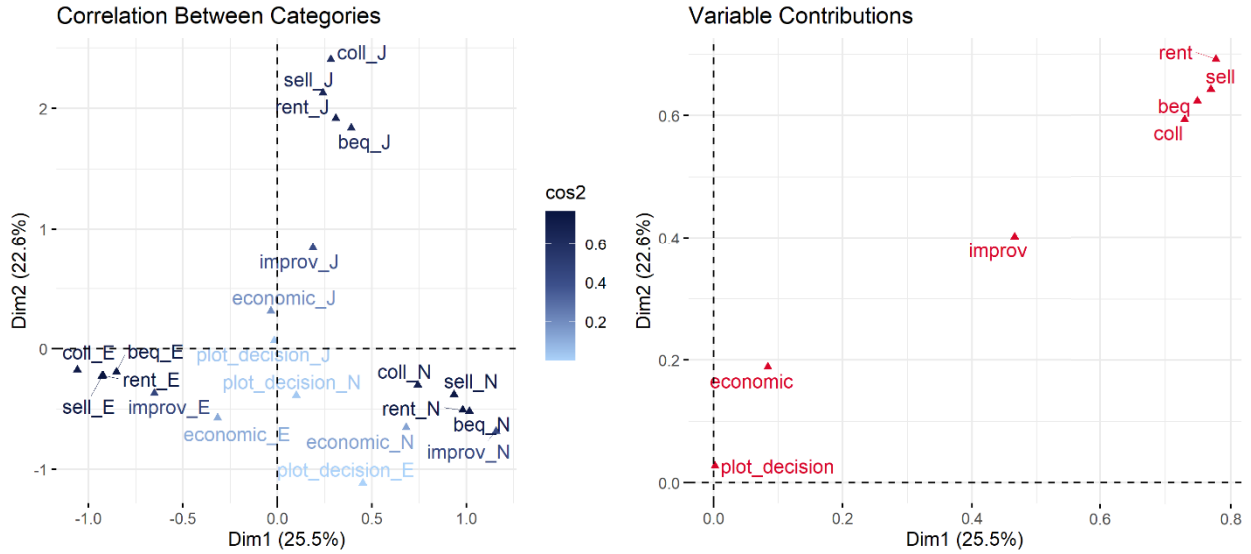
Figure 7: MCA Results for Tanzania using All Land Ownership Variables
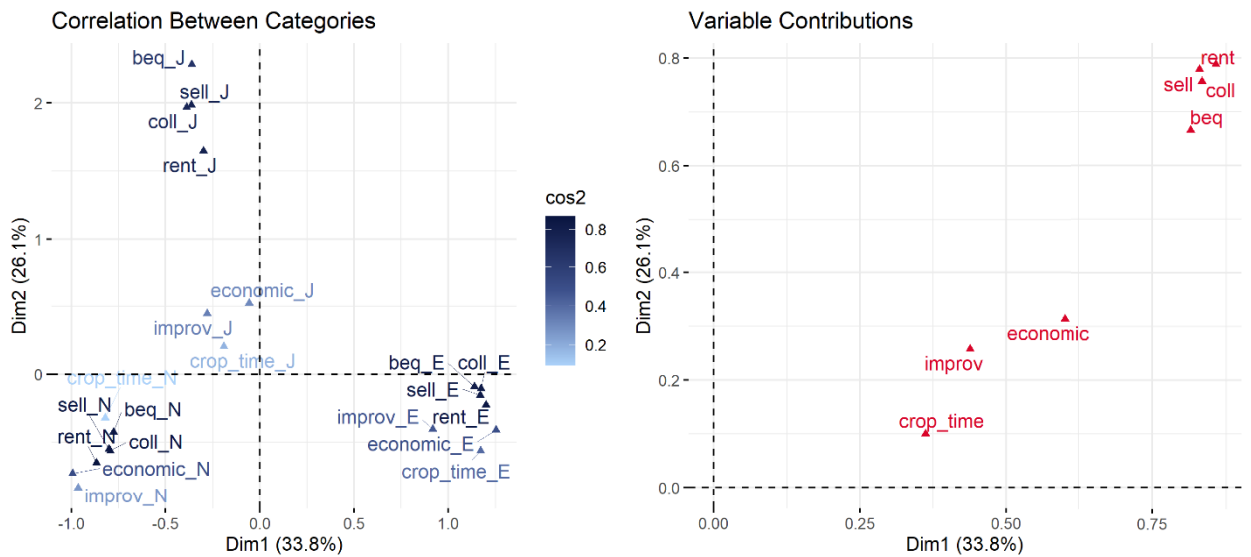
3.2 Hierarchical Clustering

Using the resulting components from MCA, we conduct Hierarchical Clustering on Principal Components (HCPC). The hierarchical clustering algorithm is quite intuitive and relies on grouping together observations that are the most similar. Our measure of dissimilarity would be the Euclidean distance on the components from the MCA. The dissimilarity between landowner-parcel *i* and landowner-parcel *l* is equal to

$$d^2(i, l) = \sum_m (x_{im} - x_{lm})^2$$

where *m* is a component. Each landowner-parcel observation has value x_{im} for component *m*.

Hierarchical clustering identifies the main groupings by building a tree-like structure. We will use an agglomerative algorithm to build the tree. The algorithm starts by treating all observations as a single cluster, at the roots of the tree. First, the two observations with the least Euclidean distance are identified and connected side-by-side. These two then are grouped together in a new cluster. For this new cluster and all the remaining observations, the Euclidean distance is recalculated again to find the two most similar groups, which are then linked as well.[20] The algorithm keeps repeating this step until all observations/clusters are linked, creating a hierarchical tree.

Once a dendrogram is created, one needs to partition the tree into smaller clusters. The HCPC method chooses the highest quality partition to determine the final clusters. A good quality partition ensures the minimum variance within a cluster (landowners within a cluster are the most similar) and maximizes the variance across clusters (landowners belonging to differing clusters are very different).

3.3 Clustering Results and Robustness Checks

The MCA analysis has shown that the transfer rights contribute the most to the variation in the composition of a wider body of constructs related to self-reported rights to and control over land. Consequently, we further restrict our specification for hierarchical clustering to use only the five rights variables (bequeath, sell, rent, improve, and use as collateral). Focusing on these rights also improves the conceptualization and interpretation of the resulting clusters.

As a robustness check, we compare how the results change when we base the clusters on all land-related variables versus only rights variables. The resulting tabulations are presented in Table 4. Very similar clusters result in either approach, with about less than 3 percent of individuals assigned to different clusters depending on the method. This confirms that rights variables are what drives the algorithm in choosing the cluster categories, even when other variables are fed into the algorithm. MCA results using only rights variables are consistent with MCA discussed in the previous section and are provided in the appendix.

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[20] For the previously new created cluster that encompasses two observations, one can use the mean of the two observation and find the Euclidian distance between this mean and the other observations.

Table 4: Cross-Tabulations of Clusters Based on All Variables vs. Only Variables on Rights

Ethiopia				Tanzania				Malawi			
Cluster w/ All Variables				Cluster w/ All Variables				Cluster w/ All Variables			
Cluster w/	1	2	3	Cluster w/	1	2	3	Cluster w/	1	2	3
Right Variables				Right Variables				Right Variables			
1	33.95	0.26	0.13	1	46.84	0.00	1.20	1	44.64	0.00	0.15
2	0.32	19.34	0.16	2	0.24	17.69	0.00	2	0.00	14.28	0.00
3	1.26	0.63	43.95	3	0.08	0.08	33.87	3	1.24	0.21	39.48
Sum of Diagonal			97.24	Sum of Diagonal			98.40	Sum of Diagonal			98.40

Notes: The table reports the cluster in which the landowner is assigned to. Those assigned in the diagonal are the proportion of landowners that were grouped to the same people in both clustering algorithms.

As an additional check, we further analyze different combinations of rights variables in creating clusters. Given that the MCA analysis shows that the right to make improvements on land does not exhibit similar patterns as the other rights, one could potentially take out the right to improve from the clustering algorithm without changing the resulting cluster categorization significantly. When comparing clustering results with all variables and transfer rights (right to use as collateral, bequeath, rent, and sell), and dropping improvement rights, we found that 94 percent of landowners in Malawi), 97 percent in Ethiopia, and 99 percent in Tanzania were groups in the same three clusters.[21] For the rest of the paper, our preferred specification for hierarchical clustering is based on the four transfer rights (without the right to improve).

In Table 5, we experiment with taking out each transfer right one by one, to see how the results change. Again, the clusters created by different combinations of rights are quite robust, with more than 90 percent of individuals generally being grouped the same way. One exception is Ethiopia, where clustering across two rights were effectively compared after dropping one (the right to sell was not available, given how land markets operate in the country, and improvement was automatically taken out in this exercise) and the algorithm created more than 3 clusters. Fortunately, there were only 3 clusters with the most observations, which is what was counted in Table 5, but this resulted in a lower percentage of matches in Ethiopia. For Ethiopia and Tanzania, taking out the right to use as collateral from the algorithm created the least percentage of matches but still fairly large. For Malawi, taking out the rights to bequest, sell or collateral provides a similar percentage of matches.

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[21] Interestingly, neither documented nor economic ownership in Ethiopia followed similar patterns as the right to transfer variables in the MCA. These two variables have to do with land transfers; however, the results indicate that they are separate from the rights to transfer in the country.

Table 5: Extent of Identical Cluster Assignment After Omitting a Specific Right

Clustering w/ 3 rights variables instead of 4	Sum of diagonal		
	Ethiopia	**Tanzania**	**Malawi**
w/o bequest	89.66	98.64	94.23
w/o sell	N/A	96.96	94.02
w/o collateral	**85.42**	**95.44**	94.18
w/o rent	86.16	97.28	96.34

Notes: In Ethiopia, the right to sell was not asked.

In Table 6, we compare the clustering results based on only one right, as opposed to the set of rights together. The results are consistent with findings in Table 5 which shows that the right to use land as collateral has one of the most important roles in Ethiopia and Tanzania. The right to sell, on the other hand, was more closely aligned to the clustering result for Malawi.

Table 6: Extent of Identical Cluster Assignment After Omitting All but One Right

Comparing cluster using all rights with individual right variable x	Sum of diagonal		
	Ethiopia	**Tanzania**	**Malawi**
bequest	92.66	91.27	86.96
Sell	N/A	**94.64**	**90.82**
collateral	**94.92**	**94.08**	85.41
Rent	**94.50**	92.79	88.97
improvement	84.10	57.00	63.40

Notes: The table reports the cluster that the landowner is assigned to. Those assigned in the diagonal are the proportion of landowners that were grouped to the same people in both clustering algorithms.

The issue with using only one right, as seen in Table 6, is that there are landowners who only have one or two rights and not fully all. Using an aggregate land ownership variable from a clustering algorithm will capture this but using an individual variable as a proxy would not. However, for certain countries such as Ethiopia and Tanzania, using transfer one right variable would give a similar result as the cluster with limited loss of information (approximately 94% of information is consistent with clustering results).

Given the importance of the four transfer rights, in the following analysis we maintain the clusters based on these rights and further explore cross-country differences in clusters, as well as in relation to landowner characteristics. It is worth keeping in mind that the clustering results separates landowners in terms of transfer rights when interpreting results in the next section.

4. Cluster Distribution and Composition across Countries

Although the analysis leads to every country having the same three clustering categories (joint, exclusive, and not holding transfer rights), the distribution of landowners across the three clusters differs by country. In this section, we use the clustering results to illustrate key differences across countries in the distribution of clusters, as well as the variation of rights within a cluster. The variation of rights within a cluster refers to whether bundles are mostly the same, i.e., the majority of landowners in a given cluster have the same bundle of rights, which can also be thought of as the "rigidity" of the cluster.

4.1 Comparison of Clusters within a Country

Figure 8 summarizes the proportion of landowners in each cluster by gender; Figure 8a presents country-by-country comparisons, and Figure 8b compares landowners in Malawi by whether they are in matrilineal/patrilineal marriages. Looking first at Figure 8a, when considering men and women together, the exclusive cluster consists of about 40-50 percent of all landowners. With the exception of Malawi, men are more likely to be in the exclusive cluster compared to women. Interestingly, a large share of landowners falls into the cluster of mostly not having transfer rights ("not hold" cluster) on their land – 42 percent in Malawi, 44 percent in Tanzania, and 21 percent in Ethiopia. These findings further underscore the importance of considering rights alongside reported ownership to more accurately characterize landowners' range of responsibilities and control over parcels.

There are substantial gender differences within this cluster as well, for example in Tanzania where women are more likely to be in the not hold cluster (29 percent of women, compared to 15 percent of men). Whether landowners fall in the joint ownership cluster varies more by country, with a lower share in Malawi and Tanzania, but a higher share in Ethiopia. Within Ethiopia, the magnitude of gender differences is also smaller within clusters.

Figure 8: Distribution of Landowners by Clusters

8a. Across Countries

8b. By Marriage type (Malawi)
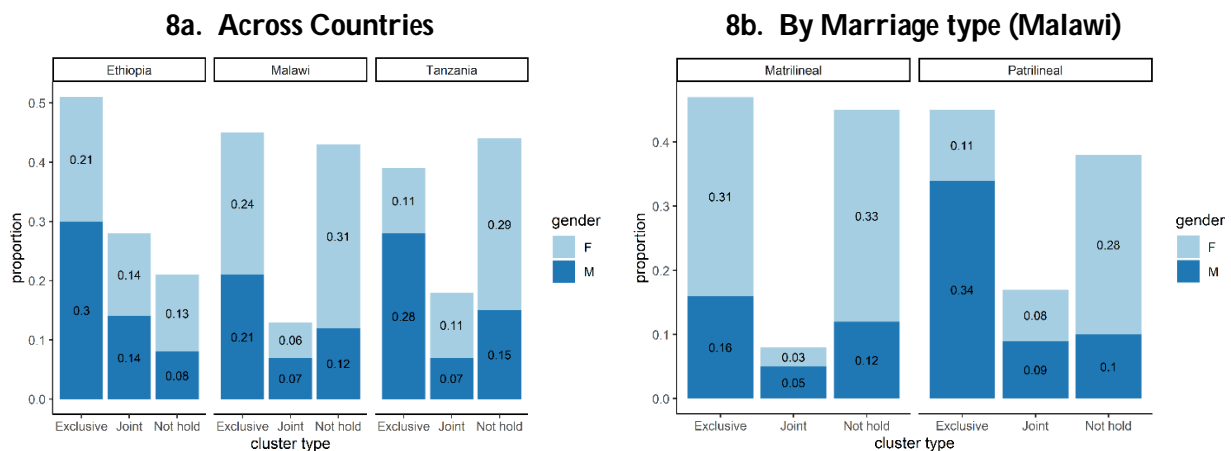
Notes: The figure shows the proportion of reported owners that belong to a cluster type. For each country, the proportions add up to one. Raw sample calculations (not weighted) of landowner observations are reported. The figure on the right is for married individuals only in Malawi.

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At a glance, Malawi's cluster distribution for exclusive rights is quite balanced. Country level statistics, however, mask differences between matrilineal and patrilineal communities. When parsing the Malawi data into matrilineal and patrilineal marriages (Figure 8b), one observes stark gender differences in the compositions of clusters. Women landowners in matrilineal marriages are more likely to be in exclusive clusters (31 percent, compared to 16 percent for men) and vice versa for patrilineal marriages (12 percent, compared to 35 percent for men). For the "not hold" cluster, the majority in both customs are female. There are more joint landowners in patrilineal marriages as well.

4.2 Rigidity of Rights Bundles within a Cluster

Within a cluster, we find substantial variation in bundles of rights (Table 7). In Malawi, for example, the cluster in the first column reflects about 60 percent of observations (landowner-parcel level) that do not have the right, in the following order, to bequest, collateral, rent, and sell ("NNNN"). The second most commonly recurring bundle type is ENNN (bequeath is exclusively held and no other rights held), reflecting about 7 percent of observations.

Cluster bundles vary in terms of their rigidity, or how much rights vary within a cluster. Ethiopia has the least variation in rights bundles. The majority in the "exclusive" cluster (approx. 84 percent) hold exclusive rights for all four rights, while 88 percent in the "joint" cluster hold all joint rights. When one randomly chooses a parcel-landowner combination from Ethiopia who has a right to bequeath, for example, there is a high probability that this landowner will also have the other two transfer rights. Within Ethiopia, for the cluster where rights are mostly not held, 65 percent of landowners hold no rights at all (NNNN) — a substantial number but nevertheless reflecting less rigidity than Tanzania.

For Tanzania and Malawi, the "joint" cluster has more variation of bundles; 52 percent of landowners have all joint transfer rights in Tanzania and 36 percent in Malawi. As discussed earlier, the joint cluster does have fewer observations in these two countries compared to other clusters. In Malawi, especially, those with joint rights tend to also have some exclusive or no rights in their bundles.

Given the variation in rights bundles observed in the data, having a machine learning algorithm prevents researcher bias when assigning individuals to a cluster and is more efficient in doing so compared to assigning individuals manually.

Table 7: Bundles of Rights Belonging to a Cluster by Country (Agricultural Land)

Malawi

Type of rights in order: bequest, collateral, rent, sell
Not Hold (**N**), Jointly Hold (**J**), Exclusively Hold (**E**)

Cluster 1: Mostly Not Hold		Cluster 2: Mostly Joint		Cluster 3: Mostly Exclusive	
Rights Bundle	%	Rights Bundle	%	Rights Bundle	%
NNNN	61.22	JJJJ	37.96	EEEE	75.67
ENNN	6.72	JNJN	10.7	ENEE	11.12
JNNN	5.09	JNJJ	8.2	EEJE	2.15
NNEN	4.99	EJJJ	5.35	EEEN	1.89
ENNE	4.02	JEEJ	4.43	EENE	1.63
ENEN	3.52	NNJJ	3.95	NEEE	1.58
NNNE	3.33	EEJJ	3.69	EEEJ	1.54
NNJN	2.54	JNNJ	3.52	JEEE	1.17
NNEE	1.78	JJJE	2.65	ENJE	0.98
NNNJ	1.1	JEJJ	2.5	EJEE	0.97
NJNN	1.03	JJEJ	2.3	JNEE	0.54
EENN	0.89	JEJE	2.08	ENEJ	0.33
NEEN	0.8	JNJE	1.9	EEJN	0.22
JNEN	0.78	NJJN	1.79	NEJE	0.11
ENJN	0.76	JJJN	1.74	JEEN	0.1
NENN	0.33	EJJE	1.49		
JNNE	0.32	EJEJ	1.13		
ENNJ	0.24	JJNN	0.66		
EJNN	0.21	NJJJ	0.59		
NENE	0.11	JJEN	0.41		
NNJE	0.1	EJJN	0.36		
NEJN	0.1	JJEE	0.35		
		JNEJ	0.3		
		JJNJ	0.29		
		NJJE	0.29		
		JENJ	0.29		
		NEJJ	0.28		
obs	932	obs	303	obs	914

Tanzania

Type of rights in order: bequest, collateral, rent, sell
Not Hold (**N**), Jointly Hold (**J**), Exclusively Hold (**E**)

Cluster 1: Mostly Not Hold		Cluster 2: Mostly Joint		Cluster 3: Mostly Exclusive	
Rights Bundle	%	Rights Bundle	%	Rights Bundle	%
NNNN	87.35	JJJJ	51.35	EEEE	82.21
NNJN	4.28	NJJJ	10.91	EEJE	4.99
NNEN	1.75	NNJJ	7.71	EEEN	3.64
NNNE	1.56	NJJN	6.37	NEEE	3.13
ENNN	1.31	EJJE	6.37	ENEE	2.42
NJNN	1.25	EEJJ	4.12	NNEE	1.61
NENN	0.85	EJJJ	4.11	ENJE	0.44
NNNJ	0.62	JEJJ	3.92	ENEN	0.35
NNEJ	0.32	JEEJ	1.81	EJEE	0.35
ENNE	0.28	JJJN	1.03	NEEN	0.32
JNNN	0.20	JEJE	0.87	EEEJ	0.26
NEJN	0.16	JJEJ	0.56	NENE	0.13
NJEN	0.06	EJJN	0.48	EEJN	0.07
JNEN	0.02	JNJJ	0.20	NJEE	0.07
		NJNJ	0.14	JEEE	0.02
		JJJE	0.06		
obs	612	obs	225	obs	472

Ethiopia

Type of rights in order: bequest, collateral, rent
Not Hold (**N**), Jointly Hold (**J**), Exclusively Hold (**E**)

Cluster 1: Mostly Not Hold		Cluster 2: Mostly Joint		Cluster 3: Mostly Exclusive	
Rights Bundle	%	Rights Bundle	%	Rights Bundle	%
NNN	65.42	JJJ	87.93	EEE	84.78
ENN	14.39	JJE	3.16	JEE	4.72
JNN	10.75	JEJ	2.12	EEN	2.96
NNE	6.12	EJJ	2.05	ENE	2.64
NNJ	1.97	JJN	1.90	NEE	1.27
NEN	0.68	NJJ	1.65	EEJ	1.27
NJN	0.67	JNJ	1.19	EJE	1.25
				JEN	0.52
				ENJ	0.23
				JNE	0.17
				EJN	0.11
				NJE	0.05
				NEJ	0.02
obs	746	obs	1,338	obs	1,844

Notes: The table reports rights bundle for a parcel-individual level observation that is assigned into a cluster.

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5. Ownership Bundles, Decision-Making, and Permission Structures by Cluster

The previous section highlighted the importance of transfer rights for profiling landowners. The descriptive statistics in Tables 8-10 show that in all countries, those having transfer rights, either jointly or exclusively, will almost always have roles in decision making, economic ownership, and the right to make improvements. In Tanzania, for example, women in the joint and exclusive right clusters all reported having the right to make investments in/improve the parcel. Those not having transfer rights still enjoy these decision-making and management powers but to a lower extent. In some cases, there are large gaps — in Ethiopia, for example, only 27 percent of non-landowners indicated they had the right to make improvements, even though a high share in this group had economic ownership (79 of men and 62 percent of women) as well as decision-making power (89 percent of men and 82 percent of women). Despite having low levels of documented ownership, most reported landowners do have tenure security in Ethiopia and Tanzania, with higher reported rates of secure tenure among women having mostly exclusive rights.[22]

Furthermore, the LSMS+ surveys included unique questions on whether permissions are needed for respondents to exercise each right, revealing some interesting differences across clusters. While landowners having exclusive transfer rights exhibit similar patterns on decision-making roles vis-à-vis those having joint transfer rights, permission structures look very different across these groups, and more likely to affect landowners in mostly joint clusters. The statistics on needing permission at the bottom of Table 8 through Table 10 are provided just for joint and exclusive clusters in columns (2) and (3), since the number of individuals with rights for the not-hold clusters (column (1)) is small. In some countries, we find that a high share of landowners need permission to exercise rights. In Ethiopia, for example, men and women with mostly joint rights reported always needing permission, as well as 75 percent of men and 84 percent of women in the exclusive cluster. The comparable levels are lower in Malawi and Tanzania. Permission is not necessarily needed to exercise all rights (this applied to about 60 percent of mostly exclusive landowners in Ethiopia, and only around 20 percent in Malawi and Tanzania). Again, the numbers are much higher for the joint clusters. We also find that the increase in the share of respondents not needing permission to exercise any right over land (when moving from those who have mostly joint rights to mostly exclusive rights) is much greater for women as compared to men.

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[22] Data on tenure security for Malawi was not available. In Ethiopia and Tanzania, respondents were asked "on a scale from 1 to 5, where 1 is not at all likely and 5 is extremely likely, how likely are you to involuntarily lose ownership or use rights to this parcel in the next 5 years?" Our secure tenure variable takes the value 1 for the response "not at all likely", and the value 0 for other responses (i.e. some likelihood of losing tenure).

Table 8: Land Rights, Decision-Making and Permissions Variables by Cluster (Malawi)

	Male Landowners by Cluster			Female Landowners by Cluster		
	(1)	(2)	(3)	(6)	(7)	(8)
	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights
Document Owner	0.04	0.06	0.07	0.03	0.02	0.02
	(0.20)	(0.23)	(0.25)	(0.17)	(0.15)	(0.15)
Plot Decision Making	0.78	0.93***	0.92***	0.86	0.90	0.90
	(0.41)	(0.26)	(0.27)	(0.35)	(0.30)	(0.30)
Economic Owner	0.76	0.98***	0.97***	0.85	0.96***	0.96***
	(0.43)	(0.15)	(0.17)	(0.36)	(0.19)	(0.21)
Right to Improve	0.71	0.98***	0.98***	0.57	0.9***	0.98***
	(0.45)	(0.14)	(0.13)	(0.50)	(0.31)	(0.15)
Need permission for at least 1 right#		0.83***	0.42***		0.98***	0.44***
		(0.38)	(0.49)		(0.15)	(0.50)
Need permission for some rights (at least 3 out of 5 inc. right to improve)		0.77***	0.32		0.88***	0.33
		(0.42)	(0.47)		(0.33)	(0.47)
Need permission for all rights		0.67***	0.22***		0.75***	0.22***
		(0.47)	(0.41)		(0.44)	(0.42)
Perc. of rights needing permission		0.77***	0.32***		0.87***	0.35***
		(0.38)	(0.42)		(0.24)	(0.43)
Observations	165	90	289	416	76	319

Notes: Permission statistics for non-holders were not provided as very few individuals in this category held rights.

Table 9: Land Rights, Decision-Making and Permissions Variables by Cluster (Tanzania)

	Male Landowners by Cluster			Female Landowners by Cluster		
	(1)	(2)	(3)	(6)	(7)	(8)
	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights
Document Owner	0.01	0.36**	0.10***	0.01	0.08*	0.06
	(0.10)	(0.48)	(0.30)	(0.12)	(0.28)	(0.25)
Plot Decision Making	0.77	0.95***	0.99***	0.82	0.96**	0.98**
	(0.42)	(0.22)	(0.11)	(0.38)	(0.19)	(0.14)
Economic Owner	0.27	0.89***	1.00***	0.51	0.95***	0.99***
	(0.45)	(0.32)	(0.03)	(0.50)	(0.21)	(0.09)
Right to Improve	0.68	1.00***	0.96***	0.73	1.00***	1.00***
	(0.47)	(0.00)	(0.20)	(0.44)	(0.00)	(0.00)
Tenure Security	0.46	0.73	0.87***	0.72	0.9**	0.92***
	(0.50)	(0.45)	(0.34)	(0.45)	(0.31)	(0.27)
Need permission for at least 1 right#		0.95***	0.42*		0.98***	0.31
		(0.21)	(0.49)		(0.14)	(0.46)
Need permission for some rights (at least 3 out of 5 inc. right to improve)		0.93***	0.35***		0.91***	0.24***
		(0.25)	(0.48)		(0.28)	(0.43)
Need permission for all rights		0.32***	0.19***		0.51***	0.19***
		(0.47)	(0.39)		(0.50)	(0.39)
Perc. of rights needing permission		0.82***	0.34		0.92***	0.26***
		(0.22)	(0.44)		(0.18)	(0.41)
Observations	117	55	223	235	86	88

Notes: Permission statistics for non-holders were not provided as very few individuals in this category held rights.

Table 10: Land Rights, Decision-Making and Permissions Variables by Cluster (Ethiopia)

	Male Landowners by Cluster			Female Landowners by Cluster		
	(1)	(2)	(3)	(6)	(7)	(8)
	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights
Document Owner	0.49	0.85***	0.76***	0.55	0.86***	0.76***
	(0.50)	(0.35)	(0.43)	(0.50)	(0.35)	(0.43)
Plot Decision Making	0.79	1.00***	0.97***	0.62	0.89***	0.89***
	(0.41)	(0.05)	(0.16)	(0.49)	(0.31)	(0.32)
Economic Decision Making if Plot Sold	0.89	1***	0.98**	0.82	0.98***	0.96***
	(0.31)	(0.00)	(0.14)	(0.38)	(0.13)	(0.19)
Right to Improve	0.27	0.92***	0.91***	0.28	0.89***	0.91***
	(0.44)	(0.27)	(0.29)	(0.45)	(0.31)	(0.28)
Tenure Security	0.57	0.59	0.63	0.55	0.65	0.68*
	(0.50)	(0.49)	(0.48)	(0.50)	(0.48)	(0.47)
Need permission for at least 1 right#		1.00***	0.84***		1.00***	0.75***
		(0.01)	(0.37)		(0.00)	(0.43)
Need permission for some rights (at least 3 out of 5 inc. right to improve)		1.00***	0.79***		1.00***	0.72***
		(0.01)	(0.40)		(0.00)	(0.45)
Need permission for all rights		0.88***	0.63***		0.85***	0.59***
		(0.33)	(0.48)		(0.36)	(0.49)
Perc. of rights needing permission		0.99***	0.78		1.00**	0.72***
		(0.06)	(0.38)		(0.03)	(0.43)
Observations	153	286	609	253	283	430

Notes: Permission statistics for non-holders were not provided as very few individuals in this category held rights.

6. Sensitivity Analyses

6.1 Comparing Reported Owners versus Individuals with Use Rights

The analysis above is based on respondents identifying themselves as landowners. In Ethiopia and Tanzania, rights and decision-making variables were asked to both owners and users of land (even if they were not self-reported owners). This allows us to investigate whether including the user-only group will change the categorization of bundles. Table 11 shows that our findings are quite robust — incorporating individuals who are only users in the analysis still leads to three cluster categories based on the rights to transfer. Users were assigned to clusters which included the owners instead of populating their own cluster category. This suggests that transfer rights and distinguishing exclusivity/jointness determine users' right bundles similarly to owners.

In Ethiopia, 19 percent of the sample are users who have mostly exclusive transfer rights, which amounts to 58 percent of users. Thus, research that focuses only on reported ownership would miss out a large portion of individuals who would identify as non-owners but would still be exclusive

holders of transfer rights over the land. These patterns can vary by country context, however—in Tanzania, for example, users tend to not have transfer rights. We also find that users are rarely in the joint cluster in comparison to owners (only 2.2 percent of users in Tanzania and 1.7 percent in Ethiopia).

Table 11: Percentages of Land Users and Owners in Each Clusters

Ethiopia

	Cluster Category Based on Holding Transfer Rights		
	Mostly Exclusive	Mostly Joint	Mostly Not Holding
Using but not an owner	19.0%	1.7%	12.3%
Reported owner	29.8%	26.0%	11.2%
Total number of obs.	6189		

Notes: Percentages sum to 100%.

Tanzania

	Cluster Category Based on Holding Transfer Rights		
	Mostly Exclusive	Mostly Joint	Mostly Not Holding
Using but not an owner	4.6%	2.2%	16.5%
Reported owner	28.2%	13.9%	34.6%
Total number of obs.	1681		

Notes: Percentages sum to 100%.

6.2 Clustering Using a Simpler Specification (Hold versus Not Hold)

When narrowing the categorization of rights and decision-making roles from mostly exclusively/jointly/not held, to simply whether rights and decision-making are "held" versus "not held", we continue to find that transfer rights tend to cluster together and explains a large part of the variation in the first dimension. Figure 9 demonstrates the MCA results for Ethiopia (using all variables). Separately, we found similar results for Tanzania and Malawi, further underscoring the importance of transfer rights in categorizing different types of landowners.

Figure 9: MCA Results for Ethiopia (Simple Specification)
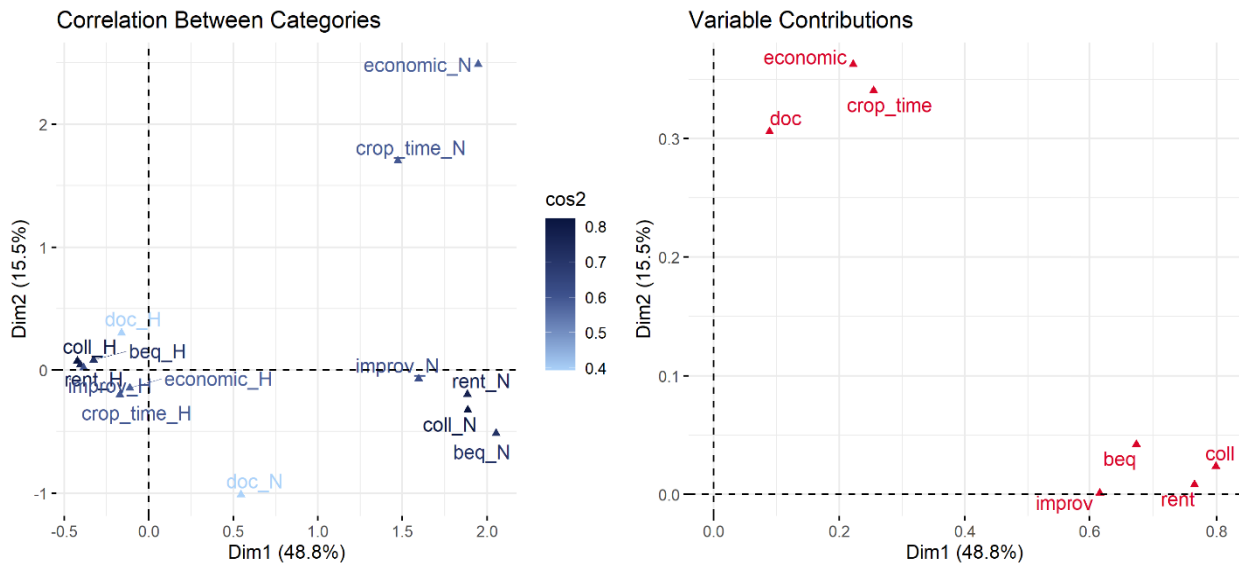
In Ethiopia, Figure 9 shows that economic ownership and transfer rights distinguish the cluster categories. By inspection, we found that every landowner in the largest two clusters had economic ownership, while those in the smallest cluster did not (only 5.5 percent of landowners). The difference between the largest (80 percent) and second largest cluster (14 percent) again lies in the amount of transfer rights that landowners have, which is consistent with our finding that transfer rights are important variable to distinguish clusters. The second largest group has fewer transfer rights.

For Tanzania, the algorithm created four different clusters. The largest cluster (54.8 percent of landowners) mostly have transfer rights, while the other landowners with no transfer rights were divided into three other clusters: 25 percent of landowners were in a cluster without parcel decision-making; 11 percent were in a cluster where the right to improve land was not held; and 8.4 percent included landowners with both the right to improve and decision-making. Unlike Ethiopia, economic ownership was not used to separate the clusters.

Lastly, for Malawi, three clusters were also created. The first largest (53 percent) cluster were landowners with transfer rights. The second and third clusters did not have transfer rights but were differentiated by whether they had the right to improve (28.9 percent) or not (18 percent).

The distribution of landowners across clusters does vary when simplifying the categorization, although the underlying importance of transfer rights is consistent across approaches. The specification using exclusivity/jointness, however, provides a more detailed picture of ownership, and is conceptually more clearly linked with the literature on intra-household bargaining and joint ownership of assets (Browning et al., 2013; Doss et al., 2020). A categorization by exclusive versus joint ownership also creates more variation in clusters relative to the simple approach, and also results in clusters that are much more consistent across countries, easing cross-country comparisons as well.

7. Conclusion

Individual land ownership can ease access to credit, allow for better consumption smoothing during economic volatility, as well as improve bargaining power within the household. Understanding these channels has been difficult, in view of cross-country differences in common forms of ownership (e.g. reported, economic versus documented), and different rights that landowners may have over their parcels particularly under customary land tenure. Leveraging unsupervised machine learning techniques and nationally-representative, intra-household survey data elicited in private from men and women, this paper creates unique profiles of landowners in Ethiopia, Malawi, and Tanzania, anchored in a range of constructs related to their self-reported rights to and control over land parcels.

The analysis reveals a high degree of cross-country consistency in new insights. Landowners, particularly women, often do not have full rights and decision-making power over land. Multiple Correspondence Analysis demonstrates that transfer rights (rights to bequeath, sell, rent out and use as collateral) contribute the most to the variation in the composition of the constructs related to rights to and control over land. These transfer rights are aligned with the alienation rights discussed by Schlager and Ostrom (1992).

Hierarchical clustering further shows that landowners can effectively be clustered into three categories: (1) owners with mostly exclusive transfer rights, (2) owners with mostly joint transfer rights, and (3) owners without any or with only limited transfer rights. Owners with transfer rights are shown to have all other decision-making and rights. Provided that transfer rights are included in the mix, the cluster definitions are also robust to the changes in the composition of the rest of the variables that are used in hierarchical clustering. This, together with the MCA findings, implies that household survey questions on land rights can be trimmed down to only include those on transfer rights, without any loss in our ability to cluster reported landowners.

Moreover, hierarchical clustering allows for a more nuanced investigation of structural and gender differences in land ownership across countries. For example, in Tanzania, within the cluster of landowners with no/limited transfer rights, 87 percent have none of the four transfer rights. In Malawi, this share is about 60 percent. And in general, women are over-represented in this cluster of landowners across the three countries. In addition, the results highlight the importance of collecting data on permissions to exercise rights over land. For example, we find that although landowners with either mostly exclusive or mostly joint rights typically have the same bundles of rights and other ownership variables, permissions to exercise these rights vary between the two clusters. In Malawi and Tanzania, landowners who need permission for at least one transfer right ranges from 31-33 percent within the exclusive cluster to 93-98 percent within the joint cluster. The analysis also reveals that in each country, moving from the cluster with mostly joint transfer rights to the one with mostly exclusive transfer rights, the increase in the share of individuals not needing permission to exercise any right is considerably greater among women than men. These findings motivate the need for further research on how joint owners exercise their rights and what restrictions they may face when permissions are involved.

Finally, sensitivity analyses demonstrate that the findings regarding transfer rights are robust to the implementation of hierarchical clustering with (i) simpler categorization (holding versus not holding) of rights variables and (ii) an expanded sample that includes individuals with land use rights, together with landowners. The inclusion of individuals with land use rights in the analysis sample is particularly important in Ethiopia, where 19 percent of the individuals within the cluster with mostly exclusive transfer rights are those with land use rights (constituting 50 percent of the sample of individuals with land use rights). Therefore, research that focuses only on self-reported landowners would miss out on a large portion of individuals who would otherwise hold transfer rights over their land.

Overall, our findings provide a more nuanced perspective on land ownership and rights among men and women across different countries in Sub-Saharan Africa. The analysis showcases the utility of machine learning techniques that can be applied to high-dimensional, intra-household, individual-disaggregated survey data on asset ownership to (a) identify the subset of rights that is essential to the conceptualization of land ownership under customary tenure arrangements and that is consistent across Ethiopia, Malawi and Tanzania, and (b) allow for a cross-country-comparable approach to profiling landowners across contexts with significant variation in institutions and norms governing land ownership.

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Appendix

A. Multiple Correspondence Analysis and Hierarchical Clustering

A1. Multiple Correspondence Analysis Graphs

Figure A: MCA Results Using Only Rights Variables

Malawi
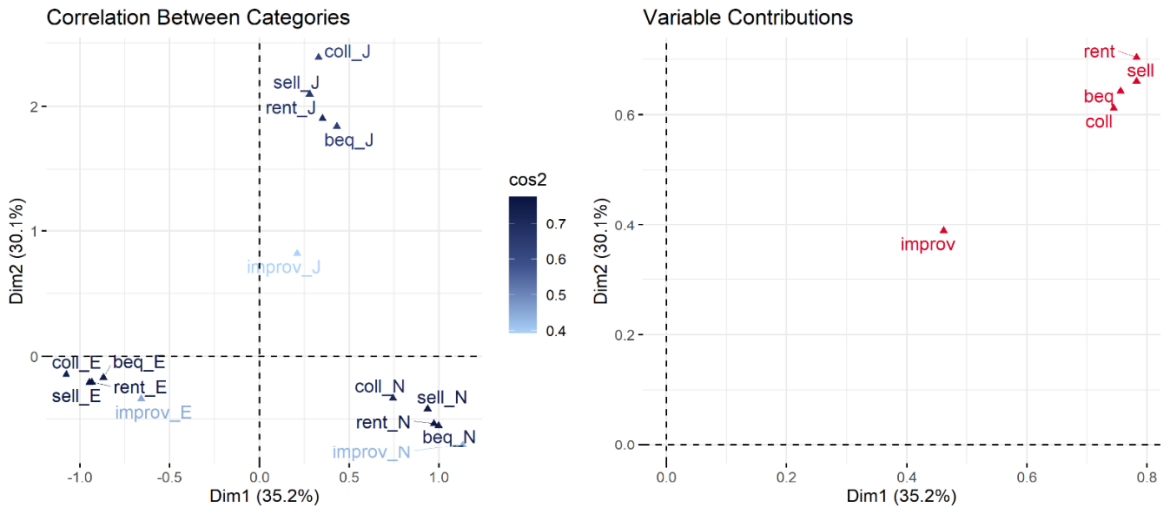
Notes: Documented ownership was excluded from the analysis for Malawi. Categories are attached to the variables: joint owner (J), exclusive owner (E), and not hold (N). The figures only describe the first two dimensions from the MCA.

Ethiopia
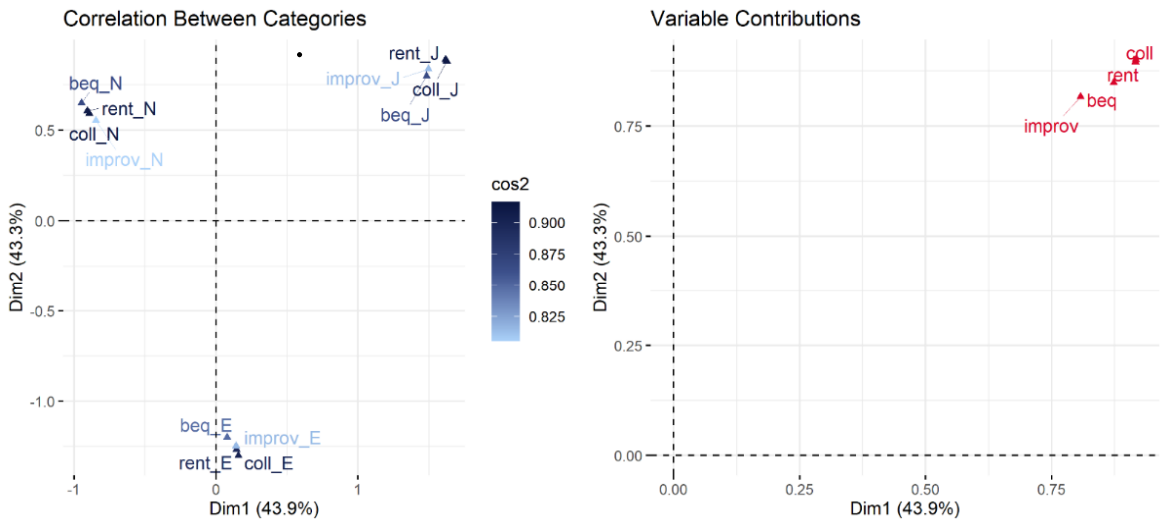
Notes: Documented ownership was excluded from the analysis for Tanzania. Categories are attached to the variables: joint owner (J), exclusive owner (E), and not hold (N). The figures only describe the first two dimensions from the MCA.

Tanzania
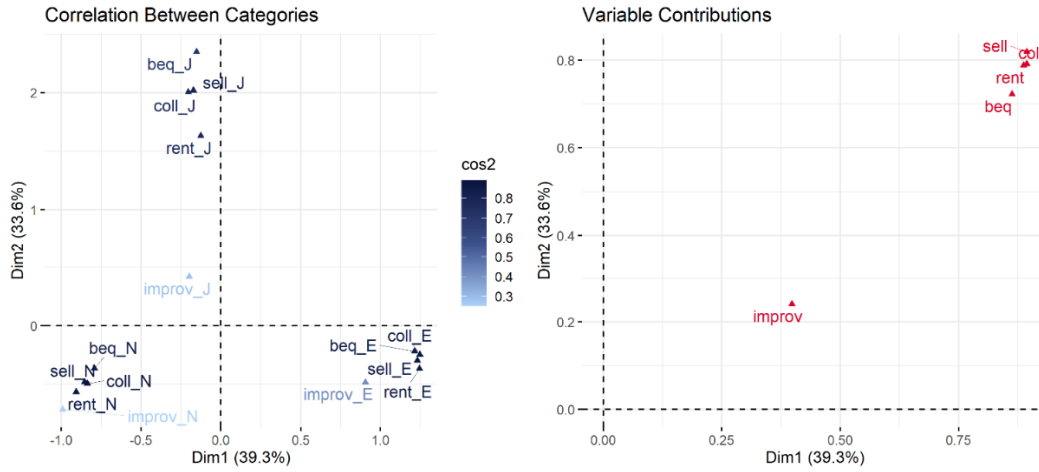
Notes: Documented ownership was excluded from the analysis for Tanzania. Categories are attached to the variables: joint owner (J), exclusive owner (E), and not hold (N). The figures only describe the first two dimensions from the MCA.

A2. Characteristics of Landowners and Non-Landowners

Table A2-1: Characteristics of Landowners and Non-Landowners in Malawi (Agricultural Land)

|	Male					Female				
	Malawi Landowners by Cluster			Non-Landowners		Malawi Landowners by Cluster			Non-Landowners	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights	Non-landowners in HH with land	All Non-Landowners	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights	Non-landowners in HH with land	All Non-Landowners
HH head	0.75	0.87**	0.98***	0.47***	0.61***	0.17	0.08**	0.24***	0.01***	0.22***
	(0.43)	(0.33)	(0.14)	(0.50)	(0.49)	(0.37)	(0.28)	(0.43)	(0.11)	(0.41)
Married	0.74	0.9***	0.97***	0.54***	0.6***	0.81	0.84	0.78	0.52***	0.62***
	(0.44)	(0.30)	(0.18)	(0.50)	(0.49)	(0.39)	(0.37)	(0.41)	(0.50)	(0.49)
Age group 18 - 24	0.28	0.08***	0.07***	0.43***	0.35	0.18	0.14	0.15	0.46***	0.34***
	(0.45)	(0.28)	(0.26)	(0.50)	(0.48)	(0.39)	(0.35)	(0.36)	(0.50)	(0.47)
Age group 25 - 34	0.18	0.27*	0.3***	0.20	0.26**	0.28	0.33	0.25	0.2***	0.28
	(0.38)	(0.44)	(0.46)	(0.40)	(0.44)	(0.45)	(0.47)	(0.43)	(0.40)	(0.45)
Age group 35 - 44	0.23	0.34**	0.23	0.17*	0.19	0.21	0.28	0.24	0.17	0.16***
	(0.42)	(0.48)	(0.42)	(0.38)	(0.39)	(0.41)	(0.45)	(0.43)	(0.38)	(0.37)
Age group 45 - 54	0.14	0.17	0.18	0.08**	0.09**	0.13	0.12	0.17	0.06***	0.09***
	(0.35)	(0.38)	(0.39)	(0.28)	(0.28)	(0.34)	(0.33)	(0.37)	(0.25)	(0.29)
Age group above 55	0.17	0.14	0.21	0.11	0.11	0.19	0.13	0.2	0.11***	0.13***
	(0.37)	(0.35)	(0.41)	(0.32)	(0.32)	(0.40)	(0.34)	(0.40)	(0.31)	(0.33)
Have attended school	0.91	0.95	0.92	0.91	0.93	0.81	0.84	0.79	0.88***	0.88***
	(0.29)	(0.21)	(0.27)	(0.29)	(0.25)	(0.39)	(0.36)	(0.41)	(0.32)	(0.33)
Years of school, if attended	7.44	7.27	6.62**	7.36	8.51***	5.70	6.35	5.35	6.84***	7.46***
	(3.88)	(3.78)	(3.61)	(3.85)	(4.06)	(3.49)	(3.44)	(3.15)	(4.39)	(4.28)
Agri activity in last 7 Days	0.52	0.59	0.54	0.38***	0.31***	0.39	0.64***	0.5**	0.43	0.36
	(0.50)	(0.49)	(0.50)	(0.49)	(0.46)	(0.49)	(0.48)	(0.50)	(0.50)	(0.48)
Hours worked in agri last 7 days if worked	15.48	17.96	18.02	14.64**	15.13***	11.64	13.58	13.27	14.14	12.38
	(13.11)	(16.47)	(14.45)	(13.16)	(14.34)	(13.78)	(12.30)	(11.45)	(12.49)	(11.25)
NFE work last 7 days	0.16	0.14	0.17	0.14	0.17	0.13	0.28***	0.15	0.13	0.15
	(0.37)	(0.35)	(0.37)	(0.35)	(0.38)	(0.34)	(0.45)	(0.36)	(0.33)	(0.36)
Wage work last 7 days	0.11	0.19**	0.11	0.09	0.2***	0.02	0.03	0.03	0.03	0.07***
	(0.31)	(0.40)	(0.32)	(0.29)	(0.40)	(0.13)	(0.17)	(0.17)	(0.17)	(0.26)
Ganyu work last 7 days	0.19	0.26	0.15	0.22	0.22	0.21	0.11**	0.19	0.19	0.16***
	(0.39)	(0.44)	(0.36)	(0.42)	(0.41)	(0.41)	(0.32)	(0.39)	(0.39)	(0.36)
Financial Asset Owner	0.17	0.29*	0.25*	0.13	0.24**	0.19	0.32**	0.28**	0.16	0.25***
	(0.38)	(0.46)	(0.43)	(0.34)	(0.43)	(0.39)	(0.47)	(0.45)	(0.36)	(0.43)
Mobile Phone Owner	0.54	0.65	0.61	0.39***	0.54	0.28	0.39	0.26	0.24	0.38***
	(0.50)	(0.48)	(0.49)	(0.49)	(0.50)	(0.45)	(0.49)	(0.44)	(0.43)	(0.49)
Log hh non-food cons	8.52	8.53	8.48	8.11**	8.72	8.12	8.79***	8.14	8.4***	8.65***
	(1.57)	(1.63)	(1.60)	(1.70)	(1.82)	(1.55)	(1.82)	(1.68)	(1.68)	(1.82)
House has elecricity	0.09	0.08	0.08	0.09	0.23***	0.10	0.16	0.08	0.09	0.21***
	(0.29)	(0.28)	(0.27)	(0.29)	(0.42)	(0.30)	(0.37)	(0.27)	(0.28)	(0.41)
House walls made of concr	0.03	0.01	0.02	0.01	0.03	0.01	0.03	0.02	0.01	0.03***
	(0.17)	(0.11)	(0.13)	(0.11)	(0.18)	(0.08)	(0.16)	(0.13)	(0.09)	(0.16)
Rural	0.86	0.84	0.89	0.86	0.63***	0.89	0.81	0.88	0.87	0.68***
	(0.35)	(0.37)	(0.31)	(0.35)	(0.48)	(0.31)	(0.39)	(0.32)	(0.34)	(0.47)
Observations	165	90	289	575	1574	416	76	319	436	1820

Notes: This table reports descriptive statistics within a cluster as well as samples of non-landowners. Significance-levels were added to compare the base cluster (mostly not hold) with the other two clusters.

Table A2-2: Characteristics of Landowner in Tanzania (Agricultural Land)

	Male						Female					
	Tanzania Landowners by Cluster			Non-Landowners			Tanzania Landowners by Cluster			Non-Landowners		
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)	(9)		(10)
	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights	Able to use but not owner	Non-landowners in HH with land	All Non-Landowners	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights	Able to use but not owner	Non-landowners in HH with land	All Non-Landowners
HH head	0.52	0.85***	0.98***	0.16***	0.23***	0.55	0.10	0.03***	0.68***	0.10	0.03***	0.19***
	(0.50)	(0.36)	(0.15)	(0.37)	(0.42)	(0.50)	(0.31)	(0.17)	(0.47)	(0.30)	(0.17)	(0.40)
Married	0.48	0.82***	0.81***	0.20	0.13	0.15	0.67	0.77	0.28***	0.22	0.09	0.10
	(0.50)	(0.39)	(0.40)	(0.40)	(0.34)	(0.36)	(0.47)	(0.42)	(0.45)	(0.42)	(0.28)	(0.29)
Age group 18 - 24	0.30	0.12**	0***	0.48**	0.53***	0.28	0.21	0.11*	0.04***	0.32	0.39***	0.32**
	(0.46)	(0.33)	(0.03)	(0.50)	(0.50)	(0.45)	(0.40)	(0.31)	(0.20)	(0.47)	(0.49)	(0.47)
Age group 25 - 34	0.42	0.39	0.17***	0.42	0.27	0.39	0.19	0.3	0.08	0.22	0.30	0.3*
	(0.50)	(0.49)	(0.37)	(0.50)	(0.44)	(0.49)	(0.40)	(0.46)	(0.28)	(0.42)	(0.46)	(0.46)
Age group 35 - 44	0.14	0.10	0.22	0.01**	0.07	0.14	0.32	0.11***	0.19	0.20	0.2***	0.16***
	(0.35)	(0.30)	(0.41)	(0.10)	(0.26)	(0.35)	(0.47)	(0.32)	(0.40)	(0.40)	(0.40)	(0.37)
Age group 45 - 54	0.08	0.19	0.22***	0.03	0.07	0.09	0.14	0.25	0.24	0.11	0.06	0.10
	(0.27)	(0.39)	(0.41)	(0.17)	(0.25)	(0.29)	(0.35)	(0.43)	(0.43)	(0.32)	(0.23)	(0.30)
Age group above 55	0.06	0.2	0.4***	0.07	0.07	0.09	0.14	0.23	0.44***	0.14	0.12	0.16
	(0.24)	(0.41)	(0.49)	(0.25)	(0.25)	(0.29)	(0.35)	(0.42)	(0.50)	(0.35)	(0.33)	(0.36)
Have attended school	0.88	0.96	0.85	0.95	0.87	0.90	0.71	0.76	0.71	0.77	0.75	0.8*
	(0.33)	(0.19)	(0.36)	(0.22)	(0.34)	(0.30)	(0.45)	(0.43)	(0.46)	(0.43)	(0.43)	(0.40)
Years of school, if attended	7.53	7.09	6.72	6.25	6.85**	7.62	6.63	7.65***	6.8	7.46*	7.81	7.97***
	(2.71)	(2.08)	(2.30)	(2.35)	(2.46)	(2.68)	(1.83)	(1.78)	(1.93)	(1.79)	(2.38)	(2.49)
Agri activity in last 7 Days	0.63	0.67	0.63	0.66	0.45**	0.33***	0.70	0.7	0.63	0.52	0.36***	0.33***
	(0.49)	(0.47)	(0.48)	(0.48)	(0.50)	(0.47)	(0.46)	(0.46)	(0.49)	(0.50)	(0.48)	(0.47)
Hours worked in agri last 7 days if worked	17.03	14.84	17.87	18.98	19.17	16.37	14.86	14.65	21.29	15.82	14.11	13.85
	(11.76)	(13.96)	(13.27)	(14.97)	(16.09)	(12.70)	(11.11)	(8.18)	(18.31)	(9.66)	(7.49)	(7.01)
NFE work last 7 days	0.15	0.12	0.21	0.16**	0.05*	0.18	0.15	0.12	0.19	0.15	0.05***	0.15
	(0.36)	(0.33)	(0.41)	(0.37)	(0.22)	(0.38)	(0.36)	(0.33)	(0.39)	(0.35)	(0.22)	(0.36)
Wage work last 7 days	0.37	0.42	0.22	0.29	0.24	0.30	0.12	0.12	0.12	0.11*	0.06	0.13
	(0.48)	(0.50)	(0.42)	(0.45)	(0.43)	(0.46)	(0.33)	(0.33)	(0.32)	(0.31)	(0.24)	(0.34)
Financial Asset Owner	0.13	0.38	0.2	0.18	0*	0.12	0.03	0.1*	0.12*	0.07**	0.01*	0.1***
	(0.33)	(0.49)	(0.40)	(0.38)	(0.07)	(0.33)	(0.17)	(0.30)	(0.33)	(0.25)	(0.09)	(0.30)
Mobile Phone Owner	0.73	0.75	0.75	0.74	0.24***	0.51**	0.51	0.63	0.59	0.52*	0.19***	0.47
	(0.45)	(0.44)	(0.44)	(0.44)	(0.43)	(0.50)	(0.50)	(0.49)	(0.49)	(0.50)	(0.39)	(0.50)
Log hh non-food cons	12.44	12.83	12.54	12.53	12.56	12.57	12.33	12.52	11.98	12.26	12.69**	12.52
	(1.08)	(1.24)	(1.00)	(1.08)	(1.14)	(1.19)	(1.04)	(1.17)	(1.36)	(1.19)	(0.93)	(1.24)
House has elecricity	0.62	0.62	0.62	0.61	0.61	0.68	0.53	0.62	0.57	0.57	0.66*	0.68**
	(0.49)	(0.49)	(0.49)	(0.49)	(0.49)	(0.47)	(0.50)	(0.49)	(0.50)	(0.50)	(0.47)	(0.47)
House walls made of concr	0.07	0.11	0.06	0.08	0.09	0.26	0.06	0.11	0.14	0.09	0.10	0.27**
	(0.25)	(0.32)	(0.25)	(0.27)	(0.29)	(0.44)	(0.23)	(0.32)	(0.35)	(0.28)	(0.30)	(0.44)
Rural	0.72	0.85	0.85*	0.87	0.85	0.64	0.83	0.8	0.82	0.91	0.85	0.68
	(0.45)	(0.36)	(0.36)	(0.34)	(0.36)	(0.48)	(0.38)	(0.41)	(0.38)	(0.29)	(0.36)	(0.47)
Observations	117	55	223	47	252	1012	235	86	88	50	282	1171

Notes: This table reports descriptive statistics within a cluster. Significance-levels were added to compare the base cluster (mostly not hold) with the other two clusters.

	Male						Female					
	Ethiopia Landowners by Cluster			Non-Landowners			Ethiopia Landowners by Cluster			Non-Landowners		
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)	(9)		(10)
	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights	Able to use but not an owner	Non-landowners in HH with land	All Non-Landowners	Mostly Not Hold (base)	Mostly Joint Rights	Mostly Exclusive Rights	Able to use but not an owner	Non-landowners in HH with land	All Non-Landowners
HH head	0.69	0.92***	0.94***	0.38***	0.12***	0.57***	0.10	0.05	0.31***	0.02	0.01**	0.23***
	(0.47)	(0.27)	(0.24)	(0.49)	(0.33)	(0.49)	(0.30)	(0.22)	(0.46)	(0.13)	(0.08)	(0.42)
Married	(0.69)	0.91***	0.9***	0.43***	0.17***	0.55***	0.92	0.93	0.73***	0.81**	0.44***	0.56***
	(0.46)	(0.28)	(0.30)	(0.50)	(0.37)	(0.50)	(0.28)	(0.26)	(0.44)	(0.40)	(0.50)	(0.50)
Age group 18 - 24	0.24	0.08***	0.06***	0.41***	0.56***	0.3***	0.14	0.1	0.08	0.27***	0.44***	0.3***
	(0.43)	(0.27)	(0.24)	(0.49)	(0.50)	(0.46)	(0.34)	(0.30)	(0.28)	(0.45)	(0.50)	(0.46)
Age group 25 - 34	0.29	0.21	0.2	0.26	0.27	0.3**	0.42	0.3**	0.29**	0.30	0.26	0.29
	(0.46)	(0.41)	(0.40)	(0.44)	(0.44)	(0.46)	(0.49)	(0.46)	(0.46)	(0.46)	(0.44)	(0.46)
Age group 35 - 44	0.27	0.25	0.29	0.11***	0.08***	0.17*	0.24	0.34	0.25	0.26	0.23***	0.21***
	(0.45)	(0.43)	(0.45)	(0.31)	(0.27)	(0.38)	(0.43)	(0.47)	(0.43)	(0.44)	(0.42)	(0.41)
Age group 45 - 54	0.12	0.17	0.18	0.11	0.04***	0.11**	0.12	0.12	0.17	0.13	0.07*	0.10
	(0.32)	(0.38)	(0.38)	(0.31)	(0.21)	(0.31)	(0.33)	(0.32)	(0.38)	(0.33)	(0.25)	(0.29)
Age group above 55	0.07	0.29***	0.27***	0.11***	0.06***	0.12***	0.08	0.15*	0.21***	0.04***	0.10	0.12
	(0.26)	(0.46)	(0.45)	(0.32)	(0.23)	(0.33)	(0.27)	(0.35)	(0.40)	(0.19)	(0.30)	(0.33)
Have attended school	0.60	0.42***	0.46**	0.59***	0.55***	0.62***	0.30	0.17**	0.18**	0.4***	0.27***	0.39***
	(0.49)	(0.49)	(0.50)	(0.49)	(0.50)	(0.48)	(0.46)	(0.38)	(0.39)	(0.49)	(0.44)	(0.49)
Years of school, if attended	6.03	6.42	6.11	7.42***	7.06***	8.29***	6.11	5.95	6.05	6.46***	6.64***	7.98***
	(3.31)	(3.85)	(3.56)	(3.28)	(2.99)	(3.96)	(3.18)	(3.51)	(3.07)	(3.97)	(3.28)	(3.92)
Agri activity in last 7 Days	0.82	0.91*	0.81	0.78***	0.59***	0.48***	0.52	0.60	0.53	0.47	0.34***	0.3***
	(0.39)	(0.29)	(0.39)	(0.42)	(0.49)	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)	(0.47)	(0.46)
Hours worked in agri last 7 days if worked	33.05	34.3	29.21	28.86*	27.96***	26.8***	20.58	24.52	20.63	23.53	22.28	19.69**
	(18.93)	(17.59)	(16.95)	(18.14)	(17.26)	(17.47)	(15.17)	(14.62)	(14.87)	(16.69)	(15.41)	(14.84)
NFE work last 7 days	0.07	0.05	0.03	0.05	0.04	0.11***	0.08	0.05	0.05	0.06	0.05	0.09*
	(0.25)	(0.22)	(0.18)	(0.22)	(0.20)	(0.31)	(0.28)	(0.22)	(0.22)	(0.23)	(0.22)	(0.29)
Wage work last 7 days	0.04	0.08	0.04	0.05	0.03*	0.11	0.00	0.00	0.01	0.00	0.00	0.06***
	(0.20)	(0.27)	(0.18)	(0.21)	(0.17)	(0.32)	(0.03)	(0.06)	(0.08)	(0.06)	(0.04)	(0.23)
Financial Asset Owner	0.22	0.3	0.26	0.26	0.16***	0.33	0.10	0.13	0.13	0.12	0.05**	0.2***
	(0.42)	(0.46)	(0.44)	(0.44)	(0.37)	(0.47)	(0.30)	(0.34)	(0.34)	(0.32)	(0.22)	(0.40)
Mobile Phone Owner	0.57	0.4**	0.39***	0.42	0.41	0.53***	0.18	0.08***	0.1**	0.12**	0.18***	0.32***
	(0.50)	(0.49)	(0.49)	(0.49)	(0.49)	(0.50)	(0.39)	(0.26)	(0.30)	(0.32)	(0.39)	(0.46)
Log hh non-food cons	8.40	8.66**	8.44	8.44*	8.58	8.65	8.36	8.62**	8.36	8.36	8.50	8.58
	(0.76)	(0.78)	(0.96)	(0.94)	(0.93)	(1.15)	(0.81)	(0.79)	(0.96)	(0.95)	(0.97)	(1.21)
House has elecricity	0.21	0.08**	0.17	0.15**	0.12	0.36***	0.19	0.07**	0.16	0.14**	0.16**	0.39***
	(0.41)	(0.27)	(0.38)	(0.35)	(0.32)	(0.48)	(0.39)	(0.26)	(0.37)	(0.35)	(0.37)	(0.49)
House walls made of concr	0.02	0.01	0	0.01	0.01	0.08***	0.02	0.01	0*	0.01	0.01	0.08***
	(0.13)	(0.10)	(0.06)	(0.09)	(0.11)	(0.27)	(0.15)	(0.09)	(0.05)	(0.09)	(0.08)	(0.28)
Rural	0.83	0.94**	0.91	0.92	0.94	0.65***	0.87	0.95*	0.91	0.89	0.90	0.62***
	(0.38)	(0.23)	(0.28)	(0.27)	(0.23)	(0.48)	(0.34)	(0.22)	(0.28)	(0.31)	(0.29)	(0.48)
Observations	153	286	609	176	509	6187	253	283	430	197	552	7187

Notes: This table reports descriptive statistics within a cluster. Significance-levels were added to compare the base cluster (mostly not hold) with the other two clusters.

A3. Individuals Belonging to Multiple Clusters

Since the clustering was done at an individual-parcel level analysis, we need to account for individuals who belong to multiple clusters to continue the analysis at the individual level. Approximately 7% to 8% of individuals across the three countries have multiple parcels, which shows different right profiles as shown in Table A3. For Tanzania and Malawi, more than 45% of these individuals have parcels where they mostly have exclusive rights and parcels where they

have mostly no rights at all. OLS regression of individuals having identified with multiple clusters on household head, female, rural, age, and number of parcels revealed that only number of parcels in all countries seems to be correlated with multiple clusters.

Table A3: Individuals in Multiple Clusters

	Tanzania	Malawi	Ethiopia
Individuals belonging to multicluster	59 out of 761	99 out of 1220	137 out of 1933
Multicluster type:			
not hold - joint	21	21	40
not hold - exclusive	27	50	49
joint - exclusive	11	26	43
all three cluster	0	2	5

Notes: The table reports individuals who belong to multiple clusters because they may own multiple parcels with different right bundles.
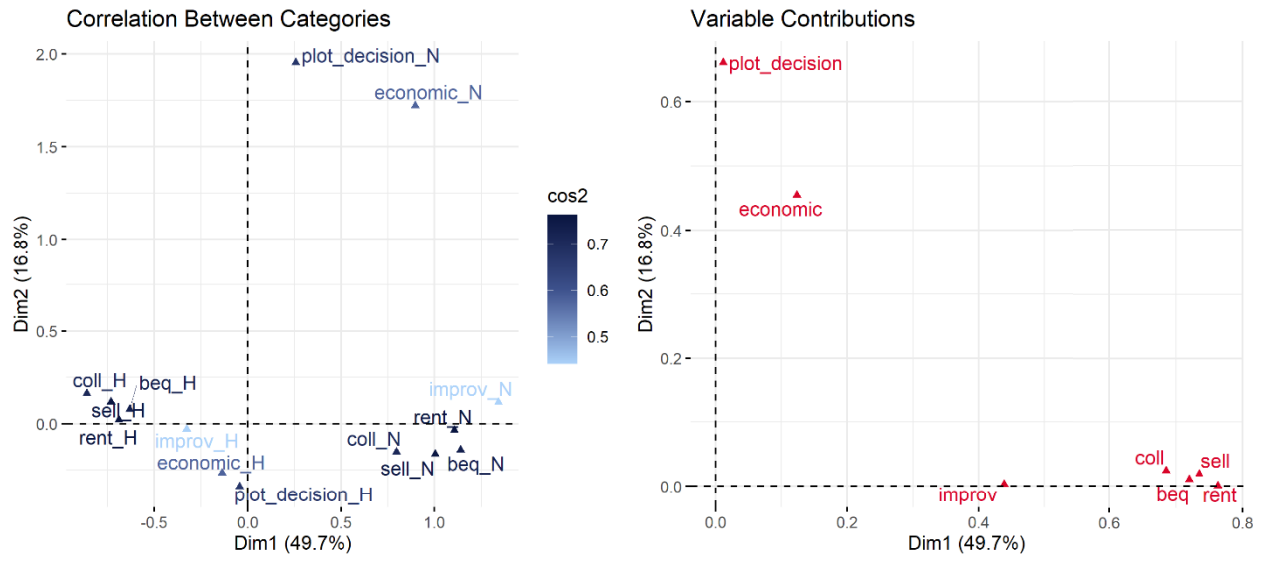
A4. MCA Result Simple Specification

Figure A4 - 1: MCA Results for Tanzania Simple Specification
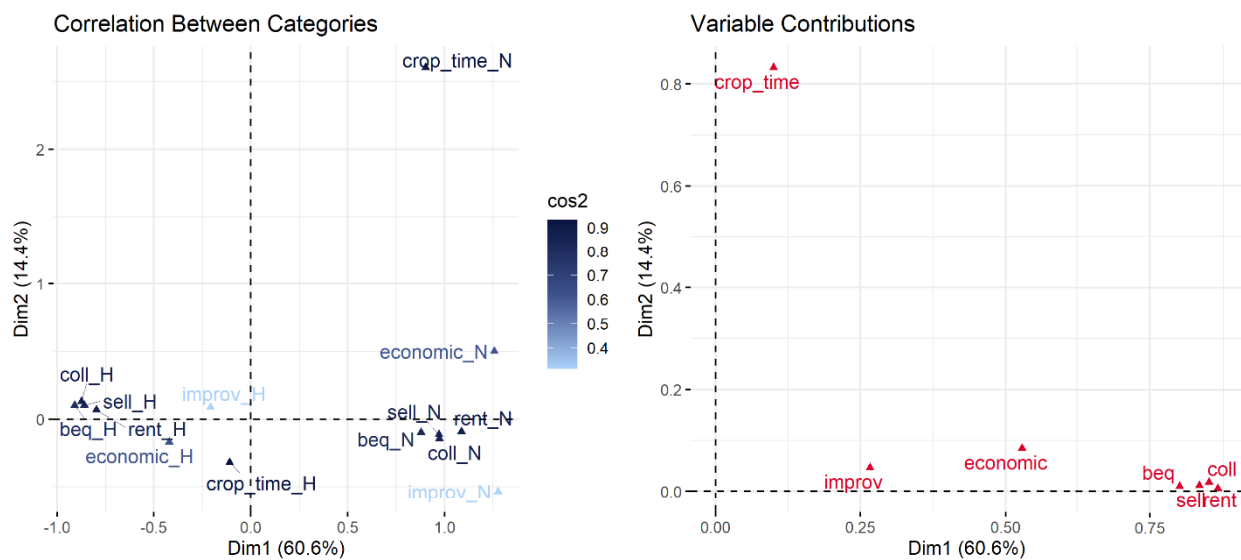
Notes: MCA results using all variables for Tanzania.

Figure A4 - 2: MCA Results for Malawi Simple Specification

Notes: MCA results using all variables for Malawi.