Mutual Insurance and Land Security in Rural Ghana

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Abstract

We study the impact of land rights' formalization on the functioning of informal insurance and land re-allocations in Ghana's rural communities. First, we provide empirical evidence suggesting that communities holding more formal land titles enjoy higher land security, as measured by number of disputes due to multiple claims over land. Second, we find that land re-allocations are more intense in those places, leading to increases in agricultural productivity and average consumption. Third, we show that communities with higher formality of land rights enjoy improved risk-sharing against idiosyncratic shocks. Motivated by this evidence, we develop a dynamic model of land and risk sharing subject to limited commitment constraints, where the equilibrium degree of co-operation is determined by the degree of formal land rights chosen. We show that the model can rationalize our empirical findings and can serve as a useful quantitative laboratory. Most interestingly, we find that although positive in the data, the effects of increasing land rights may be highly non-linear as at some point they may lead to a complete unraveling of informal co-operation in rural economies.

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" Every individual is born into a certain status relative to all other members of the community. It is not a personal status, as it might be in an individualistic society, and does not imply rank, but reciprocal obligations and benefits which he incurs as a member of the community"

— J. H. Driberg, (1934), The African conception of law

1 Introduction

The agricultural sector in Ghana constitutes one of the major employers in the country. Almost 45% of the Ghanaian labour force is engaged in agricultural activities translating into more than 7 million individuals operating a farm (Oxford Business Report Ghana, 2020). Despite its economic importance, agriculture is organized at a small scale, characterized by low mechanisation and irrigation investment, with production primarily aimed at satisfying rural population's subsistence requirements. Given severity of consumption fluctuations in such an environment coupled with the absence of government-provided social insurance, village communities have devised safety nets based on cash and in-kind transfers, gifts or loans. While not regulated by any statutory law, these insurance schemes are largely based on reciprocal interactions taking place within close-knit societies. At the same time, Ghanaian land constitutes the major productive asset of rural communities. While land markets have been traditionally governed by customary and informal land institutions,[1] Ghana has been recently experiencing formalizations resulting in a peculiar system of overlapping land rules. These coexisting sets of rules define distinct forms of tenure regimes. Customary laws prescribe communal land management with informal land transfers taking place among members of the same community, while statutory laws advance individual ownership providing access to formal land markets.

In this study, we explore how changes in land security triggered by variations in the take up of formal land titles affect informal community-wide institutions of mutual insurance and land re-allocations in rural Ghana. We do so by tracing the economic interaction between (i) the take-up of land titles providing a formal proof of land ownership; and (ii) local institutions governing land re-allocations and mutual insurance nets between neighbours and relatives. However, the effect of land security is ambiguous as it can give rise to two opposing forces. On the one hand, secured land rights potentially enhance customary tenure with land re-allocations and mutual insurance. Secured individual ownership can effectively relieve villagers of the fear of losing land when communally sharing it and hence stimulate more active participation in collective land management. On the other hand, individual land rights provide farmers with an improved outside option allowing for accessing formal land markets, and so potentially crowding out

[1] Even as of today, around 80% of Ghanaian land is held under customary law tenure (Fenrich, Galizzi, and Higgins, 2011).

community-based land sharing. Which of the two forces dominates is the core question of this work.

We address this question combining empirical and structural approaches. We use the Ghana Socioeconomic Panel Survey (Yale EGC-ISSER) on agricultural and economic activities of Ghana's rural population. This rich dataset allows us to test empirically the link between land rights and land disputes, land fluidity, agricultural productivity, consumption and, ultimately, informal risk sharing arrangements. We first show that the number of land disputes due to multiple claims decreases in the degree of land rights (measured as the share of village's land with titles). Second, we document that land re-allocations are more intense in rural areas experiencing increases in land formality. Third, we show that increases in land security provided by titles also strongly correlate with increases in overall village productivity, signifying that informal land markets become not only more fluid, but also more efficient. As a consequence we also find that these changes translate into higher aggregate consumption at the village level. Novel to the literature, we uncover improvements in risk sharing in communities with stronger rights over land. Taken together, we find that land titles may well complement traditional village institutions, such as mutual insurance and land re-allocations.

We then build a dynamic model capable of rationalizing our empirical findings. Our village economy features co-operation over insurance transfers and land re-allocations in the presence of voluntary participation (or limited commitment) constraints. We assume that the level of land security determines the amount of land owned by the household, whether cultivated or rented out. Consequently, this assumption alters households' outside option attainable had they chosen to break out of the co-operation with the rest of the community. This component is crucial to understand the nature of informal co-operation patterns under scrutiny as it effectively endogenizes the functioning of informal institutions. We next structurally estimate the model to Ghana's rural villages and find that for sufficiently low values of land rights, the dynamics generated by the model are entirely in line with the empirical evidence presented. As land security increases, land allocations become more efficient, average income and consumption increase, and consumption smoothing against idiosyncratic productivity shocks is improved. However, there exists a level of land rights above which co-operation over risk and land sharing unravels, pushing the whole society into a bad equilibrium where they can still trade land, but have to rely on self-insurance only. Thus, our model uncovers potentially non-linear effects of land formalization efforts and as such provides a candidate explanation for strong persistence of informal institutions in rural areas of developing countries.

The paper is organized as follows. In Section 2, we present the related literature. In Section 3, we describe the customary norms surrounding land conveyances in rural Ghana. In Section

4, we first discuss our data and construction of all empirical measures, and then we present our empirical results. In Section 5, we develop our quantitative framework and discuss the associated dynamics. In Section 6, we estimate the model and present the quantitative results. We conclude in Section 7.

2 Literature Review

The observed large agricultural productivity gaps in developing countries (Gollin, Lagakos, and Waugh, 2014) have incited various explanations. One of the most recent and predominant ones is land misallocation due to missing formal land markets. For instance, exploiting rich household-level data from Malawi, Restuccia and Santaeulalia-Llopis (2017) find substantial misallocation of both land and productive capital. The authors attribute the observed misallocation to the absence of formal land markets, as land in Malawi is allocated mostly by village chiefs. Evaluating effects of a reform granting farmers the right to rent out land in Ethiopia, Chen, Restuccia, and Santaeulàlia-Llopis (2017) find that the reform has stimulated more efficient allocation of agricultural land and investments, leading to higher productivity in the sector. They find that the existence of rental markets correlates with lower degree of misallocation while it boosts productive technological investment and agricultural productivity. Similarly, Adamopoulos and Restuccia (2020) study a land reform in Philippines, which extensively redistributed land above a certain threshold and banned land reallocations of the redistributed land, and find that it reduced average farm size by 34% and agricultural productivity by 17%. Chari, Liu, Wang, and Wang (2017) examine the effects of a land reform in China, that allowed farmers to lease their land. They find that the reform led to an increased participation in formal land markets, improving land allocation and raising aggregate land productivity. Focusing not only missing land markets but also interrelated distortions to occupational choice, Chen (2017) attributes international agricultural productivity differences to the existence of untitled land in the developing world. By studying formal land markets jointly with informal communal tenure regimes, our work uncovers novel effects of well-functioning land markets on the mutual insurance channel.

Our work also relates to the literature integrating social norms and informal institutions - prevalent in traditional villages - into the study of economic development (Platteau, 2015). In the absence of customary insurance markets, Townsend (1994) finds that informal insurance networks in rural India can significantly enhance consumption smoothing. Similar conclusions are found by Udry (1994) in Nigeria. Gollin and Udry (2021) find that upon accounting for unobserved heterogeneities and measurement error, the mesured efficiency of land markets in Tanzania and Uganda is greatly improved. Overall, these studies suggest that rural customs

and institutions can partly compensate for the lack of well-developed formal markets. In this paper, we make a similar point. We do this by identifying channels linking informal insurance and land institutions in the context of rural Ghana. This allows us to contribute with both empirical and quantitative analyses of how informal institutions compensate for lack of formal ones, and how the formalization of land markets affects this axis.

Furthermore, there is a small strand of theoretical literature analyzing the insurance properties stemming from output sharing of collective agriculture (e.g. Carter (1987) and Baland and Francois (2005)). They do so, however, without considering mutual insurance networks. Extending this line of work, Delpierre, Guirkinger, and Platteau (2019) study theoretically the mechanism of the aforementioned papers in a static model of voluntary risk sharing. However unlike our work, they assume fixed land endowments, and so they ignore potential efficiency gains of land re-allocations attainable within rural communities.

In order to develop the informal mutual insurance framework we build on the risk-sharing with limited commitment literature. Ligon, Thomas, and Worrall (2002) were among the first to explain the observed imperfect risk-sharing in village economies with limited commitment constraints. Attanasio and Rıos-Rull (2000), Thomas and Worrall (2007), Krueger and Perri (2006) and Ábrahám and Laczó (2018) study impacts of different public or private insurance programs on risk sharing against idiosyncratic shocks. Mazur (2020) analyzes interaction between informal risk sharing networks providing insurance against idiosyncratic shocks and investments into irrigation against aggregate shocks that can be managed either by village or government irrigation reducing aggregate shocks. He shows that the two institutions may complement or substitute each other depending on the irrigation's management structure. Manalis (2019) assesses the effect of a land reform granting individual land rights on rural communities' mutual insurance and land re-allocation arrangement and documents the arising trade-off between output efficiency and extent of risk-sharing. Finally, Morten (2019) and Meghir, Mobarak, Mommaerts, and Morten (2020) employ related models of migration and risk sharing with limited commitment in order to evaluate interaction between these two margins. We contribute to this literature with a quantitative framework characterized by land constituting the main productive asset which (i) is in fixed supply; (ii) needs to be efficiently reallocated in response to idiosyncratic productivity shocks; and (iii) can also be used for self-insurance purposes. Using it, we analyze how land affects both efficiency and equity of rural economies, and how statutory reforms affect the functioning of these local institutions through their impact on the outside option.

3 Statutory and customary land institutions in Ghana

Land management in Ghana is predominantly a combination of statutory and customary practices. Those two pillars interact and overlap with each other, thus creating a dynamic and fluid institutional framework governing land issues. Whilst Ghana in its post-colonial years went through numerous institutional reforms, customary land norms have remained vastly accepted by the population, regardless of national politics (Woodman, 2003). An indication of the symbiosis between the customary and statutory laws is the Constitution of 1992 which formally recognized customary land ownership as long as the state law is not violated (Kline, Moore, Ramey, Hernandez, Ehrhardt, Reed, Parker, Henson, Winn, and Wood, 2019). Moreover, even though informal legal courts centered around Ghanaian Chiefs are no longer formally recognized, customary groups are allowed to manage the so called Alternative Dispute Resolution (ADR) programs that mediate disputes arising among members of the community (Kline et al., 2019).

During the recent legal history of Ghana, notable advancements in the legal framework regarding land were the National Land Policy in 1999 and the subsequent first and second Land Administration Projects in 2003 and 2010 respectively (Kline et al., 2019). Those acts constituted first attempts of the Ghanaian government to establish an efficient land administration system, providing the underlay for the latest Land Bill of 2016. The latter act advances Ghanaian land management by ensuring equitable access to land for women, registering and protecting customary land and facilitating land conveyances among other provisions.

Under customary norms, land can either belong to "Stool lands" or to "Skin lands". Those two types differ in the rules conditioning inheritance of land. The former are inherited to heirs of patrilineal descent, while the latter of matrilineal. "Stool land" is usually found in the southern part and refers to the wooden carved stool. "Skin land" is found in the northern part of the country and refers to animal's skin. In both cases, these are invariably symbols of the Chieftainship, signifying the importance of customary rules for land management in rural Ghana.

Driberg (1934) emphasizes the difference between the European and African concepts of law by highlighting their disparate foundations. European law is founded on the individualistic assumption, while the African law is based upon collectivist organization. This collectivist view characterises land management under customary law in Ghana until today. Land might either belong to the community, to the village or the family but never to the individual (Daniels, 1996). At the same time, all Ghanaian land is owned by someone (Kline et al., 2019).[2] As a

[2] "There is a Ghanaian saying to the effect that there is no land without an owner" (Daniels, 1996)

result, heads of the extended family or a traditional leaders are entitled to extended power over land issues.

Our results below ascertain that customary land management is guided by both efficiency and equity concerns. This view is warranted by numerous accounts in the literature, e.g. as succintly summarized by Turpin (1963) in a review of the book by Ollennu et al. (1962) on customary land law in Ghana

> *In illustration of the efficiency of this law in ensuring the fullest exploitation of land may be mentioned the reversion to the donor or vendor stool (community) of land not reduced to occupation by subjects of the acquiring stool; the unlimited right of a subject to exploit unappropriated land; the necessity for continuous rights of members of the general community (stool or family) to the natural produce of stool or family land; and the right of a pledgee of land to exploit it for his own benefit.*

4 Empirical analysis

4.1 Data

For the empirical component of the work, we use the Yale EGC-ISSER Ghana Socioeconomic Panel Survey, providing regionally representative data for all 10 regions of Ghana. In total, 5010 households from 334 enumeration areas (EAs) were interviewed in two waves (2009 and 2014).[3] We drop data from urban areas, leaving us with a sample of 4512 households living in 198 villages.

Income and consumption

We construct a measure of total net income by accounting for various sources and forms of income that households in our sample have. In particular, we compute for each wave and each household, total net income as the sum of crop net income, main occupation income, secondary occupation income, non farm enterprise income, animal net income and financial net income.

The main source of rural households' income is crop sales. The dataset allows us to quantify the households' net income from crops as it provides a detailed record of sales in crops markets as well as the costs incurred by the household during the preparation and cultivation of the plots and harvesting. It is important to note that crops sales income even though it constitutes an accurate measure of the revenues, in monetary units, received from crops markets, it does not reflect the produced size of crops. This discrepancy is due to the various uses of produced

[3] The third wave of the dataset is expected to become available in late 2021.

output. The households in our sample either consume or give away part of their production that survived from pests and adverse weather conditions, with a small fraction of it ending up to the market.[4] As far as the costs faced by the households over cultivation and harvest period are concerned, we employ information on (i) chemicals, (ii) seeds, (iii) tractor, (iv) labour inputs and (v) transportation costs.[5]

In order to capture additional revenues stemming from activities other than agriculture, we refer to main and secondary occupation data, as well as non-farm enterprise income. The former two sources of income refer to various sectors that the respondents might be employed to and are reported for the past 7 days from the interview date. We recover the annual value of the main and secondary occupation income by multiplying their income in the past 7 days by the number of weeks they have been employed during the past year. Non-farm enterprise income refers to revenues stemming from operating a small business outside the agricultural sector. The survey asks for detailed report of enterprise income and costs on a monthly basis for the past year. As a result, combining this information with the percentage of enterprise income that belongs to the household, we obtain a complete picture of non-farm enterprise income per annum.

The final source of potential income is households' assets. In our survey, households' assets are categorized into farm assets and financial assets. Farm assets refer to animals and the survey provides details on the revenues as well as the expenses related to their maintenance. Financial assets include households' savings, borrowing, lending, in-transfers and out-transfers received or sent. To derive the net income from this type of assets we include in our calculations savings, lending and in-transfers and we subtract the outflows (borrowing and out-transfers).

As far as consumption is concerned, the Ghana Socioeconomic Panel Survey reports consumption of food (purchased, home produced or received as gift) [6] and expenditures on clothing. In particular, the food list consists of 85 items and provides information on the way those were obtained. The consumption section also includes expenditures on durable goods with two additional categories: "other items" (including expenditures on ceremonies, vehicles and household repairs); and "fuels" (including electricity, gasoline and crops byproducts). Those two expenditure categories are reported for the past 12 months.

Our consumption variable is the sum of all aforementioned items that are categorized as non-durable goods. In order to obtain an annual measure for the food and clothing expenditures

[4] In order to compute our productivity measure we resort to assigning a value to the produced output and not to crop sales because of the described discrepancy between the two.

[5] More information about the distribution, size and calculation is provided in the Data Appendix

[6] See Figure 7 for the contribution of the relevant components to total value of food consumption

which are reported for the last month, we simply multiply by 12.[7] Finally, we express all income and consumption variables in per capita terms and in 2009 prices. [8] [9]

Land rights measure

The primary pillar of our work is how easily farmers in rural Ghana can access formal land markets. The Ghana Socioeconomic Panel Survey provides plot-level information on whether the current user carries the right to sell the parcel, or not.

As most of our analysis below pertains to co-operation at the community level, we aggregate selling rights information at the village level using a weighted (by the relative size of the plots) share of plots that can be sold in the sample:

$$\textit{sell-rights}_{v,t} = \sum_{p \in v} \left(\textit{sell-rights}_{p,t} \frac{\kappa_{p,t}}{\sum_{p \in v} \kappa_{p,t}} \right) \tag{1}$$

where p is plot, v is the village (Enumeration Area - EA), $\textit{sell-rights}_{p,t}$ is a dummy variable indicating whether the user of the plot has selling rights over it and $\kappa_{p,t}$ is the size of the plot in hectares.

Land fluidity measure

In order to formalize the degree of land variation we build a measure of size variation at the village level by exploiting the panel structure of our dataset. Our land fluidity index (LFI_v) is defined as a normalized (by the total size of land at the EA level across waves) sum of squared differences in households' landholdings over time.

$$LFI_v = \frac{\sum_{h \in v} \left(land_{h,t+1} - land_{h,t} \right)^2}{\overline{land}_{v,t/t+1}} \tag{2}$$

[7] We acknowledge the seasonality that this measure suffers from. In particular, there is large dependence on whether the interview took place before or after the harvest season. In order to deseasonalize this measure we are planning to employ the method of De Magalhães and Santaeulàlia-Llopis (2018) who regress period consumption on seasonal dummies. However, our dataset only contains two periods, and more than two calendar years are needed. As a result, we are planning to perform this upon publication of the third wave of the survey.

[8] We compute per capita quantities by dividing household-level quantities by a composite age-adjusted measure of household members, derived as in Townsend (1994) by adding the following numbers: for adult males, 1.0; for adult females, 0.9; for males aged 13-18, 0.94; for females aged 13-18, 0.83; for children aged 7-12, 0.67; for children aged 4-6, 0.52; for toddlers 1-3, 0.32; and for infants 0.05.

[9] According to World Bank data, CPI in 2009 was 90.328 and the CPI in 2014 was 150.21. Hence, we deflate total value of consumption and income in wave 2 using :

$$income(consumption)_{\text{w:2, in 2009 prices}} = income(consumption)_{w:2} \times \frac{CPI_{2009}}{CPI_{2014}}$$

where $land_{h,t}$ is the sum of size of all plots cultivated by members belonging to the same household in waves 1 (t) and wave 2 ($t+1$), and $\overline{land}_{v,t/t+1}$ is the mean of plots' size for all plots within the village (EA) across both waves.

Productivity measure

In order to construct our measure of agricultural productivity, we process data on crop sales prices, produced quantities and land size to construct a comparable measure of productivity based on the market value of agricultural production. Productivity of plot p of size κ_p in which individual i grows crops c in wave t is calculated as the market value of produced crops per unit of land cultivated, i.e. using the following formula:

$$productivity_{p,t} = \frac{p_{c,t} \cdot q_{c,p,t}}{\kappa_{p,t}} \quad \forall p, t \tag{3}$$

where $p_{c,t}$ is the crop market price in wave t and $q_{c,p,t}$ is the produced quantity of crops c.

Two characteristics of Ghanaian agricultural markets impede a direct derivation of productivity. First, very few farmers do actively participate to the crop market. Harvested crop is mostly directed to self-consumption, or is gifted to other households if not lost due to pests or weather conditions. As a result, large part of the sample reports high produced quantity but low or zero sold quantity. This fact hinders the derivation of market prices. To overcome this difficulty we proceed as follows. If the individual i has sold part of the harvest in the market, then $p_c \equiv p_{i,c}$, the price in which i sold. If individual i has not participated to the market, we first generalize at the village level by setting the crops' price $p_c \equiv p_{c,v}$, which is the average price of all other farmers in the same village that sold the same crops.[10] If no other farmers from the same EA (village) have participated to the market selling the same crops we generalize at the district, regional and country level, by setting p_c equal to $p_{c,d}$, $p_{c,r}$ and $p_{c,g}$ respectively. In this way we manage to derive prices for as many individuals as possible.

The second characteristic is the existence of multiple local units of measurement. Because of this, the sample records transactions for a given crop denominated in multiple units of measurement. In the described process, we need to account for different units of measurement. Thus, we create a three level id, EA-crop-unit, which allows us to match the same crops expressed in the same unit among different individuals residing in the same village.[11]

[10] More precisely, $p_{c,v}$ is defined as $p_{c,v} = \frac{\sum_{-i \in v} p_{-i,c}}{n_{-i}}$, where $-i$ indicates all other households living in village v other than household i.

[11] We proceed accordingly at the region, district and country level if necessary, adjusting the id to account for the granularity level.

Lastly, throughout the regression analysis, we aim to explore the link between land rights and productivity at the macro-village level. To this end, we construct the EA productivity metric using the following formula:

$$village\text{-}productivity_{v,t} = \sum_{p \in v} \left(\frac{p_{c,t} \cdot q_{c,p,t}}{\kappa_{p,t}} \frac{\kappa_{p,t}}{\sum_{p \in v} \kappa_{p,t}} \right) \quad \forall t, v \tag{4}$$

where each plot's productivity belonging to a certain EA has been weighted by the relative size of the plot to the EA's total land size.

4.2 Suggestive empirical observations

Before delving into formal econometric evidence, we motivate our study by providing descriptive statistics on the main elements of our work. In particular we present suggestive evidence signifying that (i) land conveyances in rural Ghana are confined within the limits of the extended family characterized by a complete absence of formal purchases, (ii) despite the absence of formal land sales, households' land size undergoes considerable variation over time, (iii) selling rights at the village level exhibit significant variation across villages and over time, (iv) informal risk-sharing can potentially be mirrored in the loans exchanged among individuals of close-knit. Points (i) and (ii) show the existence of informal land markets that rural populations makes use of. Point (iii) indicates a weak institutional environment regarding formal land rights that is fluid and poorly established. Last, point (iv) implies the existence of an informal safety net among members of the same family-community.

The left panel in Figure 1 documents that land acquisition in rural Ghana is mostly informal and confined within the limits of the extended family. Only 15% (20%) of the respondents have obtained their cultivated plots from a person to whom they are not related in wave 1 (wave 2). At the same time, more than 65% of the sample in wave 1 have obtained the plot either from the family head ($\sim$ 30%) or a relative ($\sim$ 35%). In wave 2, where only the option "relative" is provided, more than 70% of the plots were given to current users by a relative.

Furthermore, the right panel in Figure 1 shows a complete absence of formal land sales. Purchased plots amount to less than 5% of the sample, while there is a strong indication of plots being transferred through lineage, as inheritance constitutes the main acquisition way with more than 40% (50%) in wave 1 (wave 2).

Despite the absence of formal land markets, households' land holdings are experiencing considerable variation in size, signifying the mechanism of informal land re-allocation. In Figure 2, we present changes in aggregate land holdings at the household level across the two waves.

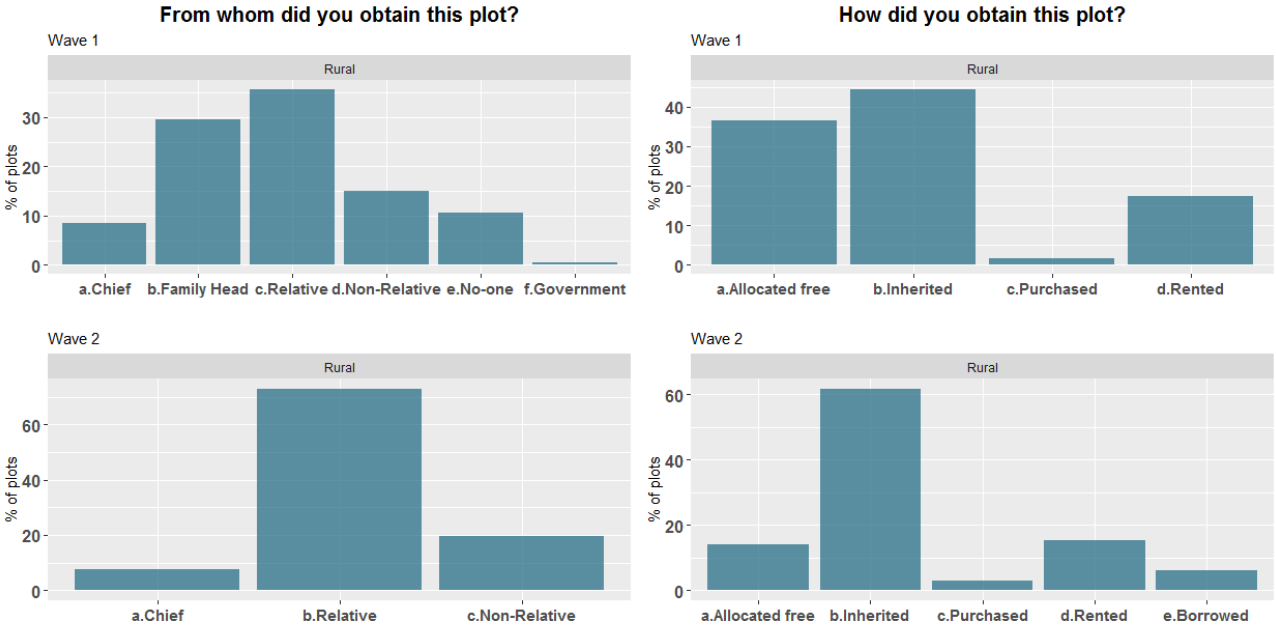

Figure 1: From whom and how did you obtain the plot?

As most of the observations lie off the 45 degree line, households' land holdings go through significant changes over time, an observation that is consistent across all ten Ghanaian administrative regions.

Furthermore, Figure 3 shows that while the share of villages' land with selling rights on it is small on average, it is varying significantly both over time and regions. This confirms existence of pluralistic land tenure regime documented in the literature.[12]

Finally, because the central focus of this paper is on the link between land formality and risk-sharing, we document how the communities in our sample benefit from and provide insurance. First, we show in Figure 8 that vast majority of households in our sample has financial savings lower than 20% of annual consumption and that this does not change much over time. Secondly, the left panel of Figure 4 documents that more than 60% of the loans given are coming from relatives, neighbours and friends. This signifies tight links among members of the same extended family and community, as well as a lack of well-developed formal credit markets. Complementary to the latter evidence, Figure 9 shows that households in our sample mostly used the received loans either for consumption or to purchase agricultural inputs. Lastly, we observe in the right panel of Figure 4 that more than 80% of the loans did not require any form

[12] A potential concern with this data is that part of our measured changes in land formality is due to attrition of plots between waves of our data. In order to address this issue, Figure 11 in the Data Appendix presents the equivalent of Figure 3, that has been constructed using a sub-sample of plots that households reported to have been consistently cultivating between the first and second wave. As can be seen, the general patterns of changes in land formality survive.

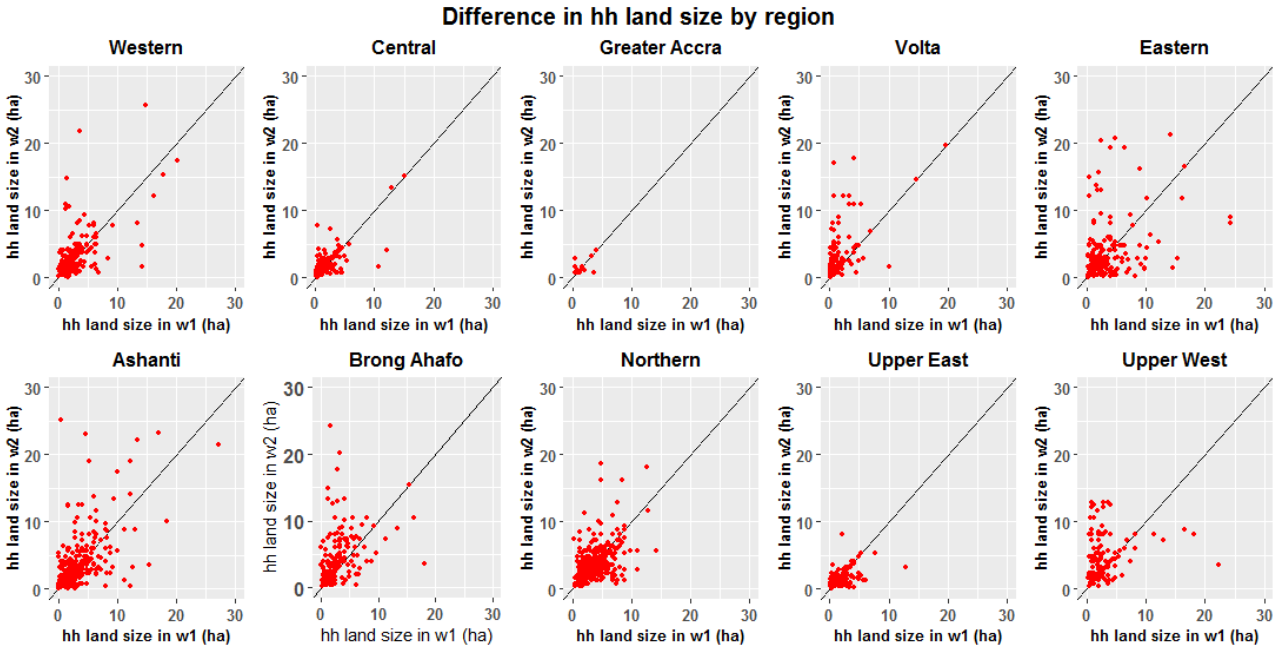

Figure 2: Difference in households' land size

of collateral. This finding indicates that loans are given on the basis of trust and potentially constitute an informal insurance mechanism developed within the community.

4.3 Regression analysis

In this part, we analyse econometrically the channel through which land rights relates to co-operation over land use and mutual insurance at the village level. This investigation will largely rely on rich empirical variations documented above.

Intuitively, increases in land formality may give rise to two opposite forces. On one hand, stronger selling rights might undermine informal land and risk sharing co-operation within communities by establishing formal land markets that make the title holders better-off on their own, and so effectively reduce incentives of these individuals to co-operate with community. On the other hand, a farmer who feels more secure about her or his rights over land, might be more willing to share it (via renting or sharecropping) with other households, if efficient (or desirable). We provide evidence that the latter force dominates in our sample, but we also present the conditions under which the former can emerge in our quantitative model.

In order to build our argument we proceed as follows. First, we show that in villages with a higher share of selling rights, land changes hands more frequently. This suggests that land holders feel more secure about their assets. Second, we show that in those villages, the average village productivity is also higher, suggesting that more intense land re-allocations are more

Figure 3: Difference in villages' selling rights

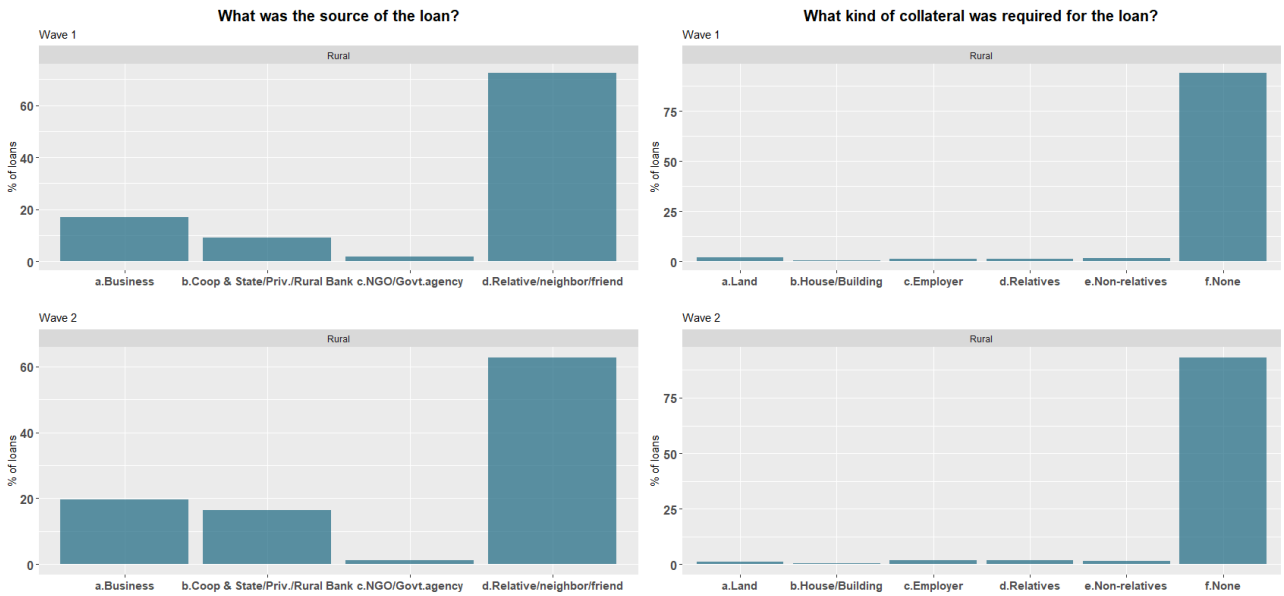

Figure 4: Source of loans and collateral request

efficient. Third, we confirm that increases in selling rights are positively related to increases in average village consumption. Finally, on top of increased agricultural productivity and implied higher consumption, we document that increases in land formality are associated with improved informal insurance against idiosyncratic shocks (or risk sharing).

Land rights and land security

First, we argue that higher take up of land titles translates into higher land security in village communities. To this end, we regress the village-level share of disputed land due to multiple claims on our measure of selling rights (1):

$$multiple\ land\ claims_{v,t} = \alpha + \beta_1 \cdot sell\text{-}rights_{v,t} + \beta_2 \cdot X_{v,t} + \epsilon_{v,t} \tag{5}$$

where $X_{v,t}$ is a vector of time-varying village and land controls containing size of village population, average years of use of land, share of land that can be fallowed, share of land with chemical use and share of land with irrigation.

Results in Table 4 show that the increases in the share of land in a village with formal titles is significantly negatively correlated with the number of land disputes due to multiple claims over land. This finding suggests that land titles provide higher security for land owners, which has important implications for the ensuing analysis below.

Land rights and land fluidity

In order to examine the role of selling rights in village-level land re-allocation, we regress our measure of land fluidity (2) on our measure of selling rights (1) as follows:

$$LFI_v = \alpha + \beta_1 \cdot \overline{sell\text{-}rights}_{v,t/t+1} + \beta_2 \cdot \overline{X}_{v,t/t+1} + \epsilon_v \tag{6}$$

Notice that regression (6) is based on the cross-sectional data as the land fluidity index uses the difference in land holdings' size over time. We adjust the right hand side of equation (6) by taking the average selling rights at the village level over the two available waves ($\overline{sell\text{-}rights}_{v,t/t+1}$). Similarly, vector $\overline{X}_{v,t/t+1}$ includes the average values over the two waves for multiple land characteristics we control for.

Table 5 presents results of the estimation. We observe that higher values of selling rights at the EA level are correlated with higher values of the LFI index. This indicates that land markets in villages with more selling rights tend to be more fluid. Importantly, Table 7 shows that increases in land rights are uncorrelated with increases in formal land sales. As such, our findings suggest that households are more inclined to share land informally, when they hold formal rights.

Land rights and productivity

Next, we investigate how improvements in land security affect agricultural productivity at the aggregate level. We investigate this using the following regression:

$$log(village\text{-}productivity_{v,t}) = \alpha + \beta_1 \cdot sell\text{-}rights_{v,t} + \beta_2 \cdot X_{v,t} + \epsilon_{v,t} \tag{7}$$

where the productivity measure is as described in equation (4).

Table 8 shows the results of the estimation. We find that villages with higher level of selling rights tend to be more productive.

Land rights and average consumption

Next, we ask whether higher land security is associated with increases in aggregate consumption using the following regression:

$$log(c_{v,t}) = \alpha + \beta_1 \cdot sell\text{-}rights_{v,t} + \beta_2 \cdot X_{vt} + \gamma_{d,t} + \epsilon_{v,t} \tag{8}$$

where $c_{v,t}$ is the mean per capita consumption at the village level and $\gamma_{d,t}$ are district-wave fixed effects controlling for district-level aggregate shocks.

Table 9 shows that the degree of land rights at the village level is indeed positively associated with the mean village consumption. Because this result informs us only about the aggregate efficiency impact of increases in land security, we turn to investigating the consumption risk sharing channels in what follows next.

Cross-sectional evidence: risk-sharing ratio

We provide evidence on informal risk-sharing in two ways. First, we construct a risk-sharing ratio accounting for the cross-sectional variation in consumption and income at the village level. We define it as follows:

$$RS_{v,t} = \frac{\mathrm{Var}_h(c_{h,v,t})}{\mathrm{Var}_h(y_{h,v,t})} \tag{9}$$

where $c_{h,v,t}$ and $y_{h,v,t}$ are the per capita consumption and income of household h in village v at time t.

Notice that the lower is the risk-sharing ratio, the better is the insurance against income shocks in the cross-section at the village level. For instance, a value of $RS_{v,t}$ equal to 1 signifies that consumption and income exhibit the same variation. Furthermore, a negative relationship between $RS_{v,t}$ and $sell\text{-}rights_{v,t}$ implies potential improvements in risk-sharing in villages with

stronger land rights.

We test whether increases in land formality are associated with improvements in the risk-sharing ratio using the following specification:

$$log(RS_{v,t}) = \alpha + \beta_1 \cdot sell\text{-}rights_{v,t} + \beta_2 \cdot X_{v,t} + \beta_3 \cdot \gamma_{v,t} + \epsilon \tag{10}$$

where $X_{v,t}$ is a vector of our village and land controls extended by mean village consumption allowing us to control for aggregate shocks affecting all villagers in a given period, $\gamma_{v,t}$ are village-wave fixed effects and the main independent variable is the degree of selling rights at the EA level as defined in expression (1).

Table 10 presents the results from estimating equation (10). Under all specifications, which differ at the calculation of the risk-sharing ratio components of consumption and income (in levels, and per capita) the degree of formal land rights is negatively correlated with the risk-sharing ratio, suggesting that increases in selling rights may not only bring efficiency gains, but also contribute to reductions in consumption inequality.

Panel evidence: consumption smoothing test

In our second measure of risk sharing, we exploit the panel dimension of the data allowing us to control for household fixed effects and run an extended consumption smoothing test in spirit of Townsend (1994).

$$log(c_{h,v,t}) = \alpha + \beta_1 \cdot log(y_{h,v,t}) + \beta_2 \cdot log(y_{h,v,t}) \cdot \overline{sell\text{-}rights_{v,t}} + \beta_3 \cdot \overline{sell\text{-}rights_{v,t}} + \beta_4 \cdot X_{h,v,t} + \beta_5 \cdot \gamma_{h,t} + \epsilon_{h,v,t} \tag{11}$$

where $c_{h,v,t}$ and $y_{h,v,t}$ are per capita consumption and income of household h, in village v at time t and $\overline{sell\text{-}rights_{v,t}}$ is the mean across waves of selling-rights for village v. $X_{h,v,t}$ is a vector of land controls including mean consumption of every other household in the village accounting for aggregate shocks ($log(\overline{c}_{v,t})$).

Results in Table 11 show that households in our sample are able to smooth their consumption very well. First, we find that the elasticity of consumption is low, but statistically significant. Second, and in line with evidence from the risk sharing ratio, we see that the income and selling rights interaction term is statistically significant and negative, implying that increases in selling rights are correlated with improvements in consumption smoothing.

Importantly, notice that consumption smoothing can be achieved either through self-insurance or mutual-insurance. To show that our results on risk sharing do not reflect self-insurance, we

test whether households' savings are correlated with changes in land formality:

$$savings_{h,v,t} = \alpha + \beta_1 \cdot sell\text{-}rights_{h,v,t} + \beta_2 \cdot X_{h,v,t} + \zeta_{v,t} + \epsilon_{h,v,t} \tag{12}$$

where $savings_{h,v,t}$ is the household's h savings in period t either kept at home, in a bank or in any other saving society or group (e.g. Susu). Importantly, now $sell\text{-}rights_{h,v,t}$ indicate the selling rights at the household level. Moreover, due to cattle being the predominant form of assets in rural Africa, we estimate the same specification with the value of cattle owned by the household as the dependent variable. Under both specifications and as shown in Table 12, selling rights exhibit no significant relationship with household savings. These findings allow us to conclude that the documented above improvements in consumption smoothing upon increasing land formality are not due to better self-insurance, but are rather associated with informal risk sharing channels in rural communities.

The empirical analysis so far aims to establish an empirical relationship between land rights and risk-sharing. The above analysis is in line with an informal mechanism of joint consumption and land sharing being in place. In particular, a higher degree of rights over land, as expressed by the ability of the user to sell the parcel, potentially ensure farmers of the safety of their land. Relieved of the fear of losing land, they are more willing to participate to land re-allocation and share their land more efficiently bringing productivity gains and higher agricultural output that can consequently be redistributed for consumption of the ones hit by bad shocks.

5 Quantitative model

In this section, we propose a dynamic model featuring co-operation over insurance and land in presence of voluntary participation (or limited commitment) constraints. We characterize the outside option (of self-insurance and land trade), first best and limited commitment benchmarks, and we argue that the framework proposed can rationalize the empirical findings documented above.

5.1 Environment

The village economy is inhabited by two ex-ante homogeneous households deriving utility from consumption according to function $u(c)$, satisfying $u'(c), -u''(c) > 0$. Time t is discrete and agents are infinitely lived.

In every period t, household i uses land $z_{i,t}$ (chosen in period $t-1$) to produce crop output

according to the following production function:

$$y_{i,t} = \phi_t \theta_{i,t} z_{i,t}^{\alpha} \tag{13}$$

where $\phi \in \Phi = (\phi_1, ..., \phi_{N_\phi})$ and $\theta_i \in \Theta = (\theta_1, ..., \theta_{N_\theta})$ denote aggregate and idiosyncratic productivity shocks following Markov chains with transition matrices π_ϕ and π_θ.

More importantly, the supply of land is fixed in every period, i.e. $z_{1,t} + z_{2,t} = 1, \quad \forall t$. Finally, because we assume ex-ante homogeneity, households start their lives with the *inherent* allocation of land $z_{1,0} = z_{2,0} = 0.5$.

The state of the economy is given by vector $x_t = (z_{1,t}, z_{2,t}, \phi_t, \theta_{1,t}, \theta_{2,t})$ and the decisions of the households are $a_t = (c_{1,t}, c_{2,t}, z_{1,t+1}, z_{2,t+1})$.

5.2 Outside Option

We begin by characterizing the outside option of households which prescribes individual land management. First, we assume that households have access to formal land titles, and so they acquire and sell land through participation in the formal land market.

Second and related, we assume self-insurance: agents can consume and store (in form of land) as much as they want, without sharing their goods with other households.

Third, we assume that in the very period of household's deviation t_{dev} from the contract on land and risk sharing (LRS, described below), the deviator owns the claim to and produces using land equal to:

$$z_{i,t_{dev}}^{out} = \psi \cdot z_{i,0} + (1 - \psi) \cdot z_{i,t_{dev}}^{LRS} \tag{14}$$

with $\psi \in [0, 1]$ standing for the degree of land rights and $z_{i,t_{dev}}^{LRS}$ being exogenously given here. In other words, the higher is the degree of land rights ψ, the higher is the weight on the household's inherited land in its portfolio in the period of deviation.

From the second period of deviation onward (i.e. for $t > t_{dev}$), the deviating household keeps the title to economic benefits of the entirety of land they possess.

Formally, given the degree of land rights ψ, the period's t_{dev} value of outside option for the household i with current state $x_{i,t_{dev}} = (z_{i,t_{dev}}^{out}, \phi_t, \theta_{i,t})$, deviating from the contract, reads:

$$V_{i,t_{dev}}^{out}(x_{i,t_{dev}}; \psi) = \max_{\{c_{i,t_{dev}}^{out}, z_{i,t_{dev}+1}^{out}\}} u(c_{i,t_{dev}}^{out}) + \beta E_{\phi,\theta} V_{i,t_{dev}+1}^{out}(x_{i,t_{dev}+1} | x^{i,t_{dev}}) \tag{15}$$

subject to:

$$t = t_{dev}: \; c_{i,t}^{out} + q_{z,t} z_{i,t+1}^{out} \leq \phi_t \theta_{i,t} \left(z_{i,t_{dev}}^{out} \right)^{\alpha} + q_{z,t} z_{i,t_{dev}}^{out} \tag{16}$$

$$t > t_{dev}: \; c_{i,t}^{out} + q_{z,t} z_{i,t+1}^{out} \leq \phi_t \theta_{i,t} (z_{i,t}^{out})^{\alpha} + q_{z,t} z_{i,t}^{out} \tag{17}$$

where $z_{i,t_{dev}}^{out} = \psi z_{i,0} + (1-\psi) z_{i,t}^{LRS}$, $x_{i,t_{dev}} = (\psi z_{i,0} + (1-\psi) z_{i,t}^{LRS}, \theta_{i,t})$ and $x_{t+1} = (z_{i,t+1}^{out}, \phi_{t+1}, \theta_{i,t+1})$ and $q_{z,t+1}$ is a land price such that $z_{i,t} \in [0,1]$ $\forall i$ and the market clearing condition $z_{1,t} + z_{2,t} = 1$ $\forall t$ holds in equilibrium.

The associated land-FOC reads:

$$q_{z,t} = \beta \mathrm{E}_{\phi,\theta} \frac{u_{i,c_{t+1}}}{u_{i,c_t}} (\alpha \phi_{t+1} \theta_{i,t+1} (z_{i,t+1}^{out})^{\alpha-1} + q_{z,t+1}) \tag{18}$$

Land holdings are chosen in (18) such that the marginal cost of an additional unit of land (that costs $q_{z,t}$) is equalized with its expected marginal gain, given by the marginal increase in crop output and the capital value of land (all in terms of marginal utility of consumption).

Notice that the degree of land rights has important implications for the value function of deviators:

Proposition 1 *$V_{i,t_{dev}}^{out}(x_{i,t_{dev}}; \psi)$ is increasing in ψ for the household with $z_{i,t_{dev}}^{LRS} < z_{i,0}$.*

Intuitively, higher land rights increase land security of agents: whenever they deviate from the co-operation with other villagers, they maintain rights to their inherent amount of land. Consequently, this implies that the value of deviation for the individuals with a relatively high (low) land allocation within the LRS contract would decrease (increase) with improvements in land rights. This dynamic will be very important for characterization of the LRS contract below.

5.3 First best

In the first best allocation with Pareto weights λ_1, λ_2, the social planner's (village chief or family head) problem reads:

$$
\begin{aligned}
V_t^{FB} &= \max_{\{c_{i,t}^{FB}, z_{i,t+1}^{FB}\}} \sum_{i=1}^{2} \lambda_i u(c_{i,t}^{FB}) + \beta E_{\phi,\theta} V_{t+1}^{FB}(x_{t+1}|x^t) \\
\text{subject to :} \quad & \sum_{i=1}^{2} c_{i,t}^{FB} \leq \sum_{i=1}^{2} \phi_t \theta_{i,t} (z_{i,t}^{FB})^{\alpha} \\
& z_{1,t} + z_{2,t} = 1, \; z_{i,t} \in [0,1]
\end{aligned} \tag{19}
$$

where $s_{i,t+1} \geq 0$, $x_{t+1} = (z_{1,t+1}, z_{2,t+1}, \theta_{1,t+1}, \theta_{2,t+1}, \phi_{t+1})$. Notice that prices $q_{z,t}$ are not present in this benchmark as they are not relevant to the planner choosing land allocations directly (subject to the land market clearing condition).

Then, the associated FOCs read as follows:

$$
\frac{u_{1,c_t}}{u_{2,c_t}} = \frac{\lambda_2}{\lambda_1} \tag{20}
$$

$$
E_{\theta_{1,t+1}}[u_{1,c_{t+1}} \theta_{1,t+1}] \lambda_1 z_{1,t+1}^{\alpha-1} = E_{\theta_{2,t+1}}[u_{2,c_{t+1}} \theta_{2,t+1}] \lambda_2 (1 - z_{1,t+1})^{\alpha-1} \tag{21}
$$

This benchmark differs in three important ways. First, the planner directly redistributes consumption between agents according to (20) with exogenously given Pareto weights.

Second, land is allocated according to (21), such that the marginal output gain of an additional unit of land given to household 1 is equalized with the one of household 2 (all in marginal utility terms). In other words, the planner first ensures that the land is allocated in the most productive way maximizing the aggregate crop output, and then redistributes the realized output according to her preferences.

Third, the land rights are irrelevant in this benchmark. This is a direct consequence of the fact that the planner is assumed to be benevolent and to be able to enforce all allocations she desires. We relax the latter assumption in what follows.

5.4 Land and risk sharing with limited commitment

This benchmark differs from the first best in that it subjects the planner's decisions to the limited commitment constraints. Satisfying those requires the planner to make such consumption and land transfer decisions that make both households participating in the contract in every period and state realization at least as well off as in the outside option.

Formally, the planner solves the following problem:

$$V_1^{LRS}(\psi) = \max_{\{c_{i,t}^{LRS}, z_{i,t+1}^{LRS}\}} \sum_{i=1}^{2} \lambda_{i,0}^{LRS} u(c_{i,1}) + \beta E_{\phi,\theta} V_{i,2}^{LRS}(x_2|x^1) \tag{22}$$

subject to:

$$\left(\zeta_t^{LRS}\right) \quad \sum_i c_{i,t}^{LRS} \leq \sum_i \phi_t \theta_{i,t} \left(z_{i,t}^{LRS}\right)^{\alpha} \tag{23}$$

$$\left(\mu_{i,t}^{LRS}\right) \quad E_t\Big[\sum_{t'=t}^{\infty} \beta^{t'-t} u(c_{i,t'}^{LRS})\Big] \geq V_{i,t}^{out}\Big(\psi \cdot z_{i,0} + (1-\psi) \cdot z_{i,t}^{LRS}, \phi_t, \theta_{i,t}\Big) \quad \forall i, x^t \tag{24}$$

$$z_{1,t} + z_{2,t} = 1, \;\; z_{i,t} \in [0,1]$$

where $\mu_{i,t}^{LRS}$ denotes the Lagrange multiplier on the limited commitment constraint for household i in period t.

In this case, the FOCs read:

$$c_t: \quad \zeta_t^{LRS} = u_{i,c_t} \cdot \left(\lambda_{i,t-1}^{LRS} + \mu_{i,t}^{LRS}\right) \;\; \forall i \;\; \Rightarrow \;\; \frac{u_{1,c_t}}{u_{2,c_t}} = \frac{\lambda_{2,t-1}^{LRS} + \mu_{2,t}^{LRS}}{\lambda_{1,t-1}^{LRS} + \mu_{1,t}^{LRS}} \quad \forall i \neq j \tag{25}$$

$$\begin{aligned} z_{1,t+1}: \quad & \mathrm{E}_{\phi,\theta}\left[u_{1,c_{t+1}} \left(\lambda_{1,t}^{LRS} + \mu_{1,t+1}^{LRS}\right) \phi_{t+1}\theta_{1,t+1}\alpha \left(z_{1,t+1}^{LRS}\right)^{\alpha-1} - \mu_{1,t+1}^{LRS} \frac{\partial V_{1,t+1}^{out}}{\partial z_{1,t+1}^{LRS}}\right] = \\ & \mathrm{E}_{\phi,\theta}\left[u_{2,c_{t+1}} \left(\lambda_{2,t}^{LRS} + \mu_{2,t+1}^{LRS}\right) \phi_{t+1}\theta_{2,t+1}\alpha \left(1 - z_{1,t+1}^{LRS}\right)^{\alpha-1} - \mu_{2,t+1}^{LRS} \frac{\partial V_{2,t+1}^{out}}{\partial z_{2,t+1}^{LRS}} \frac{\partial z_{2,t+1}^{LRS}}{\partial z_{1,t+1}^{LRS}}\right] \end{aligned} \tag{26}$$

where $\frac{\partial V_{1,t+1}^{out}(\tilde{x}_{t+1})}{\partial z_{1,t+1}^{LRS}} = u_{1,c_{t+1}}^{out} \cdot (1-\psi)(q_{z,t+1} + \alpha\phi_t\theta_{1,t}(\psi \cdot z_{1,0} + (1-\psi) \cdot z_{1,t+1}^{LRS})^{\alpha-1}))$
and $\frac{\partial V_{2,t+1}^{out}(\tilde{x}_{t+1})}{\partial z_{2,t+1}^{LRS}} \cdot \frac{\partial z_{2,t+1}^{LRS}}{\partial z_{1,t+1}^{LRS}} = -u_{2,c_{t+1}}^{out} \cdot (1-\psi)(q_{z,t+1} + \alpha\phi_t\theta_{2,t}(\psi \cdot z_{2,0} + (1-\psi) \cdot (1 - z_{1,t+1}^{LRS})^{\alpha-1}))$.

First of all, notice the adjusted consumption sharing rule. In any period t, after the idiosyncratic shocks are realized, consumption is determined by Pareto weights inherited from period $t-1$ that are additionally updated to account for potentially binding limited commitment constraints. This is done so that in equilibrium no agent defaults on the contract and so that the long-run co-operation is achievable. Following Marcet and Marimon (2019), the Pareto weights are updated according to $\lambda_{i,t}^{LRS}(x_t) = \lambda_{i,t-1}^{LRS}(x_{t-1}) + \mu_{i,t}^{LRS}$.

The planner's decision (26) about land allocations is a version of condition (21) in the first

best benchmark, adjusted for expected next period's binding limited commitment constraints whenever land rights are incomplete, i.e. $\psi < 1$. Because $\frac{\partial V^{out}_{i,t+1}(\tilde{x}_{t+1})}{\partial z^{LRS}_{i,t+1}} > 0 \; \forall i$, the planner needs to shade the land allocated to agent i in period t, if she expects this household to have binding participation constraints in the next period.

Overall, the extent of efficient consumption risk sharing is pinned down in equilibrium by "how slack" are the limited commitment constraints of the agents. In particular, the ability of the planner to provide consumption insurance to both households is an increasing function of the distance between the (inside) value of co-operation and the (outside) value of deviating in the enforcement constraints (24) of both households.

While a similar statement holds true about the efficiency of land allocations, the degree of land rights chosen ex-ante has important implications for the co-operation between households in equilibrium. To make this clear, we make the following three observations. First, we know from the literature[13] that the limited commitment constraints in a given period are usually binding for individuals with currently higher productivity. Second, achieving economic efficiency calls for allocating relatively more land to the more productive household (i.e. the one with higher θ). Third, we showed in Proposition 1 that the value of deviation is increasing in ψ for households with current allocation of land satisfying $z^{LRS}_{i,t} < z_{i,0}$.

Taking these observations together implies that higher degree of land rights ψ will drive down the outside option (and so relax the limited commitment constraints) of the more productive households. Because it is precisely these agents who determine the degree of land and risk sharing co-operation in equilibrium, increases in ψ will improve the efficiency of both margins.[14] As a direct consequence, the aggregate crop output will also increase, and so will the average consumption.

6 Structural Estimation

6.1 Estimation procedure

We fit the model using empirical data of the Ghana Socioeconomic Panel Survey. To this end we employ the method of simulated moments as introduced by McFadden (1989) and Pakes and Pollard (1989). Our ultimate aim is to find an estimated value of a θ-vector consisting of

[13] See e.g. Alvarez and Jermann (2000)

[14] Notice that even if land rights are complete, i.e. $\psi = 1$, the land allocation under limited commitment will be distorted (relative to the first best benchmark) due to potential adjustments in Pareto weights.

structural parameters of the model which minimizes the following criterion:

$$\big(g(\theta) - g\big)' \cdot W \cdot \big(g(\theta) - g\big)$$

where g is a vector of moments derived by the data; $g(\theta)$ is the corresponding simulated moments derived from simulating the model for different values of the θ-vector; and W is a positive definite weighting matrix.

Our structural estimation consists of two stages, namely the solutions to an inner and an outter problem.

Inner problem: We construct simulated moments from solving the full model of land and risk sharing with limited commitment for a given candidate value of the θ-vector. With long simulated time series of the key results in hand we are able to generate the vector of targeted moments which are going to be a function of the structural parameter θ-vector $\big(g(\theta)\big)$.

Outter problem: In this stage we estimate the value of θ-vector that minimizes the aforementioned criterion.

$$\hat{\theta} = arg\,\underset{\theta}{min} \quad \big(g(\theta) - g\big)' \cdot W \cdot \big(g(\theta) - g\big)$$

To form the criterion, we use the model-generated vector of moments from the inner problem and we also derive the data-generated vector of moments (g).

6.2 Parameter vector and targeted moments

As shown in Table 1 there are three groups of variables to estimate. The first refers to the time preferences of the household and how much they discount future utility. The second refers to the curvature of the production function and the marginal product of land. The last group refers to parameters that govern the stochastic component of the model. As the model is fairly complex allowing for multiple strategic interactions to take place, choice of one parameter value affects the dynamics of many equilibrium variables within the risk sharing contract as well as outside of it. Indicatively, in Figure 11 and Figure 12 we show average village consumption and income as well as the corresponding coefficient of variation and consumption elasticity, as functions of discount factor β and production function parameter α respectively. We infer that the dependence of these equilibrium variables is significant both within the land and risk-sharing contract as well as the outside option. Consequently, the overall effect will be the outcome of the interactions in and out the land and risk sharing arrangement.

Preferences: We use logarithmic preferences $(u(c) = logc)$ with agents discounting future utility with a factor, β. We simulate the model and choose parameter β as to match coefficients

Parameters	
Preferences	
Time preference	β
Technology	
Output elasticity	α
Stochastic processes	
Idiosyncratic risk	$(\theta_{i,h}, \theta_{i,l})$
Persistence of idios. risk	Π_θ
Aggregate risk	(ϕ_H, ϕ_L)

Table 1: Elements of θ-vector

of regression (27) in its model-implied equivalent.

$$log(c_{h,t}) = \alpha + \xi_1 \cdot log(y_{h,t}) + \xi_2 \cdot log(y_{h,t}) \cdot sell\text{-}rights_{v,t} + \xi_3 \cdot sell\text{-}rights_{v,t} + \gamma_h + \zeta_{v,t} + \epsilon_{h,t} \quad (27)$$

where $c_{h,t}$ and $y_{h,t}$ is per capita consumption and income respectively, as computed in Section 4 and γ_h, $\zeta_{v,t}$ are accounting for household, and village-time fixed effects. Consumption elasticity and land rights impact on the latter are informative for the time preference parameter due to the very nature of the risk sharing contract. Under limited commitment, the agents will remain within the contract as long as the long-term benefit from making a transfer today is exceeding the current incurred cost. Indicatively, in Figure 11, consumption elasticity decreases for higher values of the discount factor, β, ceteris paribus. As agents value more potential future transfers (more patient), they are more willing to participate to mutual insurance, increasing in this way consumption smoothing within the network. In a very similar fashion, time preferences govern the willingness of households to productively exchange land with each other, affecting the outside option and so the extent of sustainable risk sharing.

Technology: Land is used in production of crop output through a Cobb-Douglas technology, $y_{i,t} = \phi_t \theta_{i,t} z_{i,t}^{\alpha}$. Parameter α is the output elasticity of land and it is assumed to be lower than 1, to capture decreasing returns to scale. Deriving the logarithmic transformation of production technology provides an expression that can be brought to the data. The empirical equivalent of it takes the following form,

$$log(y_{h,t}) = \alpha + \lambda \cdot log(\kappa_{h,t}) + \gamma_h + \zeta_{v,t} + \epsilon_{h,t} \quad (28)$$

where $y_{h,t}$ is our measure of per capita income, $\kappa_{h,t}$ is total household's land holdings and γ_h and $\zeta_{v,t}$ account for household and village-time fixed effects respectively.

Stochastic Processes

Idiosyncratic risk: Idiosyncratic income risk is modelled as a two state Markov process with a persistence parameter, π_θ and symmetric shock levels $\{\theta_H, \theta_L = 1 - \theta_H\}$. Following Mazur (2020) our decomposition of household's income reads:

$$log(y_{h,t}) = \alpha + \beta_h + \gamma_{v,t} + \epsilon_{h,t} \tag{29}$$

Where $y_{h,t}$ is per capita income, as computed in our regression analysis, γ_h is households' fixed effect and $\zeta_{v,t}$ is village-time fixed effects. Having controlled for aggregate risk, the residual can be effectively account for the idiosyncratic component of income.

The error term in equation (29) is further modelled as an AR(1) process,

$$\epsilon_{h,t} = \Pi_\theta \cdot \epsilon_{h,t-1} + \theta_{h,t} \tag{30}$$

where Π_θ is the persistence exhibited by the idiosyncratic shock process. We then proceed in computing the mean standard deviation of idiosyncratic risk, $\tilde{sd}(\theta_{h,t})$. Having estimated Π_θ and $\tilde{sd}(\theta_{h,t})$ from the Ghana Socioeconomic Panel Survey, we calibrate the magnitude of the realisation of idiosyncratic shock (θ_H) as well as its persistence parameter (π_θ) in order to replicate these estimates in the quantitative model. We assume that the realisations of the idiosyncratic shock add to 1, as a result we can derive the magnitude of the low idiosyncratic productivity through $\theta_L = 1 - \theta_H$.

Aggregate risk: We calibrate the magnitude of the high realisation of aggregate risk, ϕ_H in order for the simulated data from our quantitative model to match the coefficient of variation of income ($cvi = \frac{sd(y_{h,t})}{mean(y_{h,t})}$) observed in the data. Moreover, we assume that on average the aggregate shock magnitude is 1, as such the high realisation of the aggregate shock can be determined through $\phi_H = 2 - \phi_L$. Lastly, we assume that the aggregate risk does not exhibit any persistence, therefore we set the corresponding parameter $\rho_\phi = 0.5$.

6.3 Estimation Strategy

In the quantitative model, there exists a direct counterpart of selling rights in the form of land security, denoted by parameter ψ, which governs allocation of land outside the land and risk-sharing contract. In order to estimate regression (27) using simulated data from the quantitative model, we need to take advantage of variation in selling rights. However, as the quantitative model represents a village economy, parameter ψ is held constant throughout.

To the aim of generating the necessary variation in land rights, we simulate three village economies. All three economies are identical with respect to all structural parameters but the

level of land rights (the corresponding value of ψ). We assign the levels of ψ relying exclusively on empirical data. In particular, one economy is considered as a village of low degree of land security, with ψ_L set to the value of the first quartile of the land rights distribution observed in our empirical sample, the second economy is characterised by an average level, with ψ_M set to the mean value, while the last economy has a high degree of land security, with ψ_H set to the level of the third quartile. According to Table 2, we set the degree of land security to $\psi_L = 0.14$, $\psi_M = 0.37$ and $\psi_H = 0.57$.

Min	**Q1**	**Median**	**Mean**	**Q3**	**Max**
0.0	0.14	0.35	0.37	0.57	1

Table 2: Distribution of village selling rights in rural villages

Simulating three village economies allows us to estimate regression (27) using information from all villages, thus acquiring the necessary variation in the level of land security in our simulated sample. Regarding all remaining structural parameters included in the θ-vector, we rely on average simulated moments across the low, mean and high land security villages.

Lastly, the solution algorithm followed for the land and risk sharing dynamic contract relies on exogenous Pareto weights for the initial period, which are then updated based on the realisation of the idiosyncratic shocks and in order to attain participation for both agents. As such, the simulated data will be influenced by the arbitrary, exogenous choice of the initial Pareto weights. In order to overcome this bias, we discard the first 100 periods of the simulated data.

6.4 Quantitative results

In what follows, we present results from the quantitative model assigning values to θ-vector that minimize the distance between the empirical and the model implied moments as outlined in the criterion derived from the outter problem. In particular, $\hat{\theta} = [\beta = 0.88, \alpha = 0.3, \pi_\theta = 0.6, \theta_{i,h} = 0.9, \theta_{i,l} = 0.1, \phi_H = 1.3, \phi_L = 0.7]$.

In Figure 5, we show how key statistics of village consumption, risk sharing and land reallocation change as we increase the degree of land rights ψ in the benchmark allocation with limited commitment, the first best and the outside option. First, we observe that for low enough values of ψ, land misallocation is reduced. This can be seen through the convergence of the correlation between current idiosyncratic household productivity and the amount of land cultivated towards the first best level. As a consequence, the village level agricultural productivity increases, as reflected by increases in average village consumption.

Importantly, these changes bring about not only improvements in efficiency, but also in equity.

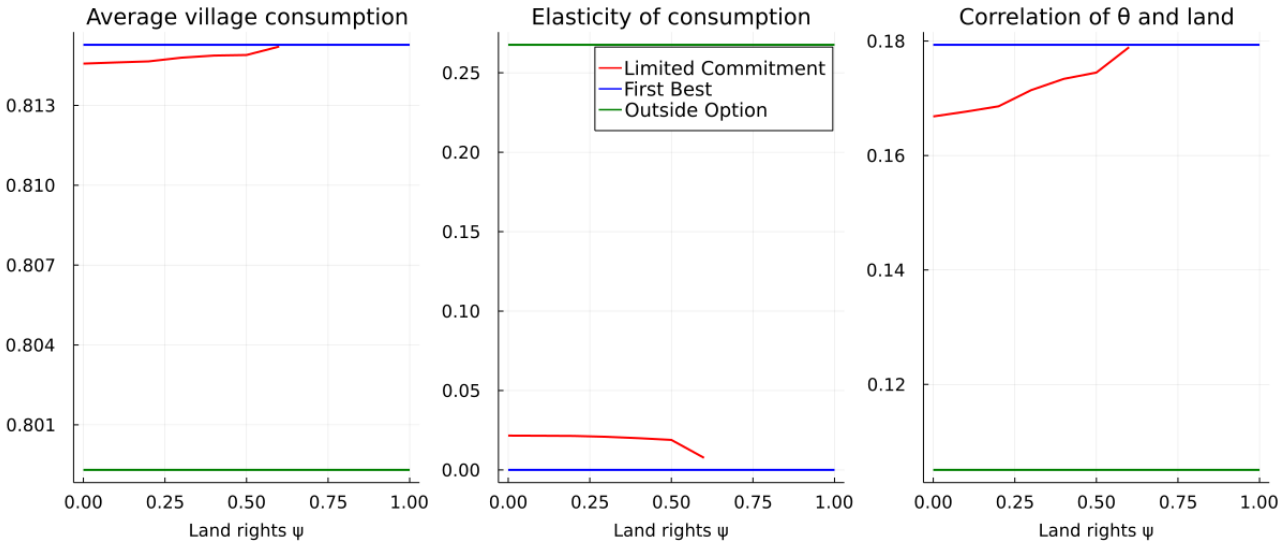

Figure 5: Quantitative results

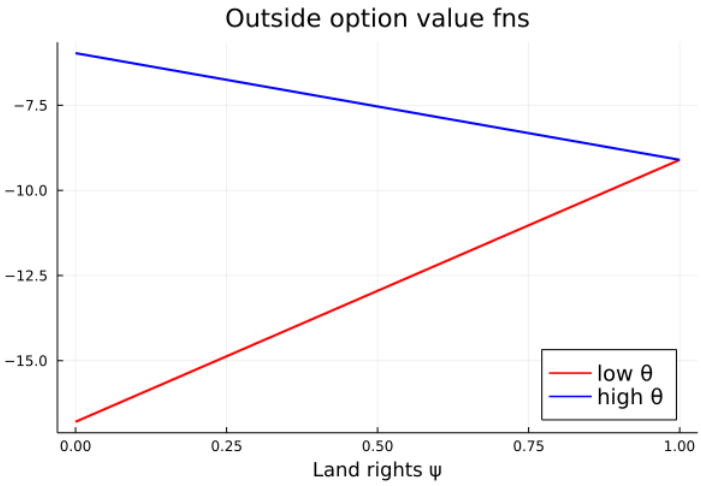

Figure 6: Changes in value of outside option

Moments	Empirical Counterpart	Data Estimates	Model Estimates
Consumption Elasticity	ξ_1 in (27)	0.070	0.030
Impact of selling rights on CS	ξ_2 in (27)	-0.048	-0.031
Output elasticity wrt land	λ in (28)	0.280	0.290
Persistence of idiosyncratic risk	Π_θ in (30)	0.304	0.350
Standard deviation of idiosyncratic risk	$\tilde{sd}(\theta_{h,t}))$	1.632	1.5
Coefficient of Variation of Income	$\frac{sd(y_{h,t})}{mean(y_{h,t})}$	0.880	0.810

Table 3: Empirical estimates of the targeted moments from Ghana Socioeconomic Panel Survey. The corresponding empirical estimates are presented in Table (13) for eq. (27), Table (14) for eq. (28), Table (16) for eq. (30)

In particular, we find that for low enough values of ψ land rights improve local risk sharing, as measured by reduction in elasticity of consumption w.r.t. idiosyncratic productivity shocks. These dynamics arise because increases in land formality relax limited commitment constraints of the more productive household, which has relatively higher incentives to deviate and so pins down the equilibrium patterns of co-operation.

The above can be seen in Figure 6 depicting changes in the current value of deviating for low- and high-productivity θ households. In line with our discussion in the theoretical outline of the model, we see that the value of outside option of the high productivity declines and the one of the low productivity agent increases in ψ. Crucially, however, notice that the pace at which the latter increases is significantly higher than the one of the high productivity households. Taken together, this implies that it is possible that at some point the values of deviation are affected so much that there is no scope for the planner to elicit equilibrium joint co-operation over land and risk sharing. This is precisely what we find in Figure 5 for values of land rights above approx. 60%.

Our quantitative results indicate a collapse of mutual insurance above a certain level of land security. For high values of land rights, the outside option providing farmers with self-insurance through access to land markets is rendered sufficiently attractive that the land and risk sharing cannot compete with. Therefore, mutual insurance cannot be further sustained.

Interestingly increasing land security affects differently agents of high and low productivity. As shown in Figure 6, their incentives to deviate follow a qualitatively opposite direction. A combination of two opposing forces is responsible for this qualitative difference. First, efficient allocation within the land and risk-sharing arrangement assigns land of bigger or smaller size - depending on idiosyncratic productivity realisation - compared to inherited land ($z_{i,0} = 0.5$). Second, the separation rule determining land assignment upon deviation in equation (14) drives land allocation towards the size of inherited land, as land security (ψ) increases.

Starting from low levels of land security, productive farmer (high θ) faces a decreasing value of her outside option as land security increases. In particular, in absence of land rights ($\psi = 0$), farmers deviating out of the village co-operation would keep the amount of land allocated most recently, $z^{LRS}_{i,t_{dev}} = z^{out}_{i,t_{dev}}$ (see eq. (14)). As ψ increases, the village is willing to allocate more of land to productive farmer as the increases in land security render their outside option less dependent on temporary land re-allocations ($z^{LRS}_{i,t_{dev}} > z^{out}_{i,t_{dev}}$) because of the higher weight (ψ) assigned to her inherited land ($z_{i,0} = 0.5$) upon deviation. On the other hand, the low productivity farmer as land security increases, she faces an increasing value of her outside option for the symmetrically opposite reason.

As incentives to deviate move towards opposite directions in the level of land security, the village can transfer resources between farmers so as to satisfy their participation constraints and render the informal arrangement sustainable. This capacity of the village decreases in ψ as the low productivity farmer faces a steeper increase in the value of her outside option compared to the decrease in the outside option value of the high productivity farmer. This difference in the rate of change in the deviating forces faced by the high and low productivity farmers is due to the concavity of the utility and production function. An extra unit of land would be valued more by the low productivity farmer. Eventually, for a given threshold of land security, the capacity of the village to shuffle land and consumption between the participating farmers is diluted, leading to the collapse of the mutual insurance arrangement.

7 Conclusion

In this paper, we address one of the major frictions affecting rural areas of Ghana: pluralistic land tenure and weak enforcement of land rights. Complementing existing literature, we not only study how missing formal land rights form a barrier for efficient allocation of land and agricultural productivity, but also how this friction interacts with the informal mutual insurance networks that are of critical importance in largely subsistence-focused Ghanaian agriculture.

Interestingly and contrary to basic intuition, we find that attempts of governments at increasing formality of land institutions relevant to the living of rural populations need not crowd-out the other informal margins of co-operation, but can even complement them. In particular, we first find that rural communities that hold more of formal titles allowing for land sales face less disputes over land. Second, we find that land changes hands more frequently in these communities with higher land security provided by formal land rights. Third, we find that these re-allocations are not only more intense, but also more efficient, as reflected by increases in agricultural productivity and average consumption. Finally, we also find that societies with

higher degree of land rights enjoy better consumption smoothing against idiosyncratic income shocks, suggesting improvements in functioning of the mutual insurance networks.

We construct a dynamic model of village co-operation over consumption transfers and land re-allocations that rationalizes our empirical findings. We endogenize the functioning of these two informal institutions by subjecting them to limited commitment constraints, stipulating that every household has to be made always better-off within the co-operation that what he could get outside of it by relying on self-insurance and trading land in formal markets. In this environment, adopting higher land rights allows for better anchoring of individuals' outside value of deviation by specifying ex-ante land ownership. Because the threat of losing one's land is reduced as the degree of land rights increases, land re-allocations are more efficient leading to gains in aggregate output. Because this implies increases in the (inside) value of co-operation, this higher output can be shared more efficiently as insurance against idiosyncratic shocks.

Interestingly, our model also uncovers an important non-linearity showing that there exists an upper bound on the degree of land formality, crossing which may trigger a complete unraveling of local co-operation. This may happen because informal rural institutions usually span multiple margins of co-operation and, as such, changes in one of those may have first order equilibrium effects on all the other ones. Because maintaining a well-functioning nexus of these institutions may be critical in developing parts of the world, traditional societies may rationally choose to remain informal at large, in spite of formal markets being present. As such, we provide a candidate explanation for often observed low take up of formal land titles in developing countries.

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8 Appendix

8.1 Regression analysis

	Dependent variable:	
	share of village land w/ multiple claims$_{v,t}$	
	(1)	(2)
sell-rights$_{v,t}$	-0.074^{**}	-0.074^{*}
	(0.034)	(0.043)
Land Controls	Yes	Yes
Village Fixed Effects	Yes	Yes
District Clustered se	No	Yes
Observations	341	341

Note: *p<0.1; **p<0.05; ***p<0.01
Total sample of rural villages is 396. 55 rural villages exhibit NA values in our main explanatory variable, so the sample is 341 observations.

Table 4: Land Disputes (multiple claims)

	Dependent variable:
	LFI
$\overline{\textit{sell-rights}}_{v,t/t+1}$	396.025^{*}
	(230.682)
Village controls	Yes
Land Controls	Yes
Observations	197

Table 5: Land Fluidity Index

	Dependent variable:
	mean share of rented land
$\overline{\textit{sell-rights}}_{v,t/t+1}$	0.043**
	(0.022)
Village controls	Yes
Land Controls	Yes
Observations	197
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 6: Mean rented land

	Dependent variable:	
	share of purchased land$_{v,t}$	
	(1)	(2)
sell-rights$_{v,t}$	0.031	0.031
	(0.032)	(0.029)
Land Controls	Yes	Yes
Village Fixed Effects	Yes	Yes
District Clustered se	No	Yes
Observations	341	341
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 7: Land Purchases

	Dependent variable:
	$log(village\text{-}productivity_{v,t}))$
$sell\text{-}rights_{v,t}$	1.195**
	(0.489)
Village + Land controls	Yes
District x Time FE	Yes
Observations	380

Table 8: Village Productivity

	Dependent variable:	
	village mean consumption per capita	
	(1)	(2)
$sell\text{-}rights_{v,t}$	0.281*	0.281*
	(0.150)	(0.170)
Village + Land controls	Yes	Yes
District x Wave FE	Yes	Yes
District Clustered se	No	Yes
Observations	341	341

Table 9: Village mean consumption per capita

	Dependent variable:	
	log(RS)	
	(1)	(2)
sell-rights$_{v,t}$	-1.444^{**}	-1.444^{***}
	(0.625)	(0.548)
log(mean village consumption pc)	1.176^{***}	1.176^{**}
	(0.450)	(0.470)
Village + Land controls	Yes	Yes
Village x Wave Fixed effects	Yes	Yes
District Clustered se	No	Yes
Observations	386	386
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 10: Risk-sharing ratio panel regression Results

	Dependent variable:
	log(consumption.per.capita)
log(income pc)	0.071***
	(0.015)
log(mean village consumption pc)	0.729***
	(0.062)
log(income pc)$\cdot\overline{\textit{sell-rights}}_{v,t/t+1}$	−0.073**
	(0.036)
Village + Land controls	Yes
HH x Wave Fixed effects	Yes
Village Clustered se	Yes
Observations	3,659

Table 11: Townsend Panel Regression Results w/ avg selling rights

	Dependent variable:	
	$savings_{h,v,t}$	
	lsdv	panel
	(1)	(2)
$\textit{sell-rights}_{h,v,t}$	−77.585	−37.508
	(152.442)	(472.114)
Constant	−193.106	
	(179.784)	
Land Controls	Yes	Yes
HH Fixed Effects	No	Yes
Village×Time Fixed effects	Yes	No
Village Clustered se	Yes	Yes
Observations	2,782	2,782
R^2	0.170	0.025
Adjusted R^2	-0.027	-3.090
Residual Std. Error	2,190.035 (df = 2246)	
F Statistic	0.862 (df = 535; 2246)	1.060 (df = 16; 663)
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 12: Savings

8.2 Endogeneity of selling rights (*Work in Progress*)

Importantly, notice that our proxy for selling rights can be endogenous to many different factors. First of all, it may respond to informal risk-sharing arrangements at the community level, generating a reverse causality problem. To address this very issue, we build the quantitative model of risk sharing and land re-allocations that explicitly contains this channel and so allows us for isolating these effects (see Section 5). However, the degree of land formality may be also differentially affected by the relative strength of formal and informal institutions present in each community, or the geographical distance of these communities to institutions allowing for formalization of land rights. To address this issue, we devise an IV strategy building on the fact that regions of Ghana have been colonized by the Great Britain for centuries, up to the country's independence in 1957. The British rule was mostly concentrated in coastal regions due to their main interest in trade. Therefore, we plan to instrument land rights with proximity of the villages in the sample to major cities in the coastal south, proxying distance to modern British institutions. In this way, we obtain exogenous variation in our explanatory variable.

8.2.1 IV strategy

Our IV strategy relies on features of the British rule of the Gold Coast during the 19th century. As colonizers of Ghana were interested in trading opportunities that the country's mineral resources offered, they were focused on the coastal area where most of the commercial activity was taking place. One additional reason why also the British activity was concentrated in the Ghanaian South was the conflictual relations with the Ashanti, one of the largest ethnic groups of inland Ghana. At the same time, coastal states (Fante, Ewe, Ga) were also in conflict with the Ashanti over control of their lands. Because of this, leaders of these states also resorted to the British protection against their inland enemies.[15] Several treaties were signed that sealed the cooperation between the coastal South and the British occupants. The most notable of all was the Bond of 1844, a special treaty with local chiefs of Fante and others from the coastal areas which laid the legal foundations of the British rule in Ghana.[16] Even though in principle, the treaty granted limited judicial powers to the British, underlying efforts to extend their judicial authority were so successful that in 1850 they considered establishing European courts in the place of African ones (Berry, 1995). However, the influence of the British judicial power was confined to the coast (at least up until the end of the nineteenth century, as the Ashanti and Northern regions were annexed only in 1896 and 1902, respectively - see Figure 10. As a result, the penetration of the British rule across Ghana exhibits substantial heterogeneity.

[15]..under Maclean's administration, several coastal tribes had submitted voluntarily to British protection Berry (1995)

[16]This document obliged local leaders to submit serious crimes such as murder and robbery to British jurisdiction Berry (1995)

It was predominant in the coastal area, limited in the Ashanti region (central Ghana) and negligible in the Northern part (Michalopoulos and Papaioannou, 2020). This heterogeneity is also mirrored in the timing of annexation for Ghana's different regions (see Figure 10).

Our IV approach exploits this form of heterogeneity to instrument for land rights according to the following assumption. Areas directly under the British control would be more likely to have adopted a land tenure regime closer to the western individualistic norm rather the customary collective one. This approach requires us to quantify the degree of influence of the British rule in different regions of Ghana and in particular in the villages appearing in our sample. We plan to do so by measuring the effective distance from the coastal centre of the British rule (taking into account rail lines or roads) and the distance from other commercial centres of the country, such as Kumasi (which did not belong to the south but constituted a strong commercial pole of the era). The minimum distance out of those two measures could accurately capture the proximity of the enumeration areas in the sample to the British rule.

8.3 Suggestive empirical observations

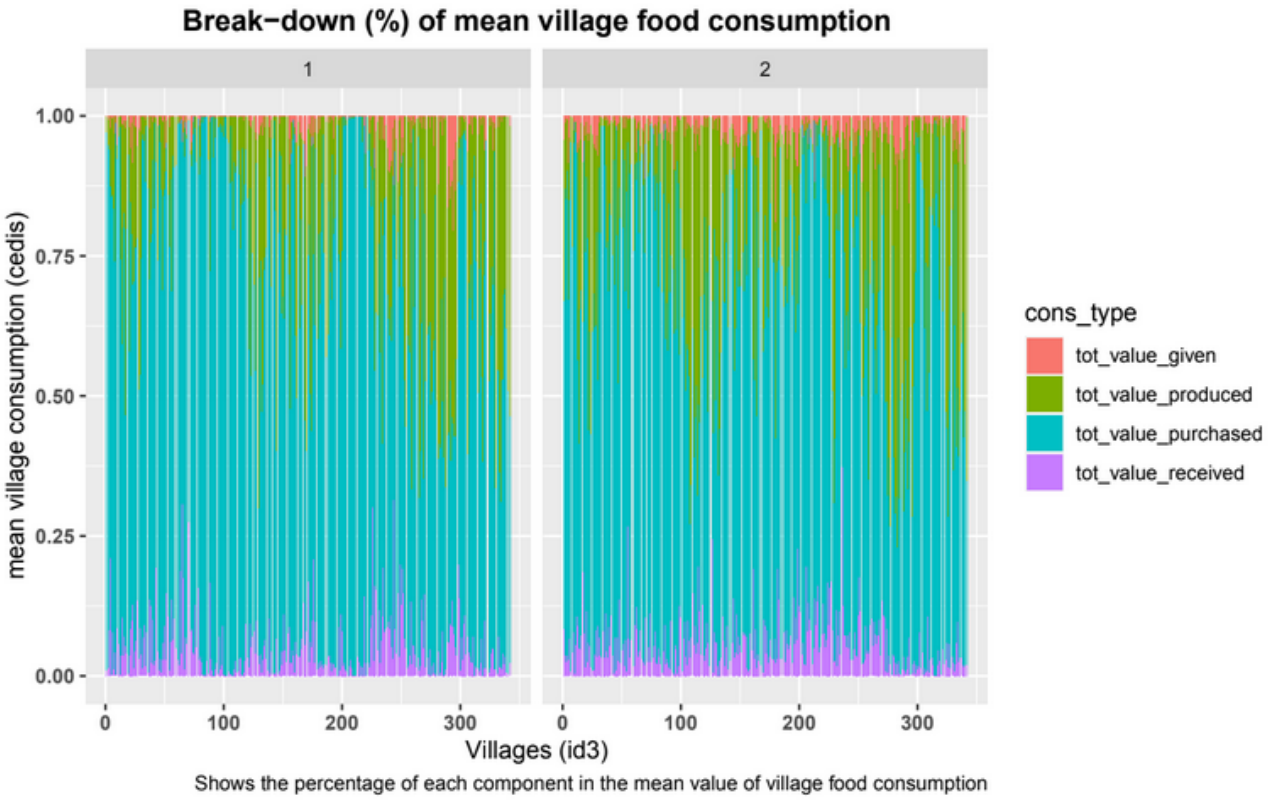


Figure 7: The figure presents the percentage contribution of each of the components comprising total food consumption

	Dependent variable:
	log(consumption.per.capita)
$\log(y_{h,t})$	0.070^{***}
	(0.014)
$\log(y_{h,t})$:$sell\text{-}rights_{v,t}$	-0.048^{*}
	(0.028)
Village + Land controls	Yes
HH x Wave Fixed effects	Yes
Village Clustered se	Yes
Observations	3,659

Table 13: Townsend Panel Regression Results

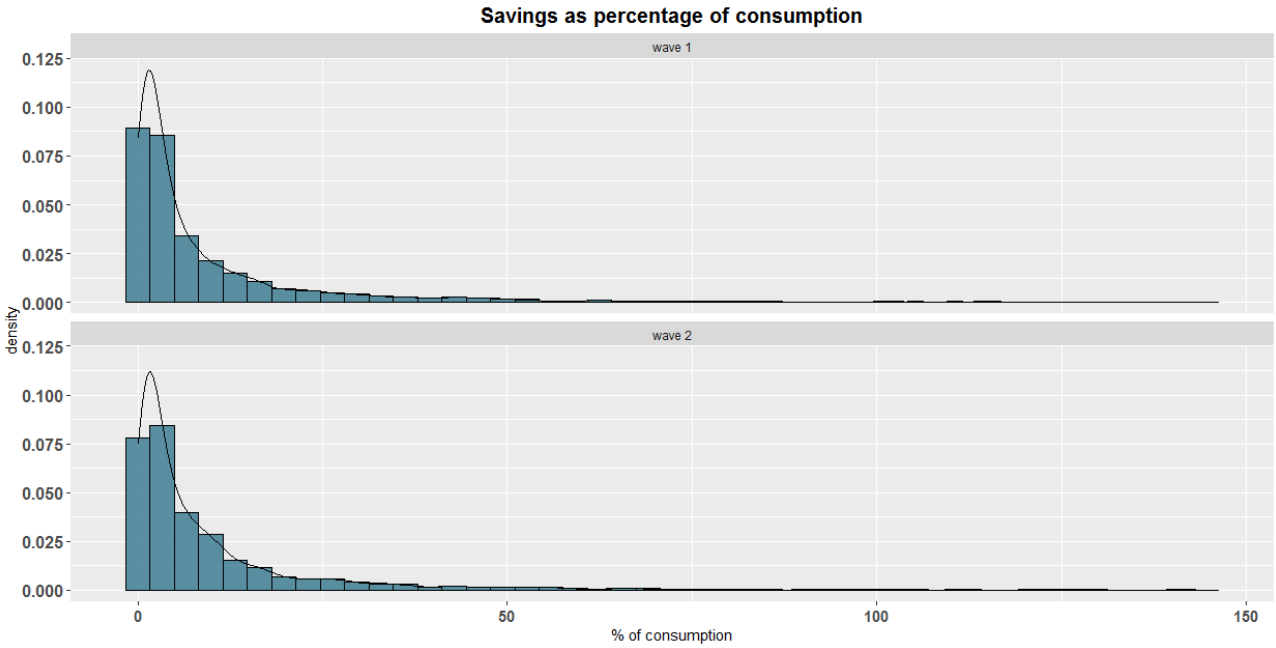


Figure 8: Savings as % of consumption

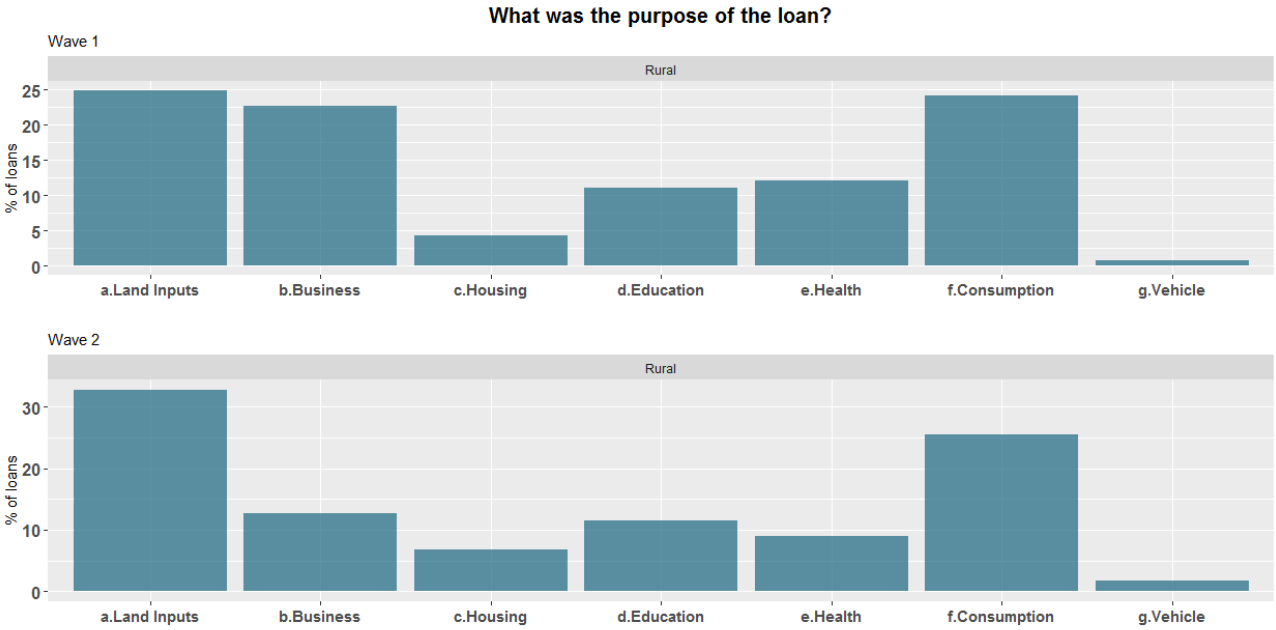
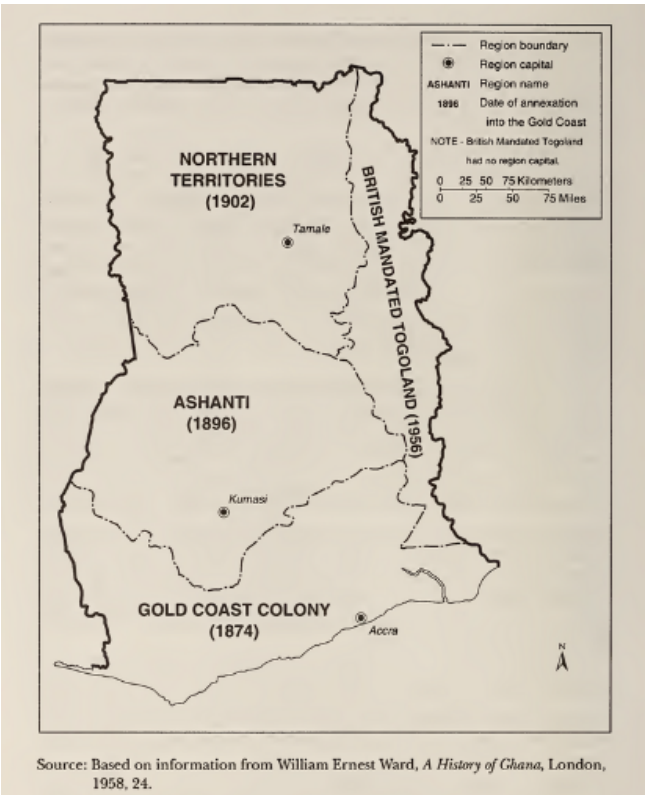


Figure 9: Purpose of the loan



Source: Berry (1995) with information from Ward (1967)

Figure 10: British annexation of coastal, central, northern and east regions

	Dependent variable:
	log(income)
log(household land)	0.280***
	(0.108)
Constant	4.956***
	(0.096)
HH FE	Yes
Villate-Time FE	Yes
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 14: **Output Elasticity of Land**: Table presents the results from estimating regression equation (28) from Ghana Socioeconomic Panel Survey. Household and Village-Time fixed effects are included and standard errors are clustered at the village level.

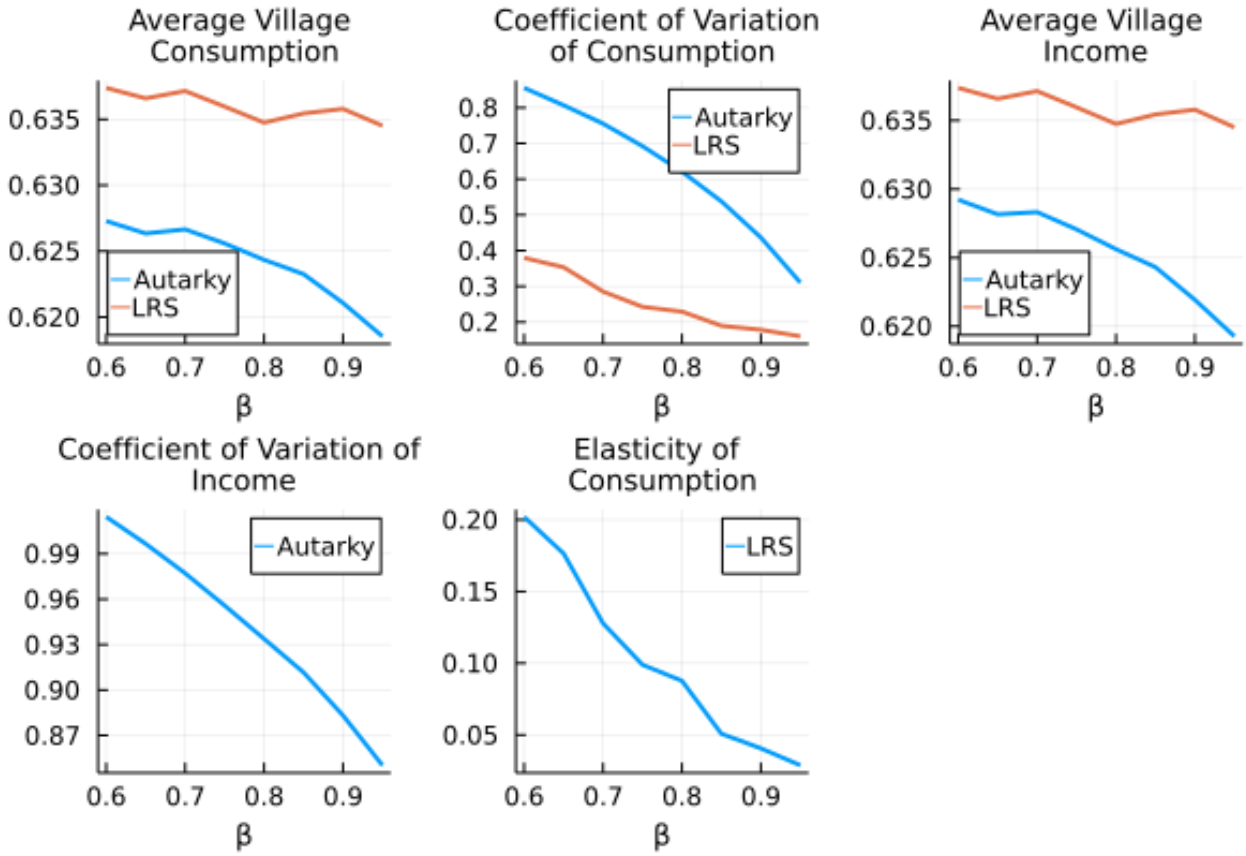


Figure 11: Equilibrium variables as a function of discount factor

The figure shows average village consumption and income as well as the corresponding coefficient of variation for each variable and consumption elasticity with respect to idiosyncratic shocks. The outside option as well the land and risk-sharing problem have been solved for various values of the discount factor, while all other parameters are kept constant.

	Dependent variable:
	$log(\epsilon_{h,t})$
$log(\epsilon_{h,t-1}))$	0.304^{***}
	(0.029)
HH Controls	Yes
Villate-Time FE	Yes
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 16: The table presents the estimated AR(1) process in (30)

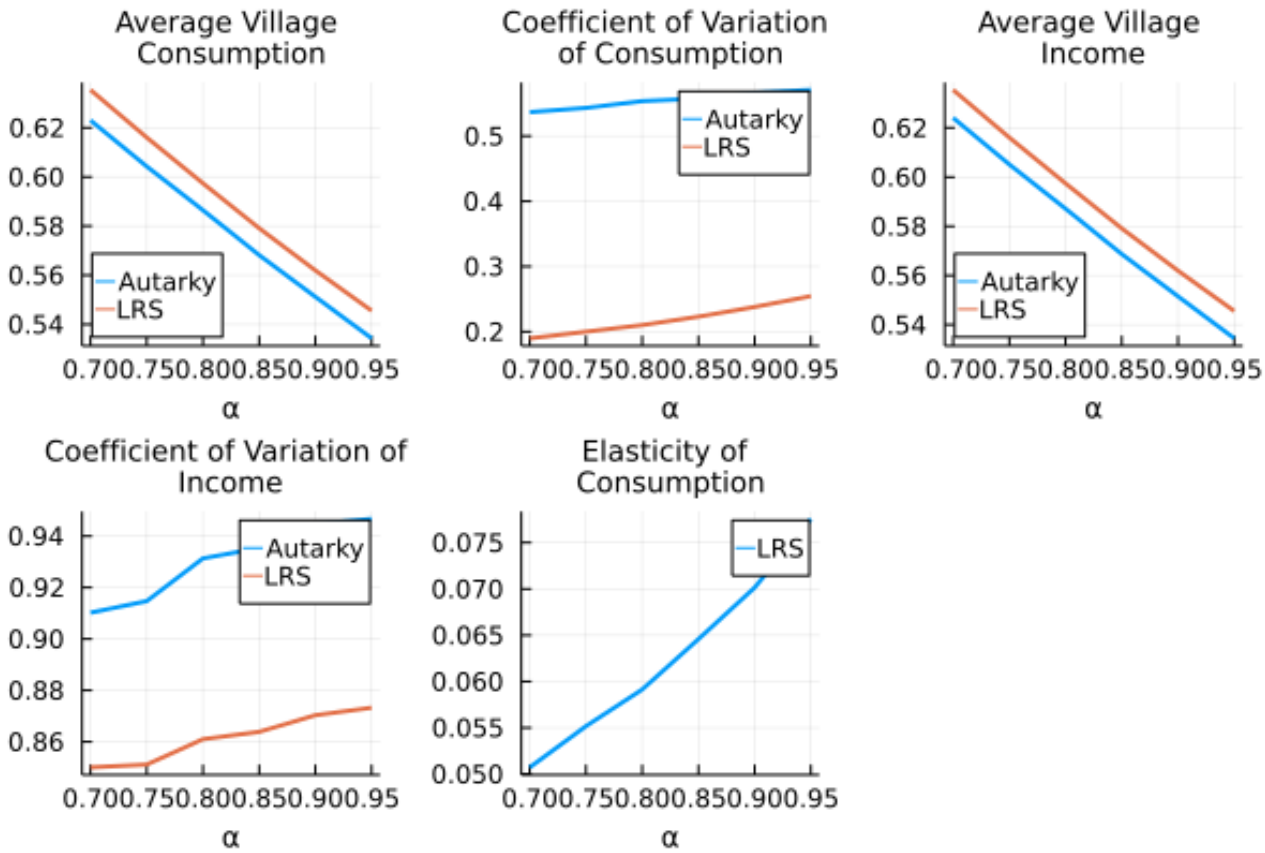


Figure 12: Equilibrium variables as a function of α

The figure shows average village consumption and income as well as the corresponding coefficient of variation for each variable and consumption elasticity with respect to idiosyncratic shocks. The outside option as well the land and risk-sharing problem have been solved for various values of α, while all other parameters are kept constant.

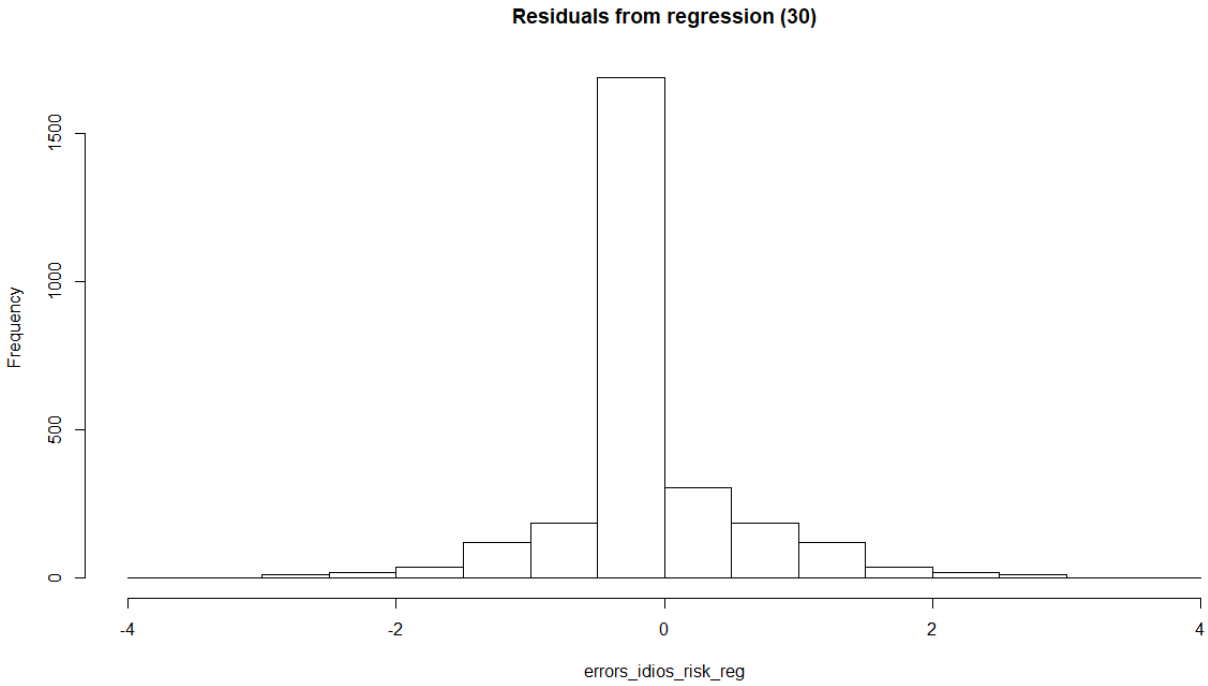


Figure 13: Residuals from regression equation 29