The Impact of Land Conflict on Land Productivity: Evidence from Liberia

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The Impact of Land Conflict on Land Productivity: Evidence from Liberia

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List of abbreviations and acronyms

CBOs	Community Based Organizations
CLRM	Classical Linear Regression Model
HIES	Household Income Expenditure Survey
IPA	Innovations for Poverty Action
LC	Land Commission of Liberia
NGOs	Non-governmental organizations
SSA	Sub-Sahara Africa

Abstract

This paper examines both the correlates of land conflict and the effects of this conflict on crop yields, farmers' investments in permanent trees and crops. The productivity effects of land conflict are estimated at the town-level, taking into account the endogeneity of conflict. We use data from the Household Income Expenditure Survey (HIES) of Liberia and from the Innovations for Poverty Action (IPA) baseline survey for the same year. The main findings reveal that gender, distance from the farm to home or the road, soil quality, slope of the farmland, marital status, soil erosion, government extension services and age of the farmers are all significantly correlated with land conflict. We find that land conflict increases investments in permanent trees relative to non-tree crops. Three policy implications of the study stand out. First, farm yields in Liberia can be increased by implementing comprehensive soil erosion reduction strategies that involve building of gabions, terraces, reforestation schemes, as well as mass education of farmers on proper agricultural practices, including, ploughing along the contours or planting cover crops in areas with massive soil erosion or mass wasting of cropland. The second policy revelation of the study is that measures to avoid land conflicts should be designed and implemented as a matter of urgency because there is strong statistical evidence that conflicts drive farm productivity practically to zero. The third policy implication is that government extension services and the opening up of remote areas via construction of access roads have large positive effects on agricultural productivity.

Key words: Land conflict; Investments in permanent trees; Productivity; Liberia.

JEL Codes: Q18; D74.

1. Introduction

Previous research shows that conflict over land[1] induces sub-optimal and inefficient land use (Feder and Feeny, 1991; Wick and Bulte, 2006; De-Oliveira, 2008; Alston and Mueller, 2010). Beyond changing the composition of crops and livestock, land conflict can reduce the returns associated with particular portfolio allocations[2] (Deininger and Castagnini, 2006). For example, within agriculture sector, yields may decrease for a variety of reasons such as premature harvesting to reduce the risk of pillage, decreased fertilizer use that may result in lower soil quality and the inability to fallow fields in extreme conflict cases (Vlassenroot and Raeymaekers, 2008). Further, its presence in agriculture has greatly had a significant negative effect on farm productivity either directly or through influencing the behaviour of the farmer investment decisions (Place, 2009).

Conflict over land remains a sensitive matter that threatens the peaceful co-existence of communities in sub-Saharan Africa and has been associated with unrest and negative economic effects (Laird, 2004). Female farmers are the worst affected by this type of conflict as both African culture and customs in some countries with weak land rights continue to support male inheritance rights to land. The female gender, for a long time, has been regarded as strangers both in their natal home and marital clan, and as such, their fathers continue to transfer land to sons or wives. However, the wife's inheritance rights are not enforceable especially when they become widows, since there has been rising cases of dispossessing them by their in-laws and rendering them homeless (Hellum and Derman, 2004; Bennett et al, 2006; Anyanwu, 2014).

Further, the wife's rights to husband's land are not guaranteed by formal institutions in sub-Sahara Africa. In the modern context, the adjudication and land titling process in most post-war nations is being conducted in favour of the already established male inheritance patterns, thereby denying female their share in family land. In some instances, female's land rights continue to be determined by their marital status and by laws of inheritance, succession and divorce, and as such, they have limited economic resources in their hands and also lack decision making power at the household level to buy land independently of their spouses.

Incidence of land conflict are high in countries characterized by weak institutions and fragile political systems and which risk being thrown into cycles of economic backwardness if resounding resolutions are not put in place. In most countries in Africa, property rights, such as rights on land, are protected using informal rules, practices and norms (Zhang et al, 2012). However, the imperfections associated with informal rules[3] have led to high incidence of land conflict (Blattman et al, 2014). Such land conflict has a negative welfare implication both at the household and the national level as well as on the general stability of the economy.

In this regard, this study sought to examine three specific questions: First, what household and farm characteristics influence land conflict among Liberian farmers? Second, what effect does land conflict have on crop productivity among farmers in Liberia? Lastly, what impact does land conflict have on farmer investment decisions on permanent trees? Little is known about the channels through which land conflicts affect agricultural investment behaviour and productivity. Though the impact of land conflicts on farm productivity may seem trivial, the channels through which its effects are transmitted are not known. Equally, there can be heterogeneous effects of land conflict on different types of investments based on farmer characteristics. For example, the rich may be more affected than the poor for long-term investments. Similarly, the effects may vary along gender dimensions as well as on spatial dimension.

This study, therefore, seeks to explore the heterogeneous effects along two dimensions; gender and spatial/regional. Results from these explorations will help policy makers understand and appreciate the heterogeneity and channels through which land conflict affects investment behaviour and agricultural productivity. In this paper, we use the case of Liberia; a fragile and post-conflict state which, in addition to having had a long history of conflicts over land access has recently begun to undertake far-reaching reforms to develop a proper land governance and administration system. For example, in the recent past, there has been approval and issuing of tribal land certificates that give consent of the community to the sale or transfer of their land under customary arrangements. However, these tribal certificates have largely failed to materialize given that they heavily relied on anecdotal evidence.

This paper, therefore, contributes to the literature on the impact of land conflict on agricultural investment by seeking to bridge the gap in the literature by providing first account documentation of agricultural investment in the face of land conflicts in Liberia. In doing so, it extends the existing literature as follows. First, unlike previous studies that look at land tenure, titling and land insecurity and agricultural productivity, this study adds to the scant literature of the impact of land conflict on agricultural investment behaviour by households and more on the composition of portfolios (i.e., the choice of crops).

Second, we extended previous studies by analysing the impact of land conflict on land productivity through various channels (such as gender and spatial). For example, the gender channel informs us of the impact of land conflict if the household head is a female. By taking into account possible heterogeneity on the impact of land conflict on agricultural production, for which previous empirical works have largely ignored, the findings will provide policy recommendations so as to serve as a basis for policy makers to understand and appreciate the heterogeneity and channels through which conflict affects investment behaviour and agricultural productivity.

Agriculture, agrarian policy and land conflict triggers in Liberia

In the global context, there are about 1.8 million agricultural producers, accounting for 22% of the global agricultural value chain (Deininger and Castagnini, 2006). However, the uneven distribution of land and its resources has exacerbated land conflict for over 50 years which, according to Sekeris (2010) and Wily (2011), land-related conflict stands at 48% globally. In sub-Saharan African countries, land is a fundamental resource and it is approximated there are 630 million hectares of arable land suitable for subsistence and commercial agriculture (Rukuni and Kambanje, 2011). Land remains important in achieving food security, poverty eradication, income stability, as well as a means of accumulating wealth and undertaking intergenerational wealth transfer, thus enabling them to evade human insecurity. Given the central role of land as a resource, secure access remains a top priority for the African continent (Yamano and Deininger, 2005). The desire to possess and have control over land, especially in an environment of deficit of proper property rights, triggers conflict over it.

According to UN-Habitat 2016 report, land conflict is an ordinary problem in almost all societies of the world, and it does not erupt without a cause (Kent, 2016). It is either inherently motivated or is anchored on the socioeconomic profile of the society, societal injustices and political patronage (Richards, 2005). Further, the USAID 2016 report highlights that the rapid population explosion in some countries, coupled with environmental problems such as land degradation, has increased pressure on land use and control escalating land conflict (Lombard and Rakodi, 2016).

Aside from environmental hazards, the global food crisis of 2007-2008 has been seen as a major factor motivating agribusiness investors to grab land in least developed countries, as land in poor countries is cheaper and is not covered by strong legal system (Christensen et al, 2018). In most instances, land conflict may arise due to contending views involving parties over issues such as decision making, equitable land distribution, and holding of land rights (Van Suu, 2007). When the justice system of a nation is paralysed and does not act in the interest of the people of that nation, they (the people) tend to resolve disputes in their own way, mostly through violence. Additionally, when land is given to concession companies for investment purposes, at times those companies fail to perform their social corporate responsibilities. This leads to landowners reacting through violent means.

Despite all the efforts for peace advocated by various governments and other relevant bodies to resolve the civil conflict in Liberia, the prevalence of conflicts especially on land remains high[4] (Hartman, 2010). Source of this conflict mainly lies in the insecure customary land tenure system in which the state has not endowed the traditional leaders with any authority to govern land-related issues. As such, there is always a conflicting claim given that the state considers customary tenure as mere “occupants” or “squatter” of the land (Unruh, 2009).

An estimated 90% of civil court cases in Liberia are related to land conflicts.[5]

Additionally, as many as 63% of violent cases in Liberia have their roots in land rights issues with the main causes of land conflict in Liberia being five-fold[6]as indicated in the USAID 2016 report. As such, land conflicts have serious repercussions on agricultural investment decisions, agricultural productivity as well as on food security.

Context and historical background of land governance in Liberia

Land remains the main source of livelihood and cultural heritage for many citizens in Liberia, especially those in rural areas. However, effort to harness maximum benefit is constrained by frequent land conflicts, and particularly the catastrophic effect of the civil war that spanned over almost a decade and a half (1989-2003) and resulted in loss of property and labour (i.e., approximately 200,000 people lost their lives). Since then, the Accra Peace agreement, entered in 2003, has seen over a million people—either internally or externally displaced returned home or resettled (Hartman, 2010).

In Liberia, the land is under customary land tenure system and thus claims over land — either seasonally or permanently through a larger group claim — is by virtue of being family members or sharing a common town. This form of ownership was, however, changed with the establishment of the Land Commission of Liberia[7] (LC). The Land Commission is intended to provide policy recommendations and draft laws addressing how land rights categories should be used, managed and administered. As an autonomous body of government in the administration of land and land-related issues, the Land Commission, through the land rights policy, has introduced land rights clusters which are sub-divided into four basic categories.[8] Currently, strategies to convert public land into private land are under way. However, the process of conversion is very long and tedious and can take over seven years, which is linked to land conflict as most people only attained the tribal certificate and not the public land sale deed (Government of Liberia, 2012).

Access, ownership, rights to and use of land are widely considered to be structural causes of both past conflicts and current tensions in Liberia. Effort to resolve land disputes is complicated by many factors. A central problem is the relationship between traditional land ownership systems and statutory laws. Formal records have limited value in rural areas, where the traditional law is strong. In urban areas, specific problems include: limited formal records of ownership (and the destruction of deeds during the war); incomplete land registry and ownership systems; disputes over ownership of land following movement of people during the wars; growing competition for land; and environmental degradation (Paczynska, 2010). Conflicts occur in agricultural, urban and forested areas. They involve local communities, local and national government actors, and increasingly business investors.

In some areas, land disputes are as a result of long-standing conflicts within communities (e.g., between the Mandingo and the Gio and Mano tribes in Nimba County) (Paczynska, 2010). New land disputes have also emerged: during the civil

war, the land was often taken by squatters, or armed groups who would give them as rewards to their supporters (Paczynska, 2010). Since the end of the war, many displaced people have returned to reclaim their land, and conflict has ensued. These tensions are often exacerbated by the fact that those that took the land often belong to different ethnic or regional groups and may have been rivals during the war. In more unstable areas, such as the border with Guinea's Forestière region, land disputes are potentially more dangerous (Adolfo, 2010).

The rest of this paper is structured as follows. Section 2 presents an overview of previous literature, including the theoretical and empirical literature. Section 3 discusses the data and methods of the study. It further discusses the sources of data used, theoretical framework and the econometric modelling adopted. Section 4 presents the data analysis and interpretation, while section 5 presents the conclusion and policy recommendation of the study.

2. Literature review

Theoretical literature

The economic literature of rural households on the risk of conflict can be grouped into two.[9] However, they do not address the potential heterogeneity of the risk of violence on household agricultural investment behaviour. On extending these strands of literature, we hypothesize that households with no land conflicts reported are more willing to make medium- to long-term investments on their land than those who have reported the existence of land conflicts. These conflicts, even if small-scale in nature, may have a considerable impact on the incentive to invest in agricultural inputs (i.e., it may constrain farmer's crop choice and input use). It also affects the propensity of households to pledge the asset as collateral as they seek to secure credit.

Theoretically, three transmission mechanisms/channels through which conflict over land disincentivizes investment—whether short-term, long-term or both—and production are put forth. First, conflicts over land are subsumed to be associated with the uncertainty of reaping the full reward of any investment (assurance channel) and, thus, a farmer considering investing in a farm has to weigh the costs and expected future benefits to be generated by the investment under consideration. This channel has received a lot of traction among policy makers and scholars in developing countries. The second channel is that land conflict erodes the credit market power. In the credit market, land can be pledged as collateral and thus be able to access credit from formal financial institutions for investment. But when there is conflict, this is not possible. Thirdly, it erodes the market for land, which would have given the owner the freedom to sell or rent out the land or make substantive investments in their parcels.

Equally, according to the theory of the risk-averse peasant, small-scale farmers may not be efficient in terms of profit maximization as they make sub-optimal decisions given a variety of risks that they face. However, with the little information they have at hand to make decisions and take actions that are rational in economic terms, the theory argues that the allocation of scarce household resources is based on the principle of 'safety first'. Resources are allocated in such a way that risks are minimized, and, therefore, subjectively expected utility is maximized on balance over a longer period.

Empirical literature

One strand of the literature has focused on land tenure and titling on agricultural productivity[10] and reveals that land ownership security positively impacts land productivity. These studies, however, do not explicitly model the impact of land conflict on agricultural productivity and investment decisions. Heterogeneity in the empirical literature on the relationship between property rights on land and agricultural productivity implies that policy makers must pay attention to both local context and the macro conditions within the area in question (Place, 2009). On the other hand, Jacoby and Minten (2007) found an insignificant relationship between land titling and land productivity in Madagascar. However, besides looking at the land security-productivity nexus, there has been increasing attention on the impact of conflict on agricultural investments, especially in post-conflict states. Alston et al (1996) argues that, land titling is a necessary condition for resolving land conflict; however, land titling has not had enough evidence to serve as a model in mitigating land crises in sub-Saharan Africa and thus leading to high yield.

In addition, Vlassenroot and Raeymaekers (2008), in the Democratic Republic of Congo, document a reduction of 12% in general food production but a greater reduction in the production of vegetables and cereals by 42% and 33%, respectively, as a result of land conflict. In Uganda, Mwesigye and Matsumoto (2013), using a linear probability model, found that land conflicts are more likely to occur in regions with diversities of tribes. Additionally, they found that there is an inverse relationship between land conflict and agricultural productivity, with eviction conflict accounting for more loss in agricultural output than boundary and inheritance conflicts. However, linear probability models applied in their study has been over-criticized: (i) assumption of non-normality of the error term in the model which implies that both t-test and F-test are invalid, making hypothesis testing a challenging task, (ii) assumption that the error term is heteroscedastic, implying that the Classical Linear Regression Model (CLRM) may not be efficient, and (iii) it may give nonsensical conditional probability that are outside the traditional probability range of [0,1].

The current study stands in contrast with the substantial literature on land tenure and titling on agricultural productivity but closely related to the studies on agricultural production under uncertainty. For example, Finnström (2003) in Northern Uganda, McKay and Loveridge (2005) in Rwanda and Vlassenroot and Raeymaekers (2008) in the Democratic Republic of Congo, find evidence consistent with households increasing the share of low-risk, low-return activities in the face of risk. According to Vlassenroot and Raeymaekers (2008), periods of insecurity among rural households are associated with an investment in crops whose harvest could be delayed, difficult to loot or those that require little attention.

Despite burgeoning studies on conflict, investment behaviour and productivity, evidence on this subject is still scanty. In addition, some studies establish the existence of a link between conflict, investment, and productivity, which stands in contrast

with substantial literature that finds no or subtle impacts on investment behaviour and productivity. Similarly, the evidence of how the exposure to perceived land conflict affects the land conflict-agricultural productivity nexus is scanty, and has not examined the heterogeneity across male and female-headed households. Lastly, despite these wide acknowledgements of the relationship between land conflict and land productivity, there exists a vacuum on the magnitude and extent to which land conflict has influenced investment decisions and agricultural productivity in Liberia.

3. Data and methods

Data Sources

To explore the impact of land conflicts on farmers' investment decisions and agricultural productivity in Liberia, we rely on two sources of data. The first is drawn from the Household Income and Expenditure Survey (HIES[11]) of Liberia. The second data was obtained from Yale University, and the Innovations for Poverty Action (IPA) baseline survey conducted in Liberia in 2009-2010 in counties of Lofa, Nimba and Grand Gedeh. The analysis is done at the town-level. To construct the analytic sample, we first identified and summed up farm-related conflicts in each town in the IPA data set; second, we assigned each household in the production data set (HIES) to a town; and third, we constructed farm productivity variable (proxied by crop yield per acre in local currency). Additionally, we created farm input investment variables (number of permanent trees planted in a farm) at the town-level. Land conflict was proxied by the number of farm households associated with land conflicts in each town.

Empirical methodology

Theoretical framework

In modelling land conflict, Mwesigye and Matsumoto (2013) indicate that land conflict is an outcome of two main factors: land tension and tension threshold level. To them, land conflict occurs if:

$$(LC_i) = \begin{cases} 1 & LT_i > TA_i \\ 0 & otherwise \end{cases} \quad (1)$$

Where, (LC_i) is land conflict, LT_i is land tension[12] and TA_i is land tension threshold. Equation 1 indicates that we are likely to observe land conflict in a given plot if the land tension is greater than the tension threshold (some latent variable). We assume that land tension is an increasing function of the demand for land and is determined by other factors.[13] The tension threshold level (TA_i), on the other hand, is mainly determined by the land institutions and heterogeneity of the community.[14] In general, land conflict enters land productivity in three ways[15]: security of tenure, ownership transfer and incentive to improve soil quality. In order to examine the links between land conflict and investment decisions and agricultural productivity, we assume an

autarkic farmer who, in each period, decides whether to invest in perennial or seasonal crops and how much to invest, whether to invest in manure, fertilizers, to reduce or increase the land under production, etc. Let p_{it} be the probability of the household suffering from a land-related conflict and that it is exogenously determined. As a result of this shock, the farmer can invest in two types of assets: short-term and long-term. The long-term asset requires a fixed cost in time *t* and then no investment is required for the next *T* years; where *T* is the expected time horizon for the long-term asset. Short-term investment is more flexible as the farmer can change his investment level every season. Also, the farmer reduces his investment if the probability of being affected by land conflict at least once in a given time period exceeds $\bar{p}_i$, which is a function of his outside option, say w_{it}.

Assume that;

$$\bar{p}_i(w_{it}) < 0 \tag{2}$$

This implies that, as the outside option becomes more attractive, it reduces the threshold level below which the farmer invests in agricultural equipment. The probability of being affected by a land conflict at least once in *n* period is therefore equal to:

$$[1 - (1 - p_{it})^n] \tag{3}$$

The farmer will, therefore, invest in short-term assets if:

$$p_{it} < \bar{p}_i(w_{it}) \tag{4}$$

Similarly, the farmer will invest in long-term assets if:

$$1 - (1 - p_{it})^T < \bar{p}_i(w_{it}) \tag{5}$$

Additionally, a farmer will also invest in short-term assets if Equation 4 holds for the short-term assets but will not invest in long-term assets if (4) holds but (5) does not. Therefore, the decision to invest in longer-term assets will be more sensitive to the probability of being affected by a land conflict. There are several points to keep in mind while understanding the conceptual framework above. First, it assumes that there are no complementarities between short-term and long-term investments. In making these decisions, they consider the likelihood of being faced with a conflict. As such, we assume that the violent shock enters the agricultural production model multiplicatively. The uncertainty caused by land conflict is included through the belief that farmers have about the distribution of the shocks. The model predicts that farmers prefer to invest in seasonal crops, use fertilizer and manure when facing more negative violent shocks.

Specification

Baseline regressions to compute the causal effect of conflicts are of the form:

$$y_i = \alpha + \beta(Land\_conflict) + \vartheta X_i + \omega D_i + \varepsilon_i \quad (6)$$

Where, y_i is the outcome variable that includes crop yield per acre, investment in permanent trees as well as investment in non-tree crops by household i, and X_i and D_i are household- and community-level control variables. The household variables (X_i) could be the gender, age, marital status and accessibility of the farm (i.e., distance to the plot or time taken to the farm). The community variables (D_i) could be the distance to the roads, and the distance to the farm. Land conflict is proxied by the number of farm households associated with land conflicts in each town. The term ε_i captures the idiosyncratic shocks to yields. We are interested in the estimate of β which would give us the effect of land conflicts on our outcome variables.

Heterogeneous effects

As suggested in the conceptual framework, the impact of land conflicts on investment is likely to vary by the wealth of farmer, spatially and along gender dimensions. If the absolute risk aversion channel dominates other channels, we should observe richer farmers showing less fall in long-term investment relative to poorer farmers. Equally, along with spatial and gender dimensions, we are likely to observe a change in investment patterns due to the differing risk aversions among them. To account for heterogeneity, this could be tested by a measure of land conflict interacting with a dummy for gender and spatial heterogeneities (Equation 7). The coefficient gives the effect of the presence of land conflict along two dimensions (i.e., gender and regions). The empirical specification for testing heterogeneous effects is as follows:

$$\begin{aligned} y_i = \alpha + \beta(Land\_conflict_i) + \varphi(Land\_conflict_i * gender_i) \\ + \delta(Land\_conflict_i * region_i) + \vartheta\ (gender) + \alpha\ (region) + \vartheta X_i \\ + \omega D_i + \varepsilon_i \end{aligned} \quad (7)$$

The coefficient φ tells us by how much additional investment is affected by land conflict if the farmer is a female rather than male, while δ tells us by how much additional investment is affected by land conflict if the farmer is from a given region as opposed to other regions under consideration.

4. Results

Summary statistics

The descriptive statistics of the data used for the empirical analysis is presented in Table 1 based on the Household Income Expenditure Survey of Liberia (HIES[16]) and IPA[17] data sets. It is worth noting that, due to data limitation at the household or farm-level, analysis of this paper was done at town-level, and that only three out of the 15 counties in Liberia (i.e., Lofa, Nimba and Grand Gedeh in which land conflict data was available) were considered. Town-level analysis was conducted in three main steps: first, we identified and summed up farm-related conflicts in each town in the IPA data set; second, we assigned each household in the production data set (HIES) to a town; and third, we constructed farm productivity variable (proxied by crop yield per acre in local currency), farm input investment variables (here we used the number of permanent trees) at the town-level. Land conflict was measured by the number of farm households associated with land conflicts in each town.

From the study findings, on average, each town in the counties of Lofa, Grand Gedeh and Nimba experienced approximately 906 farm-related conflicts with a large standard deviation of 941. This relatively large standard deviation can be interpreted that some towns, in the area of study, had higher incidence of farm-related conflicts than others. The average distance between farmer's home and their farm was slightly more than half-an-hour (37.5 minutes) walk with a standard deviation of 34.70 minutes (implying that some farms are much farther from home). Equally, on average, farmers walked more than three-quarters of an hour (46.85 minutes) from the farm to the nearest road with a standard deviation of 74.62 minutes (implying that some farms were more than an hour's walk to the road). About 5.34% of the farms in the study area received government extension services while 16% of the farms had good soil quality with a standard deviation of 36.71%. The result further reveals that approximately 31.21% of the farms were located in sloppy slopes while 29.57% of the farms reported to have been affected by soil erosion. On average, 58.32% of the farmers were married and the average age of the farmers in the study was 38.05 years with a standard deviation of 15.07 years. Further, the study reveals that farmers planted about 468 permanent trees and 117 permanent crops with a respective standard deviation of 934 trees and 487 crops (which imply that some farmers planted more permanent trees and permanent crops in their farms than others). Equally, the study reveals that approximately 3.29% of the farmers used improved seed variety and less that 1% of the farmers used organic fertilizer in their farms. Lastly, the study

shows that, on average, the crop yield productivity of each farm was approximately 13,197.46 Liberian dollars (about US$66.15) with a standard deviation of 34,574.1 Liberian dollars (approximately US$174.86, implying that some farms were highly productive than others).

Table 1: Descriptive statistics of the variables used in the analysis

Variable	Mean	Std. Dev.
Land_conflict (acreage affected)	906.4333	941.3737
Crop yield in Liberian dollar[1]	13197.46	34574.1
Time to walk from the farm to home (in minutes)	37.46817	34.69506
Time to walk from the farm to road (in minutes)	46.85421	74.62373
Government extension services		
Yes (1/0)	.0533881	.2250373
Soil quality		
Bad (1/0)	.1601643	.3671355
Slope		
Sloppy (1/0)	.312115	.4638329
Soil erosion		
No (1/0)	.2956879	.4568206
Marital status		
Married (1/0)	.5831622	.4935425
AGE, years	38.04514	15.06668
Gender		
Male (1/0)	.5112936	.5003864
Number of permanent trees	467.7926	933.9451
Number permanent crops	117.0267	486.5762
Seed type		
Improved (1/0)	.0328542	.1784382
Use of organic fertilizer		
Yes (1/0)	.0082136	.0903485

Regression results

Four regression results were carried out. The first responds to the second specific question that sought to investigate the impact of land conflict on crop productivity. The second regression responds to our first specific question on the factors influencing land conflict among Liberian farmers, while the third and fourth regression investigates the influence of land conflict on farmer's decision in investing in permanent trees and permanent crops, respectively.

Impacts of land conflict on crop yield

Theoretically, it is possible that land conflict can lower farm productivity while higher farm productivity can accelerate the likelihood of a farm experiencing land conflict (Mwesigye and Matsumoto, 2016). This led us to suspect an existence of bi-causal

relationship (potential for endogeneity) between land conflict and crop yield per acre. To account for this endogeneity in the estimation of effects of land conflict on yields per acre and farm investments, we use the two-stage least squares (2SLS) approach. In the first stage, we regressed the land conflict model (Equation 6) and predicted the residuals, which we believe are endogenous (see Table 2, model 1).

In the second stage, we use two instrumental variables: distance walked from road to farm and distance walked from farm to home. Although farmers decide whether to walk these distances, the stretch of the geographic space that must be covered is fixed (exogenous), and this tract dictates the number of minutes the farmers must walk. Excessive 'journeys to work in the farm' may influence the quantity and the quality of agricultural labour inputs but not yield. Equally, existing literature postulates that distance enters crop productivity through negatively influencing the input usage in a farm (Birch, 2018). However, distance to the farm may influence land conflict through its influence on the incidence of surveillance and monitoring of the farm. That is, closer farms to home or road could ease surveillance and monitoring than far away farms. In this respect, we hypothesize that distance to the farm influences land conflict but not yield, and as such, they are appropriate instrumental variables.

The result in Table 2 reveals that land conflict was an endogenous variable. However, we found crop yield per acre to be an exogenous variable in the land conflict model.

Table 2: Results for the first and second stages of 2SLS model

	First stage (OLS) Land_conflict	Model Two (2SLS) Ln_Crop Yield _LD
Time to walk from the farm to home (in minutes)	0.000133***	--
	(0.0000111)	--
Time to walk from the farm to road (in minutes)	-0.0000409***	--
	(0.00000727)	--
Government extension services		
Yes (1/0)	0.0250***	0.524***
	(0.000998)	(0.0394)
Soil quality		
Bad (1/0)	-0.0137***	-0.252***
	(0.000728)	(0.0228)
Slope		
Sloppy (1/0)	-0.00942***	-0.235***
	(0.000562)	(0.0162)
Soil erosion		
Yes (1/0)	-0.0196***	-0.0000229
	(0.000590)	(0.0277)
Marital status		
Married (1/0)	0.0224***	-0.0298
	(0.000782)	(0.0323)
Age	0.0643***	0.665***
	(0.000415)	(0.0874)

Age squared	-0.000558***	-0.00601***
	(0.00000452)	(0.000760)
Gender		
Male (1/0)	0.0204***	0.165***
	(0.000905)	(0.0312)
Married men (1/0)	0.00200	0.446***
	(0.00107)	(0.0176)
Male conflict	-0.0000172***	-0.000632***
	(0.000000566)	(0.0000246)
Regional conflict	0.00000830***	0.000234***
	(0.000000196)	(0.0000118)
County	0.384***	5.535***
	(0.00153)	(0.524)
Land conflict (endogenous regressor)	--	-11.46***
		(1.360)
Predicted residuals of endogenous regressor	--	10.38*
		(1.361)
Constant	-2.113***	-17.05***
	(0.00648)	(2.868)
Observations	487	487
Adjusted R^2	0.883	0.049
F-Statistic (p-value)	155.7	572.6
	(.000)	(.000)

Model 2 in Table 2 reveals that high incidences of land conflict significantly reduce farm productivity. The value of crop yield per acre (in Liberian dollars) is lower by 99.99%[18] on farms that experienced land conflicts. The high level of the loss in crop productivity could mean that in the presence of land conflict, it was irrational for farmers to invest in crops. Farmlands with poor soil quality were 22.28% less productive than those with good soil quality, while farms located in sloppy slopes were 20.94% less productive than those located in gentle slopes. In regard to gender, being a male farmer increased crop yield productivity by about 17.94% as compared to female farmers in Liberia. However, an interaction between gender and land conflict interestingly reveals that being male farmer significantly declined crop yield productivity by approximately 0.06% when faced with land conflict, as compared to the female farmers. This implies that, men were more sensitive to land conflict than their female counterparts. Evidence point out that age had a nonlinear[19] relationship with crop yield productivity among the Liberian farmers. Findings show that crop yield per acre will increase with an increase in age for the cohort 17-55 years. Beyond 55 years, crop yield per acre will be declining significantly with increase in age. Existing literature is inconclusive on the relationship between the age of the farmer and crop yield. For example, some have found a cyclical relationship (Loomis, 1983; Long, 1950) while others have revealed that farmers first display an increasing and then a decreasing productivity with age (Tauer, 1995). Tauer (1995) found that the most productive age was 35-44 years. Lastly, the study reveals that receiving government

extension services significantly increases crop yield per acre by approximately 27.12%. This implies that technical assistance is vital for the farmers in improving crop productivity among the Liberian farmers.

Analysis of land conflict in Liberia

Table 3 reveals that an extra minute walk from home to the farm triples the incidence of experiencing land conflict in the farm. Intuitively, this evidence could mean that there is more surveillance and monitoring of the farmlands closer to home than those far away (translating into less incidence of land conflict for closer farms). Interestingly, farms that were closer to the roads had low incidence of land conflict contrary to our expectation. That is, an additional minute walk from the road to the farm doubles the incidence of experiencing land conflict in the farm, suggesting that farm owners close to the road were more likely to invest in securing their farms as well as establishing or strengthening monitoring mechanisms for securing their farms than those far away from the road, which translated into less incidence of land conflict. Farmlands with bad soil quality reduce the incidence of experiencing land conflict as compared to those with good quality soils. Intuitively, good soil quality increases crop productivity which in turn increases demand for such farms. In countries such as Liberia, where the land governance is weak, we expect the increase in demand for these farmlands to accelerate the incidence of land conflict as every family member wants to use them.

On average, towns that had experienced soil erosion were less likely to experience land conflict, while being a married farmer increased the likelihood of experiencing land conflict than being unmarried. This was interesting given that we expected incidence of land conflict to be lower for the married farmers. The interaction of gender and marriage revealed that married men were more likely to experience land conflict by about 300 incidents than their female counterparts. This loosely means that men had more energy to engage in conflict than women. The study revealed that age had a nonlinear relationship with the incidence of land conflict. In particular, incidences of land conflict increased at a decreasing rate for the cohorts 17–44 years while beyond 44 years, incidence of land conflict decreased with increase in age. This could mean either the older farmers had secured their farms, or the younger farmers had the energy to engage in conflict than the older farmers.

Table 3: Analysis of factors influencing land conflict among Liberian farmers

	Model Three (OLS Results)
	Land Conflict_
Time to walk from the farm to home	3.108***
	(0.0960)
Time to walk from the farm to road	2.322***
	(0.0629)
Government extension services	-16.72
	(8.581)
Soil erosion	277.8***
Good (1/0)	(6.289)

Slope	-129.5***
Sloppy (1/0)	(4.886)
Soil erosion	-78.64***
Yes (1/0)	(5.109)
Marital status	294.8***
Married (1/0)	(6.783)
Age	82.09***
	(2.799)
Age squared	-0.900***
	(0.0321)
Gender	30.43***
Male (1/0)	(7.129)
Number of permanent trees	0.0107**
	(0.00384)
Number of permanent crops	0.173***
	(0.0115)
Seed type	763.4***
Improved (1/0)	(14.02)
Use of organic fertilizer	1478.0***
	(109.3)
Married men	-180.0***
	(9.358)
Constant	-1115.8***
	(52.92)
Observations	154090
Adjusted R^2	0.090
F	1015.4

Notes: Standard errors in parentheses; *p< 0.05, **p< 0.01, ***p< 0.001.

Impact of land conflict on investment in number of permanent trees

Model four, in Table 4, reveals that our main variable of interest, land conflict, was found to have a significant and positive influence on the number of permanent trees planted among Liberian farmers. That is, farms with high incidence of land conflict were more likely to increase the farmer's decision in investing in permanent trees marginally by two trees. This finding confirms the theoretical strategic behaviour of economic agents in arbitration game set-up. That is, in customary dominated land governance, arbitration[20] is the order of the day in solving grievances related to landownership. Literature shows that anticipation of arbitration tomorrow makes involved parties more belligerent today (as a strategic behaviour) which is in line with Nash (1953) theory of rational threat. And as such, land conflict could be inducing planting of permanent trees, that later act as an advantage to the status quo among Liberian farmers.

Conversely, farmers who reported receiving government extension services, on average, had a significant and positive impact on investing in the number of permanent trees in their farms. Receiving government extension services in a given town increased

the number of permanent trees planted by approximately 1,195 trees. The implication here is that, these government extension services were tailored toward investment in permanent trees in the study area. Equally, the study reveals that farms with poor soil quality decreased the number of permanent trees invested by about 127 trees while farmlands with sloppy slopes reduced investment of permanent trees by about 858 trees. Farmlands affected by soil erosion reduced investment in permanent trees by about 1,626 trees. However, we found that sloppy eroded soils were more likely to induce investment in permanent trees by about 1,965 trees.

Married farmers were found to have a positive and significant impact on investing in the number of permanent trees. For example, being married increased the number of permanent trees invested by about 436 trees as compared to unmarried farmers. Likewise, being a married man increased the investment in the number of permanent trees by about 743 trees, indicating that married men were more likely to invest in permanent trees than their female counterparts. However, the study shows that male farmers were more sensitive to land conflict than the female farmers. In the presence of land conflict, the male farmers were more likely to reduce investment in permanent trees by about 54.6% as compared to their female counterparts facing the same circumstance. The finding further reveals that investment in permanent trees was found to vary spatially. The study established that being located in Nimba County reduced the likelihood of investing in permanent trees by about 3,499 trees while being located in Grand Gedeh County increased investment in permanent trees by about 27,665 trees as compared to those farmlands located in Lofa County. Lastly, the study reveals that the relationship between age of the farmers and the number of permanent trees invested was nonlinear. Being in the cohort of 17–49 years increased the likelihood of investing in permanent trees by 3,479 trees, while above the age of 49 years, investment in permanent trees decreased by about 35 trees.

Table 4: Impacts of land conflict on farmer's investment in permanent trees and crops

	First stage (OLS)	Model four (2SLS)	First stage (OLS)	Model six (2SLS)
	Land conflict	Investment in permanent trees	Land conflict	Investment in permanent crops
Time to walk from the farm to home	0.0000179 (0.00000924)	--	0.0000179 (0.00000924)	--
Time to walk from the farm to road	0.0000218*** (0.00000606)	--	0.0000218*** (0.00000606)	--

Government extension services Yes (1/0)	0.0254*** (0.000833)	1195.9*** (221.3)	0.0254*** (0.000833)	1270.6*** (204.6)
Soil quality Bad (1/0)	-0.00161** (0.000608)	-127.1*** (26.30)	-0.00161** (0.000608)	-76.90** (24.31)
Slope Sloppy (1/0)	-0.0187*** (0.000565)	-858.4*** (146.6)	-0.0187*** (0.000565)	-903.2*** (135.5)
Soil erosion Yes (1/0)	-0.0359*** (0.000725)	-1626.8*** (326.5)	-0.0359*** (0.000725)	-1853.4*** (301.9)
Marital status Married (1/0)	0.0124*** (0.000656)	436.4*** (100.7)	0.0124*** (0.000656)	493.9*** (93.13)
Age	0.0735*** (0.000348)	3478.9*** (570.9)	0.0735*** (0.000348)	3344.2*** (527.8)
Age squared	-0.000745*** (0.00000383)	-35.16*** (5.742)	-0.000745*** (0.00000383)	-33.68*** (5.308)
Gender Male (1/0)	0.0108*** (0.000755)	527.9*** (122.1)	0.0108*** (0.000755)	639.4*** (112.9)
Eroded sloppy farmlands	0.0449*** (0.000979)	1956.0*** (392.2)	0.0449*** (0.000979)	-2258.2*** (362.6)
Married men	0.00904*** (0.000893)	742.8*** (80.00)	0.00904*** (0.000893)	583.6*** (73.95)
Men conflict	-0.00000797*** (0.000000474)	-0.546*** (0.103)	-0.00000797*** (0.000000474)	-0.619*** (0.0950)
Regional conflict	0.00000274*** (0.000000165)	-0.613 (0.376)	0.00000274*** (0.000000165)	-1.808*** (0.347)
Region Nimba (1/0)	-0.0981*** (0.00228)	-3498.9*** (356.6)	-0.0981*** (0.00228)	-2355.8*** (329.6)
Grand Gedeh (1/0)	0.541*** (0.00270)	27664.5*** (5458.8)	0.541*** (0.00270)	30478.0*** (5046.2)
Land conflict (endogenous regressor)	--	2.010** (0.801)	--	-4.296*** (0.807)
Predicted residuals of endogenous regressor (Model 4)	--	-47594.4*** (8333.8)	--	
Predicted residuals of endogenous regressor (Model 6)		--	--	-47947.9*** (7704.0)
Constant	-1.354*** 0.00615)	-64942.8*** (11003.6)	-1.354*** (0.00615)	-63943.5*** (10171.9)
Observations	154090	154090	154090	154090
Adjusted R^2	0.913	-0.065	0.913	-7.049
F-Statistics (p-value)	101141.9 (.000)	409.5 (.000)	101141.9 (.000)	86.65 (.000)

Notes: Standard errors in parentheses; *p< 0.05, **p< 0.01, ***p< 0.001.

Impacts of land conflict on the investment in permanent crops

From Table 4, model six, results indicate that land conflict has a significant and negative effect on the number of permanent crops invested by Liberian farmers. That is, farms with high incidence of land conflict were more likely to reduce the farmer's decision in investing in permanent crops marginally by four crops. Conversely,

farmland that received government extension services, on average, had a significant and positive effect on investing in permanent crops in their farm. For example, receiving government extension services in a farmland increased the number of permanent crops planted by approximately 1,271 crops, indicating that the technical assistance from these extension services was on encouraging permanent crop production. Equally, the study reveals that farms with poor soil quality decreased the likelihood of investing in permanent crops by about 77 crops while sloppy slopes reduced investment of permanent crops by about 903 crops. Further, eroded farmlands reduced investing in permanent crops by about 1,853 crops. The effect was greater in eroded sloppy soils which reduced investment in permanent crops by 2,258 crops.

Married farmers were found to have a positive and significant effect on investing in permanent crops. For example, farmers that were married increased the number of permanent crops by about 494 crops than the unmarried. Likewise, married men increased the investment in the number of permanent crops by 583 crops. This implies that married men were more likely to invest in permanent crops than their female counterparts. Interestingly, in presence of land conflict, male farmers were more likely to reduce investment in permanent crops by about one crop than their married female counterparts facing land conflict.

Conversely, investment in permanent crops was found to vary spatially. For example, farms that were located in towns of Nimba County were likely to reduce investment in permanent crops by about 2,356 crops as compared to those located in the county of Lofa. Equally, farms that were located in the towns of Grand Gedeh were likely to increase the likelihood of planting permanent crops by 30,478 crops. Lastly, the study reveals that the relationship between age of the farmers and number of permanent crops invested was nonlinear. Being in the cohort of 17–50 years increased the likelihood of investing in permanent crops by 3344 crops, while above the age of 50 years decreased it by about 34 crops.

5. Conclusion and policy recommendations

Land conflict, even if small-scale in nature, may have considerable effect (impact) on incentive to invest in land productivity. With incidence of land conflict significantly increasing in post-war states of SSA, in places facing stiff demand of land resource as a result of population pressure as well as weak land governance, there is a need to deviate from policies driven by anecdotal evidence to that of empirical evidence. In this regard, this study sought to provide evidence for the channels through which land conflicts affect agricultural productivity in Liberia. Firstly, it sought to establish the household and farm characteristics influencing land conflict in post-war Liberia. Second, it sought to investigate the impact of land conflict on crop productivity and last, how presence of land conflict influenced a farmer's decision on investing in permanent trees and non-tree crops in Liberia. Two econometric estimations (OLS and 2SLS) are utilized. The key results from the analysis are discussed from the perspective of the pathway through which incidence of land conflict influence crop productivity and farm investment decisions.

The first pathway is through soil erosion. We found that eroded farms were less likely to experience land conflict but had a declining effect on farm productivity in Liberia. Intuitively, erosion was leading to relative scarcity of productive farms and thus increasing the demand for the scarce un-eroded productive farms. The policy response for this observation could be an elaborate intervention mechanism by either the government or development partners to reduce soil erosion in Liberia farming areas. This will certainly lead to a double desirable impact of reduced land conflict as well as improved farm productivity. There is need for a technical assistance to farmers to help them reduce soil erosion.

The second pathway is through distance from the farm to home or road. Farms with longer walking distance from farm to home or from farm to the road were more likely to experience land conflict, but had a counter effect on farm productivity. Intuitively, improving road connectivity in the farming areas either through all-weather roads or feeder roads would likely reduce land conflict or improve crop productivity in Liberia.

The third pathway is through soil quality: We observed that farms with good soil quality were more likely to experience land conflict but increased farm productivity than those that had degenerated soil quality. Intuitively, improving soil quality across all the farming areas could both reduce land conflict and increase crop productivity. We therefore suggest technical assistance to farmers on how to improve soil quality (say through practising good agricultural practices or manuring their farms) by either the government or any development partners.

The fourth pathway is through government extension services. Interestingly, farms that reported having received government extension services were less likely to experience land conflict. Equally, evidence suggests that government extension services increased farm productivity. We recommend that the government extension services should be expanded to all parts of Liberia. There would be a need for non-state actors such as NGOs and development partners to increase extension services to Liberian farmers.

Lastly, we also found that less sloppy areas (gentle slopes) were likely to accelerate land conflict among Liberian farmers. Equally, less steep slopes led to an improvement in farm productivity among the Liberian farmers. This could result from the fact that steep slopes by nature are susceptive to mass wasting and mass movement leading to thin soils that cannot support crop production well. Intuitively, reducing the rate of mass wasting and mass movement through building terraces could reduce land conflict and increase crop productivity in Liberia.

Conclusion

Land conflict remains a sensitive matter that, not only threatens the peaceful co-existence of communities in fragile sub-Saharan Africa, but also has potential to result in negative economic effects. Evidence from this study suggests that, land conflict has a potential to drive crop yield practically to zero. This is a concern especially in Liberia which is a net importer of food, with figures from the World Food Programme indicating that in about one-quarter of Liberian households, food accounts for 65% of their total expenditures. There is thus an urgency to tackle the correlates of land conflict.

Policy recommendations

To achieve the key pathways mentioned above with the aim of reducing land conflict and increasing crop productivity in Liberia, we recommend the following strategies to the government, NGOs, CBOs, and any other key stakeholder in this area:

- Comprehensive soil erosion reduction strategies that involve building of gabions, terraces, reforestation schemes as well as mass education on proper agricultural practices to the farmers such as “plough along the contours” or planting cover crops in areas with massive erosion or mass wasting through public media, community outreach or government extension services, should be promoted;
- Opening remote areas through building of all-weather roads or feeder roads, especially in the farming areas to increase accessibility of far farms; and
- Increase the government extension services to all towns of Liberia farming areas with technical assistance designed to improve soil quality, control soil erosion as well as improvement in farm productivity.

Notes

1 It is often caused by improperly defined property rights which either lack security or enforceability.

2 For example, returns to labour may decline as more remunerative permanent employment opportunities give way to casual labour.

3 Such as biasedness towards the powerful in the community and information asymmetry that leads to costly negotiations.

4 For example, a baseline survey conducted by the Yale University and Innovations for Poverty Action in 2010 carried out in three rural counties of Liberia (Grand Gedeh, Nimba and Lofa) reveals that boundary conflict has a lion's share in the cause of land conflict followed closely by conflict arising from land taken during the civil war. The survey further reveals that one out of every three most significant conflicts in the three counties was land-driven.

5 Arising either from the resale of land, encroachment by neighbours or lack of concession companies to treat locals fairly.

6 Improper transfer of land under the customary land tenure system; inadequate documentation of land transfers/sale to prove and protect claims; distrust among different stakeholders; large-scale concession of land previously under customary land tenure to private companies, as well as unclear and contested land boundaries.

7 The overall mandate and purpose of the Land Commission are to propose, advocate and coordinate reforms of land policy, laws and programmes in Liberia. Over the years, the Land Commission has instituted several reform clusters covering areas such as: land rights, land administration, land use/management, and land dispute resolution. These clusters have their own role, though they are all intertwined.

8 These are (i) public land; land which is not presently used by government for its operation and is neither private nor customary lands, (ii) government land; land owned by the government, including land on which are located offices of government functionaries and is owned by the Republic of Liberia. This land is to be conserved and managed for the common good of all Liberians. Areas such as national parks, beaches, and monumental sites, etc., make up the Government Protected Areas, (iii) customary land; land owned by a community and used or managed in accordance with customary practices and norms. This includes wetlands, communal forestlands, and fallow lands, and (iv) private land; land owned by private individuals. An additional sub-category of land right is also embedded in the policy reforms of the Land Commission.

9 The first strand of the literature attempts to disentangle the impact of conflict on investment decisions (Deininger, 2003; Singh, et al, 2011). The second strand documents and describes the effects of conflict on crop, livestock and asset portfolios with the findings indicating that risk of conflict/violence changes the structure of agricultural asset portfolios (Finnström, 2003; Bundervoet, 2006; McKay and Loveridge, 2005; Vlassenroot and Raeymaekers, 2008).

10 See studies by Feder and Onchan (1987); Barrows and Roth (1990); Migot-Adholla et al (1991); Place and Hazell (1993); Pinckney and Kimuyu (1994); Gavian and Fafchamps (1996); Alston et al (1996); Place and Otsuka (2002); Smith (2004); Deininger and Jin (2006); Jacoby and Minten (2007); Place (2009); Mwesigye and Matsumoto (2013).

11 This data was administered to a sample of 8,350 randomly selected households between January 2016 and January 2017 by the Liberia Institute for Statistics and Geo-Information Services with support from the Government of Liberia, the World Bank, the European Union, the Swedish International Development Corporation Agency, the United States Agency for International Development, and the African Development Bank. The survey was nationally representative and collected detailed information at the household level on the following topics: education, health, employment, water and sanitary practices, household resources, grants, crime, conflicts and recent shocks to household wealth.

12 By land tensions, we imply a sort of opposing views on who is eligible to use the plot of land between different members of the community at a given period.

13 Such as the population density, urban growth as well as soil quality of the land. Thus, in general, land tension is mainly influenced by the population density of an area, remoteness of a given area as well as several tribes in a given area.

14 For example, in places with many tribes (ethnic groups), the customary tenure system seems to fail to resolve land conflicts as different tribes have different customs.

15 (1) In absence of land conflict and where landowners are entitled to the piece of land, the security of tenure of the owners can enhance farm investments (both medium-term and long-term). (2) Where entitlement exists and ownership is transparent, the farm title can be used as collateral especially in poor remote areas to access credit for agricultural investments. (3) Stability and land entitlement may stimulate the transfer of land from less productive farmers to more productive ones thus raising aggregate land productivity. The more people feel secure about their lands, the more willing and able they are to develop or improve those lands.

16 Household Income Expenditure Survey (HIES) of Liberia which was administered to a sample of 8,350 randomly selected households between January 2016 and January 2017 by the Liberia Institute for Statistics and Geo-Information Services with support from the Government of Liberia, the World Bank, the European Union, the Swedish International Development Corporation Agency, the United States Agency for International Development and the African Development Bank. The survey was nationally representative and collected detailed information at the household-level on the following topics: education, health, employment, water and sanitary practices, household resources, grants, crime, conflicts and recent shocks to household wealth.

17 This was a joint work of Yale University and Innovations for Poverty Action baseline survey in Liberia in 2009-2010 on the causes of land conflict at a household-level in the counties of Lofa, Nimba and Grand Gedeh.

18 Given a semi logarithmic equation of the form:

$\ln crop\_yield_{per\_acre} = a_0 + \sum_i a_1 X_i + \sum_i a_2 D_i + e_i$, in which a set of X_i are continuous variables and D_i are a set of dummy variables, the interpretation of dummy coefficient a_2 is given as:

$a_2 = \ln(1 + g)$

Where, g = $\frac{crop\_yield_{per\_acre_1} - crop\_yield_{per\_acre_0}}{crop\_yield_{per\_acre_0}}$;

$crop\_yield_{per\_acre_1}$ and $crop\_yield_{per\_acre_0}$ are the values of the dependent when dummy variable is equal to one and zero, respectively.

Therefore, g = exp {(a_2)-1} and the percentage effect on the dependent variable is given as: 100*g= 100 *{exp(c) -1}, where c is the estimated coefficient.

Dummy variable	a_2	**g**
Government extension services	0.524	0.2712
Soil quality	-0.252	-0.22275
Slope	-0.235	-0.20942
Gender	0.165	0.17939
Married men	0.446	0.56205
Male conflict	-0.000632	-0.0000632
Land conflict	-11.46	-99.99

See Halvorsen and Palmquist (1980)

19 That is, holding all other factors constant, the crop yield per acre - age equation from the regression Table 2 is given by:

$$Crop\_yeild_{acre} = age + -age^2$$

That is,

$$Crop\_yeild_{acre} = 0.6659age + -0.00601age^2$$

Taking derivative both side of age yields

$0 = 0.665age + 2 * (-0.00601)0.665age + 2 * (-0.00601)$ age

$0.665 = 2 * (0.00601)$ age

$\text{Age} = \frac{0.665}{0.012\,02}$

Thus, the turning point is when age = 55.407 or approximately 55 years.

20 Theory predicts that the model of arbitration bargaining may lead to a 'chilling effect' where players who anticipate a future arbitration process, that would use the current status quo as a benchmark to determine equitable recommendation, sees a positive incentive to harm the other party in order to secure a relative advantage in the status quo.

References

Adolfo, E. 2010. "*Youth, Arms & Drugs: Potential Security Developments Surrounding Elections in Liberia*." FOI, Division of Defence Analysis. http://www.foi.se/rapport?rNo=FOI-R--3120--SE

Alston, L.J. and B. Mueller. 2010. "Property rights, land conflict and tenancy in Brazil". NBER Working Paper No. w15771. National Bureau of Economic Research.

Alston, L.J., G.D. Libecap and R. Schneider. 1996. "The determinants and impact of property rights: Land titles on the Brazilian frontier". *Journal of Law, Economics, & Organization*". 12(1): 25-61.

Anyanwu, N.W. 2014. "*The Impact of the Practice and Administration of Customary Law of Inheritance on Gender Equality in Contemporary Igbo Society, Nigeria.*" Doctoral Dissertation, University of Pretoria.

Barrows, R. and M. Roth. 1990. "Land tenure and investment in African agriculture: Theory and evidence". *The Journal of Modern African Studies,* 28(2): 265-97.

Bennett, V., G. Faulk, A. Kovina and T. Eres. 2006. "Inheritance law in Uganda: The plight of widows and children". *The Georgetown Journal of Gender and the Law*, 7: 451-530.

Birch, I. 2018. "Agricultural productivity in Kenya: barriers and opportunities". K4D Helpdesk Report. Brighton, UK: Institute of Development Studies.

Blattman, C., A.C. Hartman and R.A. Blair. 2014. "How to promote order and property rights under the weak rule of law? An experiment in changing dispute resolution behaviour through community education". *American Political Science Review*, 108(1): 100-120.

Bundervoet, T. 2006. "*Livestock, activity choices and conflict: evidence from Burundi* (No. 24)." Households in Conflict Network.

Christensen, D., A. Hartman, and C. Samii. 2018. "Property Rights, Investment and Land Grabs: An Institutional Natural Experiment in Liberia." *Unpublished Paper*.

Colfer, C.J.P., B.S. Basnett, and M. Elias (Eds.). 2016. "*Gender and forests: climate change, tenure, value chains and emerging issues"*. Routledge.

Deininger, K. 2003. "*Causes and Consequences of Civil Strife: Micro-Level Evidence from Uganda"*. Washington, D.C.: The World Bank.

Deininger, K. and R. Castagnini. 2006. "Incidence and impact of land conflict in Uganda". *Journal of Economic Behaviour & Organization*, 60(3): 321-45.

Deininger, K., and S. Jin. 2006. "Tenure security and land-related investment: Evidence from Ethiopia". *European Economic Review*, *50*(5), 1245-1277.

De-Oliveira, J.A.P. 2008. "Property rights, land conflicts and deforestation in the Eastern Amazon". *Forest Policy and Economics*, 10(5): 303-15.

Feder, G. and D. Feeny. 1991. "Land tenure and property rights: Theory and implications for development policy". *The World Bank Economic Review*, 5(1): 135-53.

Feder, G., and T. Onchan. 1987. "Land ownership security and farm investment in

Thailand". *American Journal of Agricultural Economics*, *69*(2), 311-320.

Finnström, S. 2003. *Living with Bad Surroundings: War and Existential Uncertainty in Acholi Land, Northern Uganda*. Uppsala: Uppsala University Press.

Gavian, S. and M. Fafchamps. 1996. "Land tenure and allocative efficiency in Niger". *American Journal of Agricultural Economics*, 78(2): 460-71.

Government of Liberia. 2012. *Liberian Land Commission. Land Right Policy*. Monrovia: Government Press.

Halvorsen R. and R. Palmquist. 1980. "The Interpretation of Dummy Variables in Semilogarithmic Equations." *American Economic Review*, 70(3): 474-75.

Hartman, A. 2010. "Comparative analysis of land conflicts in Liberia: Grand Gedeh, Lofa and Nimba Counties". Oslo, Norway: The Norwegian Refugee Council. Google Scholar.

Hellum, A. and B. Derman. 2004. "Land reform and human rights in contemporary Zimbabwe: Balancing individual and social justice through an integrated human rights framework". *World Development*, 32(10): 1785-1805.

Jacoby, H.G. and B. Minten. 2007. "Is land titling in sub-Saharan Africa cost-effective? Evidence from Madagascar". *World Bank Economic Review,* 21(3): 461-85.

Kent, A. 2016. "Conflict continues: Transitioning into a battle for property in Cambodia today". *Journal of Southeast Asian Studies*, 47(1): 3-23.

Laird, S.E. 2004. "Inter-ethnic conflict: A role for social work in sub-Saharan Africa". *Social Work Education*, 23(6): 693-709.

Lombard, M. and C. Rakodi. 2016. "Urban land conflict in the Global South: Towards an analytical framework". *Urban Studies*, 53(13): 2683-99.

Long, E.J. 1950. "The agricultural ladder: Its adequacy as a model for farm tenure research". *Land Economics*, 26(3): 268-73.

Loomis, R.S. 1983. "Productivity of agricultural systems". In *Physiological Plant Ecology.* Berlin, Heidelberg: Springer.

McKay, A. and S. Loveridge. 2005. "*Exploring the Paradox of Rwandan Agricultural Household Income and Nutritional Outcomes in 1990 and 2000*." Research Paper No. 11582. Michigan State University, Department of Agricultural, Food, and Resource Economics.

Migot-Adholla, S., P. Hazell, B. Blarel and F. Place. 1991. "Indigenous land rights systems in sub-Saharan Africa: A constraint on productivity?" *The World Bank Economic Review*, 5(1): 155-75.

Mwesigye, F. and T. Matsumoto. 2016. "The effect of population pressure and internal migration on land conflicts: Implications for agricultural productivity in Uganda". *World Development*, 79: 25-39.

Mwesigye, F. and T. Matsumoto. 2013. "Rural-rural migration and land conflicts: Implications on agricultural productivity in Uganda." *National Graduate Institute for Policy Studies*.

Nash, J. 1953. "Two-person cooperative games." *Econometrica: Journal of the Econometric Society,* 128-140.

Paczynska, A. 2010. "*Liberia Interagency Conflict Assessment Framework Report* (ICAF Report)." US Department of State. *http://scar.gmu.edu/sites/default/files/Final_ICAF_Report_0.pdf*

Pinckney, T.C. and P.K. Kimuyu. 1994. "Land tenure reform in East Africa: Good, bad or unimportant?" *Journal of African Economies*, 3(1): 1-28.

Place, F. 2009. "Land tenure and agricultural productivity in Africa: A comparative analysis of

the economics literature and recent policy strategies and reforms". *World Development*, 37(8): 1326-36.

Place, F. and K. Otsuka. 2002. "Land tenure systems and their impacts on agricultural investments and productivity in Uganda". *Journal of Development Studies*, 38(6): 105-128.

Place, F. and P. Hazell. 1993. "Productivity effects of indigenous land tenure systems in sub-Saharan Africa". *American Journal of Agricultural Economics*, 75(1): 10-19.

Richards, P. 2005. "To fight or to farm? Agrarian dimensions of the manor river conflicts (Liberia and Sierra Leone)". *African Affairs*, 104(417): 571-90.

Rukuni, M. and C. Kambanje. 2011. "Impact of land rights on the productivity of agriculture and natural resource enterprises in Africa". In *Conference on Increasing Agricultural Productivity and Enhancing Food Security in Africa: New Challenges and Opportunities.* Addis Ababa, Ethiopia.

Sekeris, P. 2010. "Land inequality and conflict in sub-Saharan Africa". *Peace Economics, Peace Science and Public Policy*, 16(2): 1-18.

Singh, P., J.K., Thakur, S. Kumar, and U.C. Singh. 2011. "Assessment of land use/land cover using geospatial techniques in a semi-arid region of Madhya Pradesh, India". In *Geospatial Techniques for Managing Environmental Resources.* Springer, Dordrecht.

Smith, R.E. 2004. "Land tenure, fixed investment, and farm productivity: Evidence from Zambia's Southern Province". *World Development*, 32(10): 1641-61.

Tauer, L. 1995. "Age and farmer productivity." *Review of Agricultural Economics*, 17(1): 63-9.

UN-Habitat. 2016. *Planning Sustainable Cities: Global Report on Human Settlements 2009.* Routledge, Nairobi.

Unruh, J.D. 2009. "Land rights in post-war Liberia: The volatile part of the peace process". *Land Use Policy*, 26(2): 425-33.

USAID. 2016. "A strategy for further reform in Liberia's law on land: Liberia land governance support activity". At *https://www.land-links.org/wp-content/uploads/2017/05/USAID_Land_Tenure_LGSA_Report_Reform_Strategy_Liberia_Law_Land.pdf*

Van Suu, N. 2007. "Contending views and conflicts over land in Vietnam's Red River Delta". *Journal of Southeast Asian Studies*, 38(2): 309-34.

Vlassenroot, K. and T. Raeymaekers. 2008. Crisis and food security profile: The Democratic Republic of the Congo. *Beyond relief: food security in protracted crises* (pp. 157–168). Practical Action.

Wick, K. and E.H. Bulte. 2006. "Contesting resources – rent-seeking, conflict and the natural resource curse". *Public Choice*, 128(3-4): 457-76.

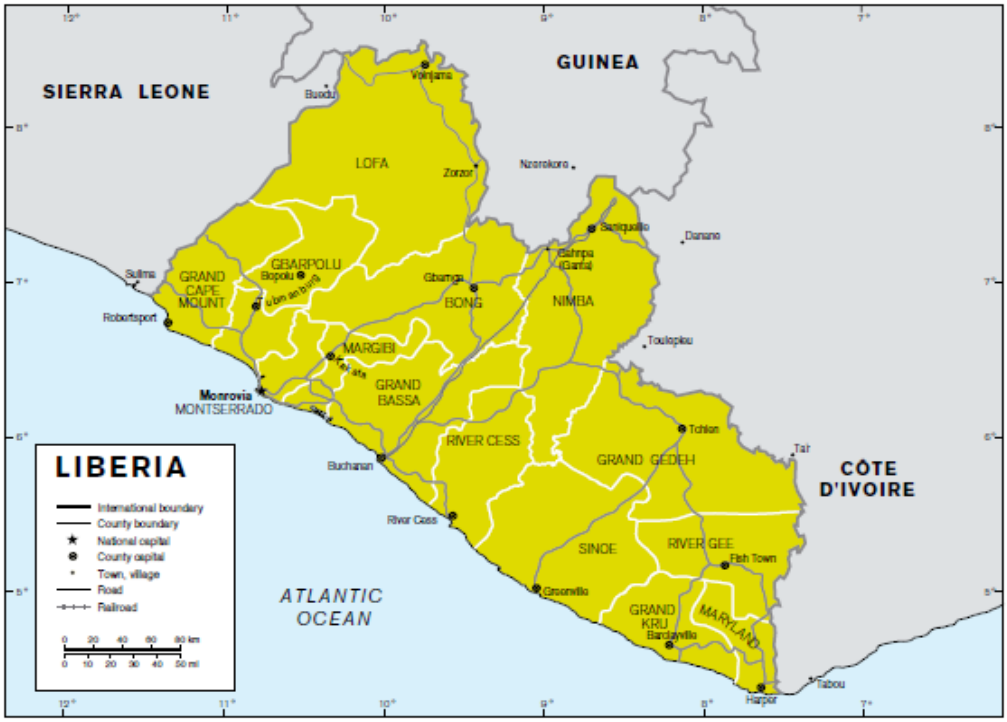
Wily, L.A. 2011. "'The Law is to Blame': The vulnerable status of common property rights in sub-Saharan Africa". *Development and Change*, 42(3): 733-57.

Yamano, T. and K. Deininger. 2005. *Land Conflicts in Kenya: Causes, Impacts, and Resolutions*. FASID Discussion Paper No. 2005-12-002.

Zhang, Y.J., A.J. Li and T. Fung. 2012. "Using GIS and multi-criteria decision analysis for conflict resolution in land-use planning". *Procedia Environmental Sciences*, 13: 2264-73.

Appendixes

Appendix 1: Political map of Liberia



Appendix 2: First stage OLS regression for land conflict model

Source	SS	df	MS	Number of obs	=	154,090
				F(14, 154075)	=	76597.99
Model	10785.7318	14	770.409412	Prob > F	=	0.0000
Residual	1549.65986	154,075	.010057828	R-squared	=	0.8744
				Adj R-squared	=	0.8744
Total	12335.3916	154,089	.080053681	Root MSE	=	.10029

Land_Conflict	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Farm_to_Home	.0001328	.0000111	11.98	0.000	.0001111	.0001546
Farm_to_Road	-.0000409	7.27e-06	-5.62	0.000	-.0000551	-.0000266
Govt_extension_serv						
Yes	.0249671	.0009983	25.01	0.000	.0230103	.0269238
soil_qlty						
Bad	-.0136825	.0007276	-18.80	0.000	-.0151086	-.0122565
Slope						
Slope	-.0094164	.0005624	-16.74	0.000	-.0105186	-.0083141
Soil_erosion						
Yes	-.0196314	.0005895	-33.30	0.000	-.0207869	-.0184759
Marital_status						
Married	.0223702	.0007821	28.60	0.000	.0208373	.0239031
AGE	.0643002	.0004152	154.87	0.000	.0634865	.065114
AgeSquare	-.0005584	4.52e-06	-123.65	0.000	-.0005673	-.0005496
Gender						
Male	.0204144	.0009046	22.57	0.000	.0186413	.0221874
Interaction_Marriage_Gender	.0019997	.0010722	1.86	0.062	-.0001019	.0041012
Inter_Gender_Conf	-.0000172	5.66e-07	-30.46	0.000	-.0000184	-.0000161
Inter_Region_Conf	8.30e-06	1.96e-07	42.46	0.000	7.92e-06	8.69e-06
county	.3841022	.0015344	250.33	0.000	.3810949	.3871095
_cons	-2.112644	.0064756	-326.25	0.000	-2.125336	-2.099952

more

Appendix 3: 2SLS results for crop yield model

IV (2SLS) estimation

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

		Number of obs =	154090
		F(14,154075) =	577.00
		Prob > F =	0.0000
Total (centered) SS	= 437608.5203	Centered R2 =	0.0498
Total (uncentered) SS	= 9616525.072	Uncentered R2 =	0.9568
Residual SS	= 415808.2858	Root MSE =	1.643

Ln_Crop_Yield_Value_in_LD	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Land_Conflict	-11.45826	1.3603	-8.42	0.000	-14.1244	-8.792124
ResidualR	10.37582	1.36094	7.62	0.000	7.708423	13.04321
Govt_extension_serv						
Yes	.523803	.0394218	13.29	0.000	.4465377	.6010683
soil_qlty						
Bad	-.252409	.0227874	-11.08	0.000	-.2970715	-.2077464
Slope						
Slope	-.2353586	.0161752	-14.55	0.000	-.2670614	-.2036558
Soil_erosion						
Yes	-.0000229	.0276654	-0.00	0.999	-.0542461	.0542004
Marital_status						
Married	-.0297707	.0323225	-0.92	0.357	-.0931217	.0335802
AGE	.6651022	.0874186	7.61	0.000	.4937648	.8364395
AgeSquare	-.0060076	.0007596	-7.91	0.000	-.0074964	-.0045188
Gender						
Male	.1646943	.0312336	5.27	0.000	.1034776	.225911
Interaction_Marriage_Gender	.4458689	.0176473	25.27	0.000	.4112809	.4804569
Inter_Gender_Conf	-.0006317	.0000246	-25.71	0.000	-.0006798	-.0005835
Inter_Region_Conf	.0002342	.0000118	19.87	0.000	.0002111	.0002573
county	5.534798	.5239408	10.56	0.000	4.507893	6.561703
_cons	-17.04627	2.867669	-5.94	0.000	-22.6668	-11.42574

Underidentification test (Anderson canon. corr. LM statistic): 1.5e+05
Chi-sq(2) P-val = 0.0000

Weak identification test (Cragg-Donald Wald F statistic): 1.5e+17
Stock-Yogo weak ID test critical values: 10% maximal IV size 19.93
15% maximal IV size 11.59
20% maximal IV size 8.75
25% maximal IV size 7.25
Source: Stock-Yogo (2005). Reproduced by permission.

Sargan statistic (overidentification test of all instruments): 46.104
Chi-sq(1) P-val = 0.0000

Instrumented: Land_Conflict
Included instruments: ResidualR 1.Govt_extension_serv 1.soil_qlty 1.Slope 1.Soil_erosion 1.Marital_status AGE AgeSquare 1.Gender Interaction_Marriage_Gender Inter_Gender_Conf Inter_Region_Conf county
Excluded instruments: Farm_to_Home Farm_to_Road
Dropped collinear: Land_Conflict
Reclassified as exog: ResidualR

Appendix 4: Land conflict model (OLS results)

Source	SS	df	MS	Number of obs	=	154,090
				F(15, 154074)	=	1015.44
Model	1.1512e+10	15	767483946	Prob > F	=	0.0000
Residual	1.1645e+11	154,074	755811.231	R-squared	=	0.0900
				Adj R-squared	=	0.0899
Total	1.2796e+11	154,089	830449.408	Root MSE	=	869.37

Land_Conflict_three	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Farm_to_Home	3.108012	.0960028	32.37	0.000	2.919849	3.296176
Farm_to_Road	2.321744	.0628754	36.93	0.000	2.198509	2.444978
Govt_extension_serv	-16.72022	8.580804	-1.95	0.051	-33.53842	.097977
soil_qlty						
Bad	277.7726	6.289209	44.17	0.000	265.4459	290.0994
Slope						
Slope	-129.5014	4.885751	-26.51	0.000	-139.0774	-119.9254
Soil_erosion						
Yes	-78.64387	5.108836	-15.39	0.000	-88.65709	-68.63066
Marital_status						
Married	294.8059	6.783364	43.46	0.000	281.5107	308.1012
AGE	82.08971	2.798984	29.33	0.000	76.60376	87.57566
AgeSquare	-.9003882	.0321034	-28.05	0.000	-.9633103	-.8374661
Gender						
Male	30.43329	7.128602	4.27	0.000	16.46137	44.4052
Number_of_permanent_Trees	.0107347	.0038447	2.79	0.005	.0031992	.0182702
Number_Perm_Crops	.1726975	.0114784	15.05	0.000	.1502001	.1951948
Seed_type						
Improved	763.4288	14.01779	54.46	0.000	735.9542	790.9034
Use_organic_fert	1478.047	109.2909	13.52	0.000	1263.839	1692.255
Interaction_Marriage_Gender	-179.9511	9.357848	-19.23	0.000	-198.2923	-161.6099
_cons	-1115.768	52.92345	-21.08	0.000	-1219.497	-1012.039

(Footnotes)

1 199.52 Liberian dollars (LD) is equivalent to one US dollar.

Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

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