Large-Scale Land Investments and Land-Use Change:

Determinants and Impacts on Rural Development

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Declaration of own contribution

This is a cumulative dissertation that consists of 4 co-authored and 2 single-authored chapters. I confirm that I am the sole author of Chapters 1 and 5.

I confirm that Chapter 2 has been co-authored with Jann Lay and Kerstin Nolte. All three authors equally contributed to the conceptualization of the study, research design, data preparation, empirical analysis and writing of the chapter.

I confirm that Chapters 3 and 4 have been co-authored with Menusch Khadjavi and Rainer Thiele. All three authors equally contributed to the study conceptualization, grant application, and writing of the chapters. Menusch Khadjavi and I were responsible for the data collection, cleaning and empirical analyses.

I confirm that Chapter 6 has been co-authored with Elisabeth Hettig and Jann Lay. All three authors equally contributed to the conceptualization of the study, the design, data preparation, empirical analysis and writing of the chapter.

I declare that all the contributions stated above are true.

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"If only the problem of food supply could be solved by large applications of capital to vast acreage of land; if only capital could 'overcome any obstacle,' then the world hunger problem might be alleviated with extraordinary rapidity"

Hogendorn and Scott (1981)

1 Introduction

1.1 Background

Agriculture is the mainstay of rural households in developing countries. It accounts for the bulk of the total labor force in most of these countries (Gollin, 2010). In sub-Saharan Africa, nearly two-thirds of the total income of rural households is generated through on-farm agriculture (Davis et al., 2017). Despite the importance of this sector, its productivity often remains low and many rural areas underdeveloped.

Various scholarly works have been put forward to explain how smallholders' productivity and contribution to economic development can be enhanced. Most prominent among these, is the theory by Johnston and Mellor (1961) and Mellor (1966) that argues that the introduction of modern technology would enhance the efficiency of smallholder agriculture and thereby foster economic growth. Within this model, growth would be spurred on through the creation of linkages in inputs and outputs between the agricultural and non-agricultural sectors. In a similar vein, one of the most well-known advocates of investments in small-scale agriculture, Theodore Schultz, argued that economic growth would be achieved through investments in the quality of inputs, increasing smallholders' access to knowledge and through the provision of incentives (Schultz, 1964; 1980). In his seminal book on *Transforming Traditional Agriculture,* he stated that "The farmer who has access to and knows how to use what science knows about soils, plants, animals, and machines can produce an abundance of food though the land be poor …"(Schultz, 1964, p. 3).

These views that place smallholders at the center of development challenged earlier development models by Lewis (1954), and Ranis and Fei (1961) on dual economies that regarded family farm workers as part of a subsistence sector that is characterized by excess labor, low marginal productivity and low wages. Lewis (1954)'s model posited that as the economy develops, smallholders would be absorbed by the more productive capitalist sector that included plantations and large-scale farms. Based on this growth theory, the market economy would push unproductive smallholders out of the stagnant subsistence sector (Timmer, 1988; Bryceson, 2000; Ellis and Biggs, 2001).

Today, few would dispute the important role that agriculture plays in fueling a structural transformation which would result in the movement of workers and resources from agriculture into more productive sectors (Gollin, 2010). What remains more contentious, however, is the type of farming system that will fuel this transformation. Based on the extensive size and direct poverty reducing impacts of smallholder agriculture, approaches that focus on smallholders still dominate the rural development discourse. For instance, the 2008 World Development Report on *Agriculture for Development* devoted a large section towards discussing the contribution of smallholders to economic growth and rural development (World Bank, 2007). The importance of investing in smallholders has also been recognized in Target 2.3 of the Sustainable Development Goals (SDGs) that aims to double the agricultural productivity and incomes of small-scale food producers by 2030 (United Nations, 2015).

Most arguments in favor of smallholder agriculture are based on a strand of literature that claims that there is an inverse relationship between farm size and land productivity. This literature, that is influenced by classic works from Alexander Chayanov and John Stuart Mill proposes that smallholders are productive because they have lower labor costs which allow them to raise their output by applying labor intensively (Sen, 1966; Barbier, 1984; Bhalla and Roy, 1988; Benjamin, 1995; Barrett et al., 2010). Another explanation that is commonly given within this literature, relates to the presence of principal-agent problems and the high supervision costs needed to prevent the shirking of hired laborers. Smaller farms that rely on family labor are believed to be more productive because they do not incur high costs of supervision or hiring labor (Feder, 1985; Barrett, 1996; Barrett, 2010).

However, others have been more skeptical about these smallholder–centric models of rural development. For instance, Collier (2008) makes a strong case for large-scale agriculture, stating that it is more suited to cater to rising global food supply needs, since it is innovative and resilient to price fluctuations. Innovations on large-scale farms, he points out, can also be shared with smallholders through out-grower and contract farming arrangements. In a later paper, co-authored with Stefan Dercon, Collier reemphasizes the importance of large-scale farms, when he argues that large-scale farms are better placed to make use of economies of scale in knowledge diffusion, technology adoption, accessing finance and capital as well as in the organization of logistics (Collier and Dercon, 2014).

Empirical evidence that compares the productivity of the two farming systems is mixed. Studies that have found evidence of the inverse relationship between farm size and higher smallholder agricultural productivity have omitted key variables such as land quality or have been prone to statistical bias (Barrett, 2010). Likewise, studies that favor large-scale agriculture rarely consider the impacts of such farms on the environment, land use and land cover. Even fewer empirical studies are available that analyze how rural development is affected when these two farming systems coexist. The primary aim of this dissertation will be to contribute to filling this research gap by analyzing how the encounter of these two farming systems affects rural development.

1.2 Challenges affecting rural development

Recently, there has been a growing tendency in the literature to use micro-level datasets to investigate the persistence of agricultural productivity gaps and the prospects for a structural transformation (Gollin et al., 2014; Hicks et al., 2017; McCullough, 2018). This literature, that departs from conventional sectoral analyses that use macro-level data, finds that productivity in the agricultural sector is not as low as has been argued to be the case if one considers factors such as hours worked and the role played by human capital. However, despite these new insights, the authors of these studies point out that large agricultural gaps remain, which continue to challenge structural transformation and rural development.[1]

One of the major reasons why many rural regions remain undeveloped is the adoption of policies that have been biased against agriculture and rural areas. Lipton (1977) brought the discussion of ‘urban bias’ to the fore when he explained why poverty persists in rural areas. According to Lipton (1977), ‘policies that are designed by and for people in urban areas’ placed a strong focus on urban industrialization and resulted in large inefficiencies in rural areas. Bezemer and Headey (2008) explain that the causes of urban bias are deep-rooted and can be traced to colonial regimes that sought to extract profits and excluded local populations from access to

[1] An exception to these studies is a paper by Diao et al., (2017) who combine macro-data from the Groningen Growth and Development Center’s Africa Sector Database with micro-data from the Demographic Health Surveys and find a decline in the agricultural labor force in Africa.

land and public resources. The demise of colonialism was followed by the adoption of industrialization policies and later structural adjustment policies whose effects on the rural poor and smallholders in particular can still be seen today (Bryceson, 2002; Bezemer and Headey, 2008).

Today, smallholders are confronted with an even larger set of challenges that continue to undermine rural development. In addition to the persisting market imperfections and infrastructural constraints that arose from urban bias, smallholders are increasingly threatened by rainfall and temperature variability caused by climate change (Collier and Dercon, 2014; Cohn et al., 2017). Furthermore, increasing price volatility and health shocks render smallholders vulnerable. In a study using the World Banks' Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA), Nikoloski et al., (2018) find that more than 60 percent of households report sudden losses in income and assets due to shocks. The authors find that price shocks that arise when crop prices unexpectedly fall or food prices suddenly rise can be just as damaging as weather-related shocks.

Added to this, are growing concerns of unsustainable smallholder land conversion and land-use change owing to demographic change. Barbier (2000) points out that African smallholders respond to declining productivity and population pressure by moving to or converting new lands for grazing and cultivation. He argues that this form of land-extensification exerts pressure on land resources and results in a cumulative causation of land degradation that further lowers smallholders' yields. More recent evidence by Jayne et al. (2014) shows that population pressure has resulted in an intergenerational subdivision of land that has decreased smallholders' farm sizes. In response smallholders have begun to crop their fields all year round, without allowing for fallow or soil replenishment between crop seasons. Similar evidence has been found for Uganda, Ethiopia, Nigeria, Tanzania and Niger by Binswanger-Mkhize and Savastano (2018), who show that fallow has gradually disappeared. These current trends associated with population pressure and land intensification were already foreseen in the 1960's by Danish economist Ester Boserup, who hypothesized that farmers would respond to land constraints imposed by rising population densities through agricultural intensification that would take the form of increased input application per unit of land, higher crop frequencies and shortened fallow periods (Boserup, 1965; Jayne et al., 2014).

While it is clear that demographic pressure and other macroeconomic factors such as agricultural commodity price fluctuations may cause smallholders to adopt more extensive or intensive land use practices, the mechanisms through which micro-level factors cause such changes at the household level largely remain unknown. Understanding the micro-level determinants of smallholders' land-use decisions is important, as it will help devise strategies that lead to the sustainable use of resources that are already constrained and enhance agricultural productivity on existing land resources. This dissertation addresses this research gap by analyzing the micro determinants of smallholders' land use decisions.

1.3 Recent developments affecting land-use in rural areas

In a bid to overcome the challenges affecting smallholders' agricultural productivity, there has been an increasing shift to adopt Lewis-model inspired policies that favor capital intensive large-scale land investments (Collier and Dercon, 2014). This new wave of large-scale land investments has mostly been driven by governments of resource-constrained countries that seek to outsource food production, international financial entities and, commercial farmers planning to expand their operations (De Schutter, 2011; Deininger et al., 2011). Policy makers view this increased interest for agricultural land as an opportunity to close high yield gaps and provide employment for rural populations.

Yet others have pointed out that a sole focus on large-scale agriculture does not come without its problems. For instance, several case studies have shown that setting up large-scale land investments in rural areas where property rights tend to be weak can lead to displacements and heightened perceptions of tenure insecurity (Sulle and Nelson, 2009; Cotula, 2011). In addition, large-scale land investments have been found to increase water scarcity, environmental degradation and pollution (Mujenja and Wonani, 2012; Johansson et al., 2016). Moreover, the employment opportunities offered by the large-scale farms have been found to be limited due to the highly mechanized nature of these farms (Nolte and Ostermeier, 2017).

Recently, a growing literature (see for instance, Anseeuw, 2016 and Jayne et al., 2016) has highlighted the emergence of a new medium-scale farming system that has not yet received much recognition in the rural development literature. Medium-scale farmers who mostly consist of the urban elite are now estimated to hold more agricultural land than smallholders. This emerging farming system has increased smallholders' land constraints that are already threatened by demographic pressures (Jayne et al., 2014).

The empirical impacts of both large-scale land investments and medium-scale farms on smallholders are still under-researched as the general discourse on rural development has mostly been shaped by case studies. While these case studies have been informative, more empirical research is needed to understand the nature and magnitude of the impacts on smallholders that arise from these interactions. This dissertation contributes to the growing empirical literature by presenting four studies that analyze how smallholders are affected by large–scale land investments.[2]

[2] For the sake of brevity, large-scale land investments are referred to as large-scale farms in the remainder of this section. In subsequent chapters they are referred to by the definition provided with the data, for instance in Chapters 2 and 4 we use the term large-scale farm, while in Chapter 5 we refer to these investments as agribusinesses and plantations.

1.4 Overview of dissertation chapters

The first research questions posed in this dissertation are: Where are large-scale farms located? and what determines their location? The answers to these questions are provided in Chapter 2 titled '*Large-scale farms and smallholders: Evidence from Zambia*' where we conduct a systematic analysis of the geographic characteristics of regions that host large-scale farms. Using a census of large-scale farms in Zambia (farms that cover an area of 20 hectares or more) that was jointly collected in 2013 and 2014 with the Zambian Central Statistical Office (CSO), we are able to identify all the wards that have had large-scale farms since 1995. Wards are the smallest administrative units in Zambia, following districts and provinces. We combine the large-scale farm locational data with geospatial datasets that provide us with ward-level information on land cover, railroad infrastructure, cities and irrigation. In addition, ward boundaries and population estimates are identified using data provided by CSO, while poverty headcount data is obtained from a World Bank report *on Mapping Poverty in Zambia* (de la Fuente et al., 2015).

Combining these multiple datasets enables us to challenge some of the commonly held perceptions on the locations of large-scale farms. For instance, it was widely believed that large-scale farms are established on 'idle lands' that would otherwise not have been put into productive use by smallholders (Cotula et al., 2009; Anseeuw et al., 2012). Our geographical analysis challenges this perception by showing that large-scale farms are not set up on idle land, but instead are clustered close to smallholder communities in wards that already host large-scale farms. The analysis further reveals that large-scale farms are located in wards that have good soil quality and infrastructure. Moreover, we find that wards that host large-scale farms have experienced considerable reductions in tree cover since the early 2000s. This indicates that large-scale farms result in extensive conversions of forest to agricultural land.

The second research question addressed in Chapter 2 asks whether large-scale farms have an impact on smallholders' agricultural outcomes. To answer this question, we match the census on large-scale farms with seven nationally representative cross-sectional household datasets that contain information on household head characteristics, assets, livestock holdings, the use of agricultural inputs, as well as the amount of crops cultivated, harvested, and sold. This combination of data enables us to create a ward-level panel with smallholder agricultural outcomes. Using a difference-in-differences estimation where our outcome variable of interest is the interaction between a variable that indicates that smallholder data was collected after the year 2010 and a variable that indicates that a ward has a large-scale farm, we investigate how smallholders' cultivated area, access to fertilizer and maize yields are affected by large-scale farms. Ward and year fixed effects are added to the regression to capture any time-invariant unobservables that may bias our results. We find significant increases in maize yields and the area cultivated by smallholders located in wards with large-scale farms. This hints at positive spill-overs that may lead smallholders to increase their productivity at the extensive margins. However, we cannot say with certainty that this result is purely driven by large-scale farms as medium-scale farmers are also active in these regions. Interestingly, despite observing significant increments in smallholders' maize yields, we do not find that large-scale farms raise access to or use of fertilizer. This is likely to be caused by distortions that have been created by the Farmer Input Support Program (FISP) (Burke et al., 2016).

In Chapters 3 and 4 of this dissertation that are respectively titled *'Social Capital and Large-Scale Agricultural Investments: An Experimental Investigation'* and '*Market exposure makes females behave more competitively and closes the gender gap'* we employ experimental economic methods to investigate whether the externalities from large-scale farms extend beyond conventional measures of agricultural productivity to smallholders' social capital and competitiveness. The general context in which these two studies occur consists of two large-scale farms in Zambia's Central Province that are not only representative of large-scale farms in Zambia but also of large-scale farms in other African countries. Using village lists and maps obtained from CSO, we randomly selected 13 villages within a 15 kilometer radius of the large-scale farms and 16 villages within a 50 to 70 kilometer radius from the large-scale farms in the year 2015. 445 smallholders from villages close to large-scale farms and 487 smallholders that live in villages located further away from the two large-scale farms participated in our experiment.

In Chapter 3, we follow Glaeser et al. (2000)'s methodological insights on combining experiments and surveys to measure trust and reciprocity ('trustworthiness') - which are two important components of social capital. In doing so, we employ Clark and Sefton (2001)'s Sequential Prisoner's Dilemma in a lab-in-the-field experiment to measure intra-village trust and reciprocal behavior in villages that are near and further away from the large-scale farms. Our results reveal that smallholders in villages close to the two large-scale farms trust each other significantly more than smallholders in villages further away. We suggest that these results are driven by smallholders banding together as large-scale farms are set up within their vicinity. Qualitative evidence collected in a follow up visit to the villages confirms that the establishment of large-scale farms brings about uncertainty and leads smallholders in surrounding communities to meet more frequently, as they discuss how to deal with the large-scale farms. In addition, we find that smallholders that have been employed on large-scale farms display significantly more trust and reciprocal behavior than those with no such experience. It is likely that these traits, that are necessary to build a good reputation in employer-employee relations (Akerlof, 1982), are internalized by large-scale farm workers.

Chapter 3 also introduces a natural field experiment in which both villages near and further away from the large-scale farms were endowed with a public good (a community solar system). The natural field experiment was undertaken to validate the results of the lab-in-the field experiment. Moreover, following the tradition of studies that measured village social capital through the management of community resources, such as Narayan and Pritchett (1996), we undertook the natural experiment to have an independent measure of intra-village social capital. One year after the public goods were gifted, we paid impromptu visits to the villages. These visits were aimed at measuring the governance of the community solar systems. The results of the natural experiment provide evidence that villages close to large-scale farms have a higher propensity to govern the public good in a more equitable manner than villages further away. We also find a high correlation between intra-village trust and the levels of public good governance. This finding validates the results of the lab-in-the-field experiment that show that intra-village trust is higher in villages next to large-scale farms.

In Chapter 4, we revisit the setting introduced in Chapter 3 and investigate whether smallholders' competitive behavior is affected by market exposure. We are mainly interested in investigating whether exogenous market exposure (driven through proximity to large-scale farms) and endogenous market exposure (resulting from active participation on crop sales markets) affects the competitive decisions of smallholders. We elicit competitive behavior, by drawing on Gneezy et al. (2009)'s lab-in-the-field experiment that compares participants' decisions to take part in a task where pay-offs are determined by competing with another anonymous village member or by receiving a piece rate.

We find that both forms of market exposure jointly and significantly increase the probability that a smallholder will decide to compete. Disaggregating these results by gender, we find that the gender gap in competitiveness that has been observed in multiple settings (Andersen et al., 2013; Buser et al., 2014; Niederle and Vesterlund, 2007; Gneezy et al., 2003; Gneezy et al., 2009; Leibbrandt et al., 2013) is levelled off for both adult and children female participants in villages close to large-scale farms. Interestingly, we also observe heterogeneity in the determinants of male and female participants' competitive decisions. To be specific, we find that females' competitive behavior is significantly affected by exogenous market exposure, while endogenous market exposure drives males' competitive behavior.

With regard to endogenous market exposure, we argue that although both male and female smallholders equally participate on the crop sales market, females' participation is constrained by the prevailing norms and customs in rural Zambia, that assign domestic and agricultural roles to women. Crop sales may not be as lucrative for women, thus explaining why they are not affected by endogenous market exposure.

Comparing male and females' socio-economic characteristics, we also observe that females are more marginalized in terms of education, assets and the diversity of crops grown. In addition, males' competitive behavior is affected by other factors such as village size, lineage and land title. Based on this, we suggest that female's competitive behavior is more responsive to exogenous market exposure since none of the other observed factors affect their competiveness. We do not find that large-scale farms increase females' employment or assets. This leads us to believe that exogenous market exposure raises females' competitive behavior through exposing women to opportunities that were previously unavailable. In line with the literature on competitiveness (Almas et al., 2015; Deckers et al., 2015), we find that competitive behavior is also passed on from adult parents to children in our setting.

Chapter 5 titled *'Agribusinesses, Smallholder Tenure Security and Plot-level Investments: Evidence from Rural Tanzania'* investigates whether spill-overs on smallholders persist when large-scale farms decrease or cease their operations. This research question is pertinent for the Tanzanian setting, where many large-scale farms that acquired land for commercial agriculture - particularly for the cultivation of biofuels – ceased their operations (Sulle and Nelson, 2013; Sulle, 2015). The land tenure system in Tanzania is multi-layered and designed to protect smallholders land rights, but it does not provide a clear indication of whether smallholders can reclaim their land following the failure of a large-scale farm (Sulle and Nelson, 2013; Byamugisha, 2014). We draw on a panel of 5,101 plots from the first and third rounds of the Tanzania National Panel Survey (TZNPS) and investigate whether a decrease in the share of land held by a large-scale farm in a village affects the likelihood that a plot cultivated by smallholders has tenure security. Using a plot-level fixed effects estimation, we find that smallholders perceive their plots to be more secure (*de facto* tenure security) and acquire more title (*de jure* tenure security), following the reduction in the area of land held by large-scale farms. This increase in tenure security is mostly undertaken as a safeguard against the uncertainty that arises after large-scale land investments fail.

A well-established theoretical literature has linked more secure land tenure to an increase in plot-level investments (Braselle et al., 2002; Besley and Ghatak 2010; Fenske, 2011). In the second part of Chapter 5, we also analyze whether this link exists for smallholders that are located in villages that have experienced a decrease in the share of land cultivated by large-scale farms. Using linear probability and tobit models with plot-level and year fixed effects, we investigate whether the share of land held by an agribusiness increases non-cash intensive investments (i.e. fallow and time spent on the plot) as well as cash intensive investments (i.e. improved seeds, irrigation, fertilizer and hired labor). We observe that a decrease in the share of land held by large-scale farms leads smallholders to increase the time spent on their plots, but find that this result is largely driven by their employment on large-scale farms and not through changes in smallholders' levels of tenure security. Moreover, we do not find that a decrease in the share of land held by large-scale farms affects smallholders' cash intensive investments. This suggests that there are no income-spillovers from large-scale farms onto smallholders within our study context.

Having established a clear case for the presence of externalities from large-scale farms on smallholders in Chapters 2, 3, 4, and 5, the sixth chapter of this dissertation titled *'Drivers of households' land-use decisions: a critical review of micro-level studies in tropical regions'* takes a different approach and answers the question: What are the micro-level drivers of households' land use decisions? As already noted above, understanding how the determinants of land-use change at the household level will lead to more sustainable use of land resources that are constrained by demographic pressures is important. Moreover, understanding the flip side of smallholders' land use and agriculture related decisions when they are not in the vicinity of large-scale farms is important as the majority of smallholders lives and cultivates land in regions that are not in the proximity of large-scale farms.

In Chapter 6, we systematically review and conduct a meta-analysis of 91 studies that use data from tropical regions and are published between the years 2000 and 2015. The studies were sourced from academic databases and search engines such as Google Scholar, Scirus, Repec, Mendeley, and AgEcon. We ensure that our systematic review only includes studies on smallholders by selecting studies that use either household or village level data. This is in line with the approaches taken in Chapters 2, 3, 4, and 5.

Our meta-analysis reveals that the most common form of land-use change undertaken by smallholders is the conversion of forest land to agricultural land. This suggests that smallholders face external pressure to expand their farm size even in the absence of large-scale farms, while in Chapter 2 it has been shown that large-scale farms increase smallholders' cultivated area.

To investigate this further, we cluster the seven main drivers that influence smallholder households' land-use decisions into key policies, technology, markets, demography, endowments, infrastructure, as well as property rights and institutions. Our choice of these drivers is influenced by pioneering literature that has analyzed the underlying causes of deforestation such as Angelsen and Kaimowitz (1999) and Geist and Lambin (2001). Amongst these factors, we find that household endowments and characteristics – especially owing to an increase in households' income and asset-holdings – account for the largest conversions of forest land to agricultural land. The results of the meta-analysis therefore highlight the role that economic growth plays in driving households' land-use decisions.

Interestingly, the review reveals that very few studies on the micro-level drivers of land use-change have been conducted on Asian countries between the years 2000 and 2015. This is surprising, considering the high rates of conversion from forest land to large-scale agricultural land (plantation farming) that has recently characterized South East Asian countries (Elz et al., 2011; Miettinen et al., 2011; Sodhi et al., 2004). It indicates that an important dimension of the literature is still missing, namely, how large-scale land conversions determine smallholders' land use decisions. As noted in Chapter 2, smallholders in Zambia increase their area cultivated if they are in the same region as a large-scale farm. Moreover, Chapter 5 shows that large-scale farms affect smallholders' land tenure security, which has been identified as one of the main drivers of land-use decisions in Chapter 6. We therefore conclude Chapter 6 by providing several recommendations for future research including one that calls for more research that analyses the micro-level drivers of land-use change in the light of large-scale land investments particularly in the form of farming and logging.

1.5 Contribution to the literature

The chapters presented in this dissertation address several empirical gaps and provide a number of novel contributions to the existing literature.

Chapter 2 is the first study to combine a systematic geographic analysis of the locations of large-scale farms with an empirical analysis of the impacts of large-scale farms on smallholders' agricultural outcomes. This combination allows for a more meaningful interpretation of the results from the impact study as it provides detailed information on the context in which farms operate.

Chapter 3 and 4 are the only studies we are aware of, that go beyond analyzing directly observable effects of large-scale farms on smallholders. The results from these studies make the case for a more comprehensive analysis of the impacts of large-scale farms on smallholders that do not only end at agricultural productivity, but also include more nuanced impacts that cannot be captured by conventional household survey methods. Analyzing both the direct and indirect impacts is a fundamental step required to make evidence-based policy decisions.

Moreover, despite large-scale farms and their impact on smallholder tenure security being a highly contentious topic, prior to the work presented in Chapter 5, no other study had investigated this link empirically. Furthermore, although this is a fairly common phenomenon, there is very little if any empirical research that analyzes how smallholders are affected by the failure or closure of large-scale farms. The work presented in Chapter 5 is intended to highlight the importance of not only addressing the impacts of large-scale farms that are operational, but also of questioning what happens to smallholders in the event that large-scale farm projects do not come into execution.

Finally, Chapter 6 builds on a well-established literature by providing a systematic overview and meta-analysis of the drivers of smallholders' land-use change decisions. The novelty of this chapter is that it does not only focus on the conversion of forest land to agricultural land through deforestation but instead introduces a matrix of assorted land-use conversions. In addition, it is one of the first works to solely focus on the drivers of households' land-use decisions at the micro-level thereby bringing new insights to the literature.

1.6 Suggestions for future research

Our recommendations for further research are multi-method because this dissertation employs a number of analytical tools. First, we recommend that more precise geospatial data that includes the location and changes in farm sizes are collected using satellite imagery. Such data would allow for more accurate spatial analysis on the impacts of large-scale farms. In addition, it would also enable more detailed analyses that integrate the changes in land-use and farm-size of smallholder, medium- and large-scale farms. Access to detailed geospatial data would also be useful in extending the research presented in Chapter 2, to include spatial measures that can be used to estimate whether the impacts of large-scale farms on smallholders are larger with increasing proximity to the farms.

Second, we suggest that studies that further analyze the impacts of large-scale farms on smallholders do so within a panel-dimension setting to enable greater causal inferences. The lack of smallholder panel data that was collected before and after the establishment of large-scale farms in Chapters 2, 3 and 4 prevent us from making strong causal statements which is a key requirement for meaningful impact analyses. Data that follows the same smallholders through the various project phases and that collects information on the changes in infrastructure, employment opportunities, tenure security, soil quality and other environmental factors would be ideal. Moreover, panel data on the indirect impacts of large-scale farms on smallholders, such as the ones presented in Chapters 3 and 4, is necessary to provide a whole picture of the impacts of these farms on smallholders.

Third, we recommend that more research should be conducted that analyses how the externalities imposed by large-and medium-scale farms affect smallholders' land-use decisions. Such research is especially pertinent in light of the results that show that large-scale farms set up in the vicinity of smallholder communities increase smallholders' area cultivated (Chapter 2) and affect their tenure security (Chapter 5). We expect large- and medium-scale farms to accelerate the process of smallholder land intensification that has already been observed in a number of studies (Jayne et al., 2014 and Binswanger-Mkhize and Savastano, 2018), because growing demographic pressures hinder smallholders' ability to expand their area cultivated. However, more research is needed to investigate this further.

Lastly, we suggest that as the number of studies that analyze the impacts of large-scale farms on smallholders increase, carefully executed meta-analyses and systematic reviews should be conducted to compare these impacts across several study settings and contexts. Synthesizing the empirical studies that analyze the impacts of large-scale farms on smallholders in a comprehensive meta-analysis will provide a better overview of the main impacts of large-scale farms identified across different study contexts.

2 Large-scale farms and smallholders: Evidence from Zambia[ζψ]

2.1 Introduction

Large-scale agricultural investments (LSAIs) gained international prominence in the early 2010's when they were depicted as 'land grabs' by the media and some civil society organizations. These reports highlighted the opaque acquisition processes and adverse impacts on surrounding local communities (Cotula et al., 2009). Since then, several scholarly works have addressed the impacts and spill-overs of LSAIs on neighboring smallholders through case studies.[3] While these case studies have provided important insights into individual LSAIs and have therewith furthered the debate on the impacts of LSAIs, they are often too specific and lack external validity beyond their study regions.

More recently, a new literature that goes beyond case studies to provide systematic evidence of the impacts of LSAIs on smallholders at the national or regional level has emerged. For instance, Deininger and Xia (2016) combine information on the location and start date of large farms with smallholder surveys to quantitatively assess spillover effects from large land-based investments in Mozambique. Ali et al. (2017) conduct a similar analysis based on a large farm census and smallholder surveys in Ethiopia, while Herrmann (2017) looks at household income and income poverty of out-growers, wage

[ζ] This chapter has been co-authored with Kerstin Nolte and Jann Lay. It is an updated version of the AGRODEP Working Paper 0011 titled *The impact of foreign large-scale land acquisitions on smallholder productivity: Evidence from Zambia* that has been co-authored with Jann Lay.

[ψ] This work was supported by the German Federal Ministry of Economic Cooperation and Development (BMZ), (project "Large-Scale Land Acquisitions: Data, Patterns, Impacts, and Policies") and the African Growth and Development Policy Modeling Consortium (AGRODEP) (2012 GAPS IN RESEARCH GRANT).

[3] For recent literature reviews and meta-analyses of these case studies, refer to Oberlack et al. (2016) and Schoneveld (2016) for meta-analyses of some of these case studies.

employees and non-participants of LSAIs in Tanzania. Ahlerup and Tengstam (2015) use three waves of panel data to analyze how large-scale farms affect smallholders' wage incomes at the district level in Zambia.

This chapter provides an innovative contribution to this literature with a context-sensitive quantitative study. We combine a systematic analysis of the geographic characteristics of wards that host large-scale farms with a differences-in-differences and fixed effects analysis of the impacts of large-scale farms on smallholders' agricultural outcomes for Zambia. Zambia is particularly interesting for our study as it has a long history of large-scale farms that have co-existed alongside smallholder communities (Chu, 2013). However in recent years, similar to many other developing countries, Zambia has experienced a sudden increase in the demand for land to be used for large-scale agricultural purposes. The Land Matrix estimates that 26 deals that cover an area of 389,774 hectares have been concluded since 2000 (Harding at al., 2016).[4]

This chapter contributes to the literature in three ways: First, the detailed assessment of the large-scale farm sector in Zambia and the study of the geographical context provides a comprehensive image of large-scale agriculture in Zambia and challenges some of the commonly held perceptions surrounding these farms. Second, our study is the first to assess the impacts of large-scale farms on agricultural outcomes of smallholders in Zambia. In addition, it covers a larger time-span than earlier studies; and uses a difference–in-differences analysis with fixed effects for wards, which are the smallest administrative unit in Zambia. Finally, the combination of the analysis of the geographic context with a quantitative impact assessment allows for a meaningful interpretation of the results from the impact study as it is based on a thorough understanding of the context in which farms operate. This link between the locations of large-scale farms and the impacts of these farms on surrounding smallholders was lacking in previous studies

[4] The Land Matrix is a database that provides information on land acquisitions that cover areas larger than 200 hectares and that have been set up after the year 2000. It is a partnership between the International Land Coalition, Centre de Coopération Internationale en Recherche Agronomique pour le Développement, the Centre of Development and Environment at the University of Bern, the German Institute of Global and Area Studies and the GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH).

The results from the geographic analysis nicely highlight the importance of access to infrastructure and the agglomeration of farms in certain regions. The regression results show that smallholders' farm sizes increase in wards with large-scale farms. This could be indicative of the fact that smallholders increase their production at the extensive margin or may be a result of increasing trend of land consolidation in Zambia. Moreover, we find a reduction in fertilizer usage and an increase in maize yields in wards with large-scale farms. While the results on fertilizer are difficult to interpret in the Zambian context where government subsidy programs simultaneously affect smallholder fertilizer use, the increase in yields are indicative of increasing smallholder productivity at the intensive margin.

The remainder of this chapter is structured as follows. The second section presents the data used for the analysis. In section 2.3, we provide a descriptive overview of large-scale farms in Zambia and analyse the local geographical contexts of wards that host large-scale farms. In section 2.4, we analyse the impacts of large-scale farms on smallholders, in particular, we discuss the hypotheses, the estimation strategy, econmetric considerations, the results and robustness checks . The final section discusses our results and concludes.

2.2 Data

To analyze the impacts of large-scale farms on smallholders' agricultural outcomes over time, we combine several datasets that provide us with large-scale farm, spatial and smallholder information.

The large-scale farm data is obtained from the Post-Harvest Survey (PHS) for Large-scale Agricultural Holdings, which is a census on all large-scale farms (defined as farms that are above 20 hectares) collected by the Zambian Central Statistical Office (CSO). The large-scale farm data contains information on the crops grown, area cultivated and harvested, fertilizer used, livestock reared and the value of sales (CSO, 2004). In 2013/2014, a total of 1,102 large-scale farms were surveyed, out of which we use a subset of 834 large-scale farms that cultivate crops and are owned by non-state actors.[5] We collaborated with CSO to include additional questions in the 2013/2014 PHS on Large-Scale Agricultural Holdings. The questions gathered information on the year in which the large-scale farms were established (i.e. the year land was acquired and the year that cultivation started); the development of large-scale farm sizes over time (i.e. the size of the farm upon acquisition, the farm size five years ago, the farm size at the time of the survey); the location of the farm (i.e. in which ward the farm is located); as well as on the countries of origin of the large-scale farm owners.

The spatial datasets that provides us with information on ward boundaries, land cover, railroad infrastructure, cities and irrigation data are obtained from CSO's Cartography and Mapping Department, the Global Land Cover database, the Digital Chart of the World, the U.S. National Imagery and Mapping Agency, and the Global Map of irrigation areas, respectively. Ward-level poverty estimates are obtained from the World Bank (de la Fuente et al., 2015) and the ward population data is obtained from CSO.

The smallholder data is obtained from the PHS for Small and Medium Sized Agricultural Holdings that is collected by the CSO and the Ministry of Agriculture and Livestock. The PHS on Small and Medium Sized Agricultural Holdings are nationally representative cross-sectional surveys that contain information on household head characteristics, assets, livestock holdings, the use of agricultural inputs as well as the amount of crops cultivated, harvested, and sold. The surveys are collected annually between August and September, after the crop harvest period has ended (Megill, 2004).

A two stage sampling procedure is used to select the households interviewed in the surveys. In the first stage, Standard Enumeration Areas (SEAs) are selected using probability proportional to size sampling methods. In the second stage, the households are stratified by farm size categories, the number of livestock and poultry and the

[5] Our main focus is on large-scale farms that engage in crop cultivation thus we exclude large-scale farms engaged in animal husbandry for the analysis. We also exclude institutional large-scale farms that are owned or managed by schools, prisons and other state facilities.

cultivation of special crops.[6] Sampling is based on the sampling frame of the current National Census of Housing and Population, and is updated when a new census is collected (Megill, 2004). We use seven cross-sections of the PHS on Small and Medium Sized Agricultural Holdings collected for the years 2002/2003, 2003/2004, 2004/2005, 2005/2006, 2010/2011, 2011/2012, and 2012/2013.[7] The first five surveys are collected using the sampling frame of the 2000 National Census of Housing and Population while the 2011/2012 and 2012/2013 surveys are based on the sampling frame of the 2010 National Census of Housing and Population. This data covers farms with a size of up to 20 hectares. Table 2.A.1 in the appendix shows the size distribution of these farms and highlights a clear trend of increases in larger farm sizes.

In the sampling frame of the 2000 National Census of Housing and Population, Zambia was subdivided into 1,286 wards which later increased to 1,421 wards in the 2010 sampling frame. The increase in the number of wards was driven by the partitioning of Northern Province into Muchinga and Northern Province in 2011. This partitioning resulted in the need to redraw several wards that cut across the boundaries of the new province. In addition, the ward boundaries were also redrawn to facilitate the work of the Electoral Commission of Zambia who held several local government elections in the period between the two censuses.[8]

The ward-level is crucial for our analysis: we investigate the geographical context on the ward-level and we link large- and small-scale farms via the location. In order to create a ward panel that accounts for the changes in the ward boundaries over time, we used the

[6] The PHS on Small and Medium Sized Agricultural Holdings identifies eight crops (sorghum, rice, cotton, burley tobacco, virginia tobacco, sunflower, soybeans and paprika) that receive special attention in the sample to ensure a representative distribution of crops and to improve the precision of crop area and production estimates (Megill, 2004).

[7] We take the 2003/2004 dataset as the base year for our analysis as ward-level information is not available for earlier PHS on Small and Medium Sized Agricultural Holdings. In 2006/2007, the PHS on Small and Medium Agricultural Sized Holdings did not include a module on the households' asset holdings. In 2007/2008, the PHS was not collected and a few questions on smallholders' harvest were included into the Crop Forecast Survey. The 2008/2009 and 2009/ 2010 PHS were not collected due to a lack of funding by the government. Thus we exclude the 2006/2007, 2007/2008, 2008/2009 and 2009/2010 PHS on Small and Medium Sized Holdings from our analysis as the datasets are incomplete or inexistent.

[8] The explanations behind the change in ward boundaries were provided by cartographers and census planners at CSO who were interviewed by one of the authors in February, 2014.

ward shapefiles provided by CSO to create a panel that only consists of wards whose boundaries have remained constant across the two sampling frames and wards whose boundaries have changed in a consistent and a systematic manner for the same period. Under the latter, we consider those wards whose boundaries have either been split or merged in 2010 and can easily be reconstructed to their 2000 boundaries.

Since the main focus of the study is to analyze the impacts of large-scale farms on smallholders in rural regions, we excluded all wards that are located in urban areas. We also excluded wards that were included in the PHS on Large-scale Agricultural Holdings but not in the PHS on Small and Medium Sized Agricultural Holdings. These restrictions result in a final panel of 439 wards, out of which 70 wards played host to a large-scale farm in 2003, and 87 in 2013. The ward panel is matched with the PHS on Small and Medium Sized Agricultural Holdings that contains data on 27,109 households that are unevenly distributed across the seven survey periods.

2.3 Large-scale agricultural farms and their host regions

In this section, we analyze the characteristics of large-scale farms and the wards that host them. Providing a descriptive overview of large-scale farms in Zambia and analyzing their geographical contexts, we question whether some of the commonly held perceptions about large-scale farms hold for Zambia. More specifically, we use the data introduced in the previous section to shed light on the origin of large-scale farm investors, the duration of large-scale farm investments and the determinants of their locations.

Who is investing in Zambian large-scale farms?

Many studies have linked the recent demand for large-scale agriculture with the aftermath of the 2007-2008 food price crisis (see for instance, De Schutter, 2011). They argue that the crisis led governments of industrialized nations to outsource food production to land abundant developing countries. At the same time, food-importing, resource constraint countries such as the Gulf countries found it attractive to partner with low-income and land abundant countries for the production of food (De Schutter, 2011).[9]

Table 2.1. Countries of origin of large-scale farm investors

Country	Freq.	Percent	Hectares
Australia	1	0.12	31
China	4	0.48	1,405
Cyprus	1	0.12	800
Denmark	1	0.12	1,080
Germany	3	0.36	32,572
Greece	4	0.48	8,191
India	5	0.59	6,635
Ireland	2	0.24	1,945
Italy	6	0.71	8,665
Kenya	1	0.12	400
Netherlands	7	0.83	10,467
New Zealand	1	0.12	1,371
Nigeria	1	0.12	400
Singapore	3	0.36	4,597
South Africa	25	2.97	35,755
Tanzania	3	0.36	3,220
United Kingdom	26	3.09	39,808
United States	4	0.48	1,698
Zambia	705	83.83	340,232
Zimbabwe	38	4.52	31,287
Total	841	100	530,559

Source: Authors own based on the 2013/2014 PHS on Large-Scale Agricultural Holding
Note: Table 2.1 reports all countries that operate large-scale farms in Zambia. Seven large-scale farms that are jointly owned by two countries are reported more than once. This raises the total number of foreign owned farms to 841 from 834.

Table 2.1 shows the countries of origin of large-scale farm investors in Zambia, the number of large-scale farms under operation per country and the total area cultivated by these large-scale farms. We find that 84 percent (705) of the large-scale farms in Zambia are operated by Zambian investors. This does not match the widely held perceptions that foreign investors from industrialized nations dominate the large-scale agricultural sector but instead renders partial support to the growing evidence on emerging medium-scale

[9] The questionnaire asks for the "country of origin of owner of the farm". Given that some large-scale farms owned by foreign investors may be registered under a Zambian subsidiary company, the numbers reported for Zambian large-scale holdings may be overestimated.

farmers in Zambia. Large-scale farmers from countries within the southern African region, i.e. Zimbabwe and South Africa, also account for a significant share of large-scale farm investments. Not surprisingly, the country's colonial history attracts a large number of investors from the United Kingdom, which has the third highest number of large-scale farms in the country.

Taking a look at the total amount of hectares cultivated per country, it is clear that the countries with the highest number of large-scale farms also cultivate large amounts of land.[10]

Have large-scale farms increased their presence over time?

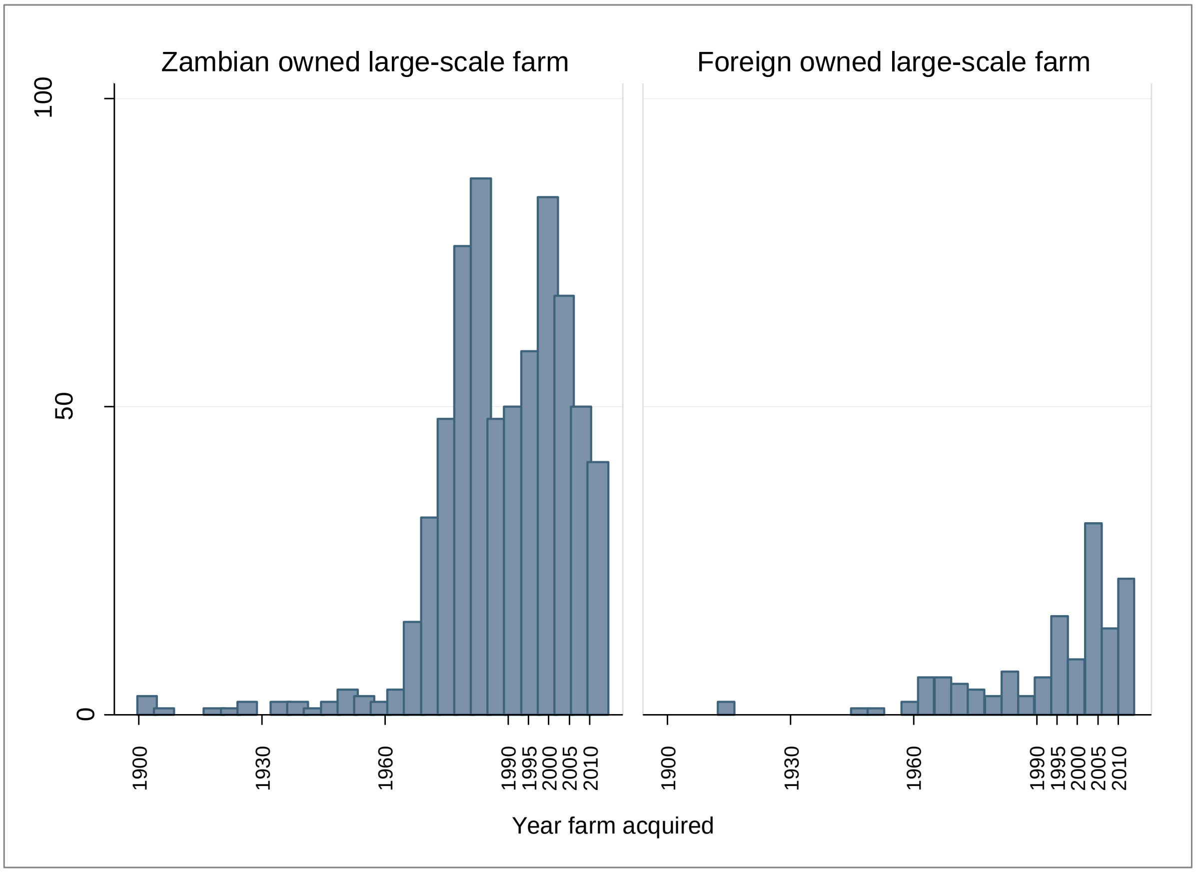
In Figure 2.1, we distinguish between Zambian and foreign owned large-scale farms to show the years in which these farms were acquired. The graph provides several interesting insights. First, it confirms that large-scale farms have had a long history in Zambia. The oldest large-scale farms were established in the early 1900s. Second, it illustrates that three key political and economic changes have influenced the number of large-scale farms in Zambia. First, in the years following Zambia's attainment of independence from the United Kingdom in 1964, the Zambian government pursued strong nationalization policies such as the Land (Conversion of Titles) Act in 1975 that aimed to increase the engagement of indigenous Zambians in the agricultural sector. The Act vested all land in the President, who held it in perpetuity for the people of Zambia (Adams, 2003). This post-independence period coincides with the first spike in Zambian-owned large-scale farms that occurred in the late 1970's.

Second, in the late 1990's, both Zambian and foreign owned large-scale farms increased significantly. This increase was driven by the adoption of the Land Act of 1995 that allowed foreign investors to acquire land in Zambia via leasehold (Nolte, 2014). The last spike in large-scale farms occurs after the year 2010 for foreign-owned large-scale farms.

[10] The exception being Germany that only has three large-scale farms in Zambia but cultivates 32,572 hectares Amatheon Agri, a German owned large-scale farm that acquired 30,000 hectares in Mumbwa, accounts for the bulk of land cultivated by large-scale farm investors from Germany.

This confirms that foreign large-scale investments have indeed increased their presence in Zambia in the years following the 2007-2008 food price crisis.

Figure 2.1. Large-scale farm acquisitions over time



Source: Authors own based on the 2013/2014 PHS on Large-Scale Agricultural Holdings.

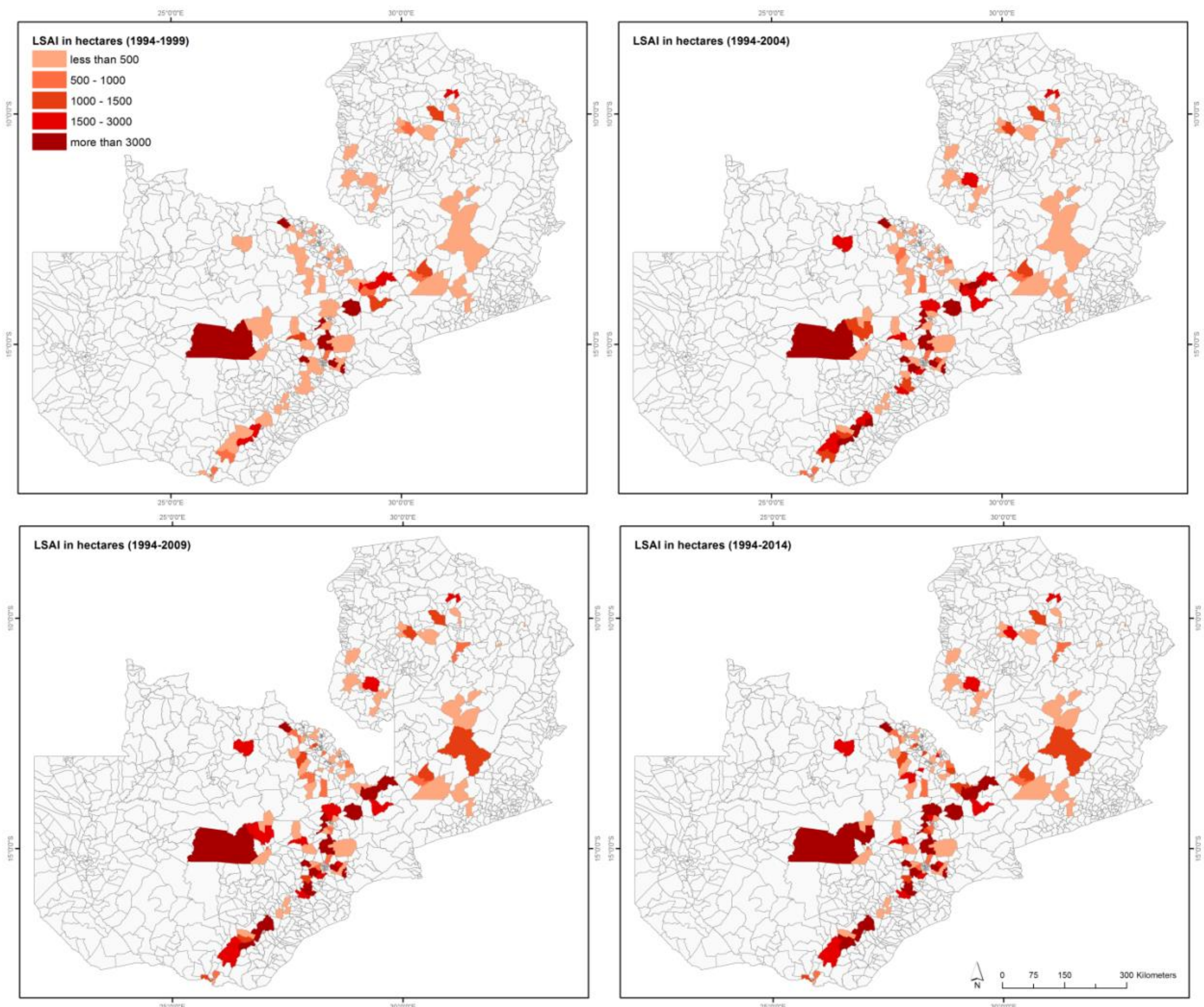
Where are large-scale farms located?

Figure 2.2 shows the wards that have hosted large-scale farms since 1995.[11] The larger the area that is under cultivation by large-scale farms, the darker the ward is shaded. We show the cumulative development of the area cultivated over time, with the first map in the top left corner covering the period between 1994 and 1999 and the next maps illustrating five year intervals until 2014.

[11] The Land Act 1995 is a crucial event in Zambia, a new era for commercial farms in Zambia. We hence consider all farms as of 1995 to be part of this new wave of commercialization. See Nolte (2014) for a detailed account of how the Land Act 1995 fostered foreign large-scale investments.

As can be seen in the map, large-scale farms are only concentrated in a few wards in Zambia. Moreover, one can see that most new large-scale farms are located in wards that already had large-scale farms prior to 1995. This hints at the agglomeration of large-scale farms in certain wards. To better understand this non-random distribution, we undertake an analysis of the wards that host large-scale farms using various spatial datasets.

Figure 2.2. Location of large-scale farms

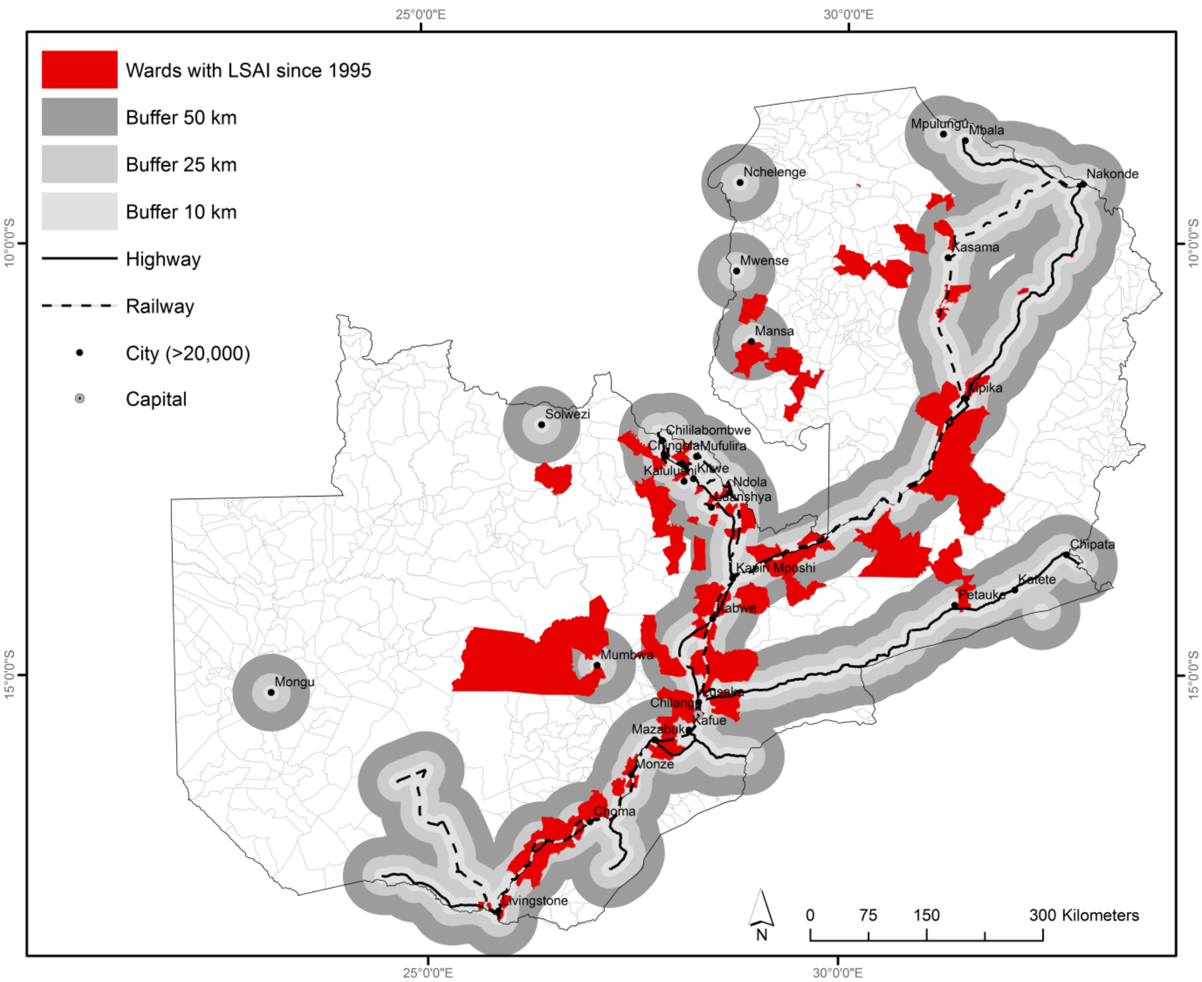


Source: Own display based on data from CSO PHS for large-scale holdings 2013/2014.

Does infrastructure influence the location of large-scale farms?

The areas shaded grey in Figure 2.3, illustrate three buffers (10, 25 and 50 km) between wards with large-scale farms, important transport infrastructure (main roads and railway routes) and urban centers (cities with more than 20,000 inhabitants).[12]

Figure 2.3. Large-scale farms and infrastructure.



Source: Own display based on data from the Digital Chart of the World (roads and railroads), and the U.S. National Imagery and Mapping Agency (cities) with cross-checking recent population sizes at http://www.citypopulation.de/Zambia-Cities.html.

[12] Sitko and Chamberlin (2016) use a travel-time model to estimate market access which shows similar patterns to the buffer areas. We opted for this simplified approach as we look at wards, i.e. larger polygons instead of exact coordinates. This display is meant to provide a rough overview on accessibility in Zambia. We use three different buffers (10, 25 and 50 kilometers) to show different degrees of access.

In addition, we calculated the Euclidian distance between the nearest point of a ward with a large-scale farm and a) a highway (mean: 43.9 km) b) a railroad (mean: 43.3 km) and c) a city with more than 20.000 inhabitants (mean: 42.7 km).

Considering the shortest distance to one of these infrastructural features only, the distance to a ward that hosts a large-scale farm is 24.5 km on average whereas the distance to wards without large-scale farms is 64 km on average. We can see both from the map and the average distance that with a few exceptions, wards targeted by large-scale farms are relatively close to main transport infrastructure and/ or urban centers.

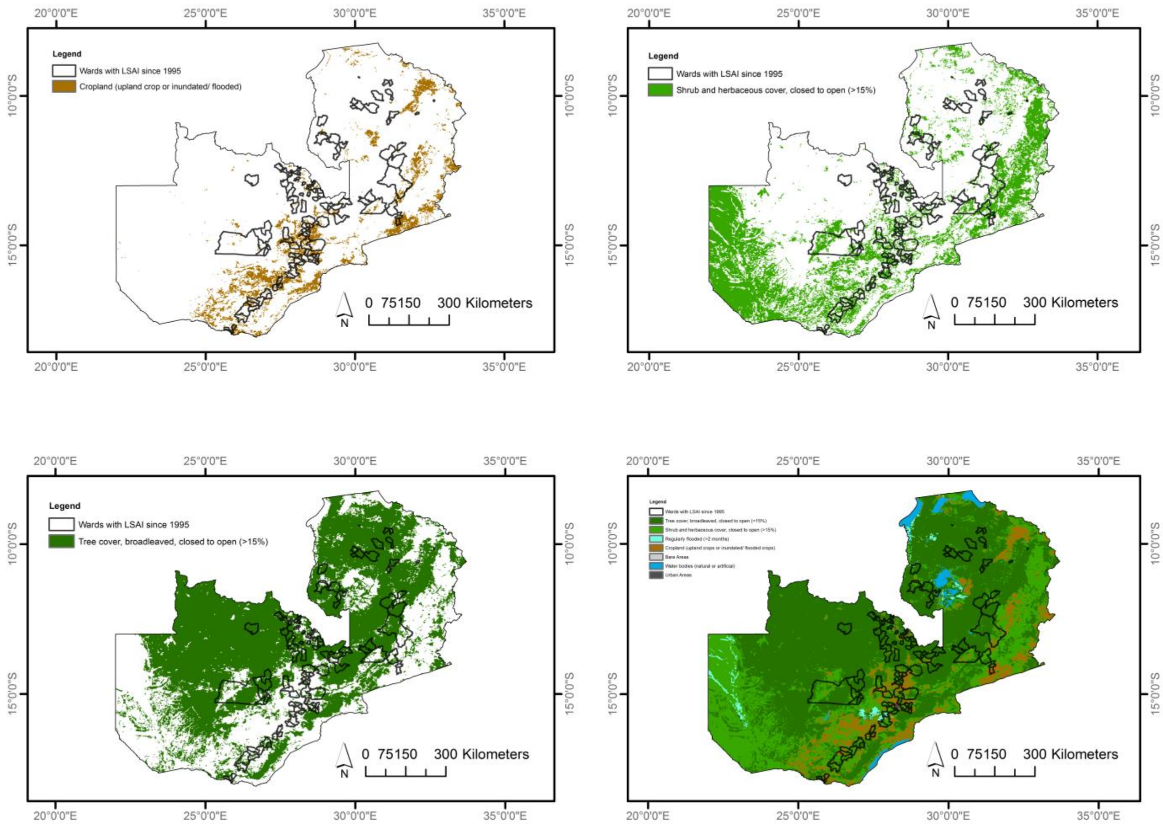
Does the idle land narrative hold for Zambia?

A number of studies have established that large-scale farms are not located on 'idle land' as was previously reported (Messerli et. al. 2014). We examine whether this growing consensus on large-scale farm location and idle land is also valid for Zambia by looking at the main land-cover of wards with large-scale farms in the year 2000.[13]

Starting from the top right of Figure 2.4 and moving in an anti-clockwise manner, we superimpose the boundaries of wards with large-scale farms (outlined in black) over maps of: cropland cover; shrub and herbaceous cover; and tree cover. The map in the bottom right corner combines all three land-covers. One can see that all three types of land-cover are present in wards that host large-scale farms. Cropland is most frequent along the line of rail and coincides with large-scale farm presence. Thus, most wards targeted by large-scale farmers already had cropland in 2000. One striking observation is that many of the wards that host large-scale farms were largely covered by trees in 2000. This hints at the scale of deforestation that occurs when land is prepared for farming activities and at the same time a loss of income for local communities since forest land is a source of firewood and non-timber forest products.

[13] The year 2000 is selected as the start data due to data availability.

Figure 2.4. Land cover and large-scale farms



Own display based on data from GLC 2000 (resampled by DIVA-GIS onto a 30 seconds grid).

Do agro-ecological conditions determine the location of large-scale farms?

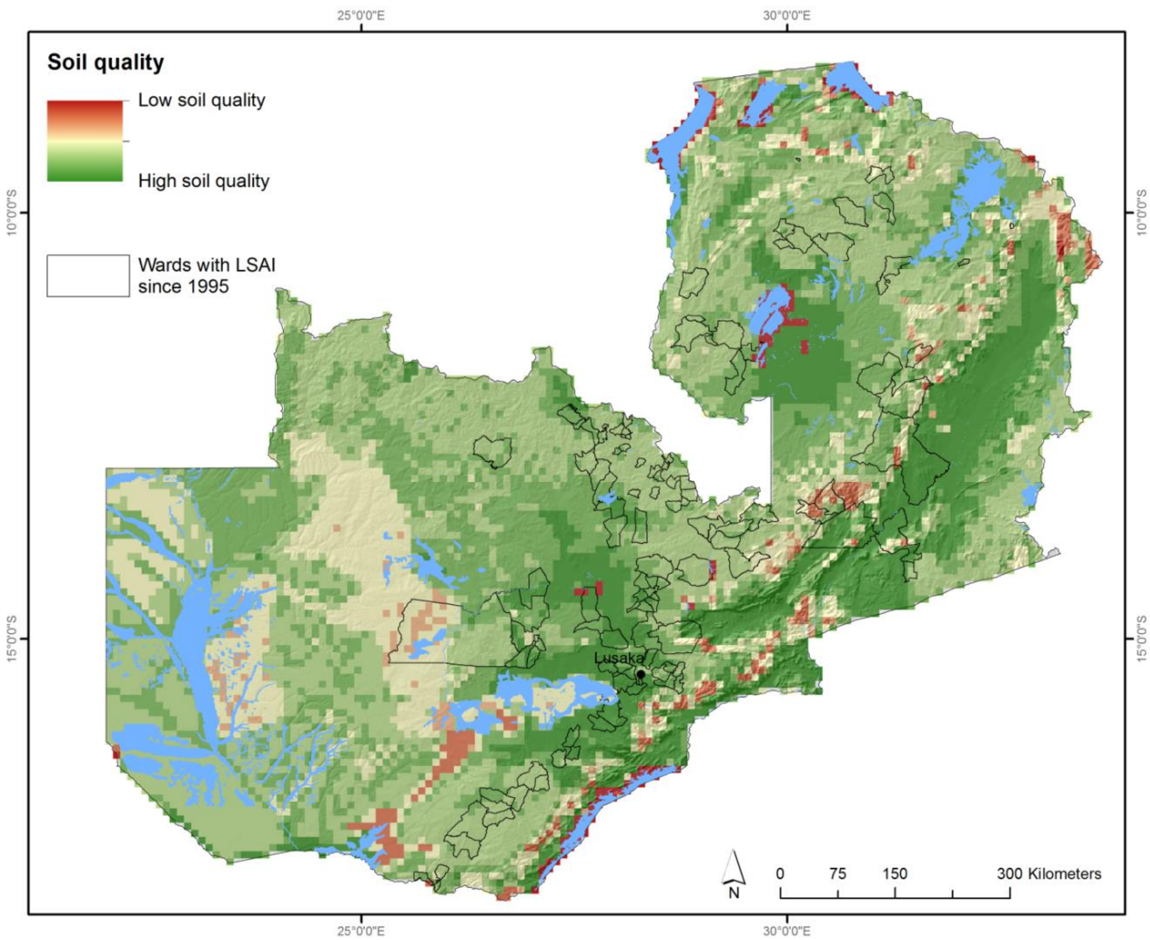
Arezki et al. (2015) show that agro-ecological potential is one of the major determinants of land based investment. In Figure 2.5, we investigate whether wards that host large-scale farms have better soil quality than wards without such farms.

To construct a measure of soil quality we combine the seven soil characteristics that have been identified as being good for crop production by the Harmonized World Soil Database.[14] The map shows the mean soil quality values, with the green cells indicating high soil quality and the red cells indicating low soil quality. From Figure 2.5, it is easy to

[14] The seven soil characteristics are 1) nutrient availability, 2) nutrient retention capacity, 3) rooting conditions, 4) oxygen availability to roots, 5) excess salts, 6) toxicity, and 7) workability. For further information, please refer to: http://webarchive.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/SoilQuality.html?sb=10. All soil classes are scaled between 1 and 7. We add up all values for the seven individual soil classes and divide this by seven so that our result is equally scaled between 1 and 7. A value of 7 indicates the best soil quality and 1 very low soil quality.

see that the majority of wards with large-scale farms are located in regions with high soil quality. Sitko et al. (2015: pp. 12) show that the southern part of Zambia has the highest variation in intra- and inter-seasonal rainfall and is also the driest part of the country.

Figure 2.5. Soil quality and large-scale farms.



Own display based on the Harmonized World Soil Database from IIASA and FAO (Fischer et al., 2008).

Interestingly, our data shows that wards targeted by large-scale farms are located both in the Northern and the Southern parts of Zambia. Thus we assume that historical legacy plays out: European settler agriculture occurred in the Southern parts of Zambia (Sitko et al., 2015:12) and thus investors today might prefer regions with a tradition in large-scale farming despite the rainfall patterns not being ideal.

Do smallholders' socio-economic characteristics determine the location of large-scale farms?

Differences in the socio-economic characteristics of smallholders living in wards with large-scale farms may determine the location of large-scale farms. For instance, if a large-scale farm is labor intensive, the large-scale farm owners may decide to set up their farm in densely populated areas where they are assured that labor is readily available.

Table 2.2 compares the socio-economic characteristics of wards that host large-scale farms with those that do not host such farms. The population in wards with large-scale farms is significantly higher than in wards without large-scale farms for both the years 2000 and 2010 when national census data was collected. The poverty head count is also larger in wards that host large-scale farms. However, there are no significant differences in population density and the incidence of poverty across these wards.

Comparing smallholder households in wards with and without large-scale farms for the years 2002/2003, 2003/2004, 2004/2005, 2005/2006, and the years 2010/2011, 2011/2012, 2012/ 2013, we observe that there are many statistically significant differences across the socio-economic characteristics of smallholders. These results are reported for the years 2003-2006 and 2011-2013 in the lower panels of Table 2.2.[15] In both time periods, smallholder households in wards with large-scale farms tend to be larger than those without large-scale farms. In addition, households in wards with large-scale farms in 2003-2006 have significantly larger areas under cultivation, grow more cash crops, apply more fertilizer and have higher maize yields.

[15] For the sake of brevity, these two periods will henceforth be referred to as 2003 to 2006 and 2011 to 2013. Survey data from the years 2006/2007, 2008/2009 and 2009/2010 which coincide with the global food price crisis are not reported due to the reasons outlined in section 2.2.

Table 2.2. Ward and smallholders' socio-economic characteristics

	Ward socio-economic characteristics				
	Wards with large-scale farms		Wards without large-scale farms		
	Mean	SD	Mean	SD	p-value
Population 2000	10386.64	5866.03	6821.23	4116.14	0.00
Population 2010	12709.86	7181.67	8367.11	5643.20	0.00
	28.04	24.28	31.02	62.89	0.32
Number of poor 2010	10593.89	6088.28	6739.76	4059.90	0.00
Poverty headcount 2010	0.78	0.11	0.81	0.12	0.09
Observations	28		323		
	Smallholder socio-economic characteristics (2003-2006)				
	Wards with large-scale farms		Wards without large-scale farms		
	Mean	SD	Mean	SD	p-value
Age of household head	45.69	14.87	44.95	14.88	0.07
Years of schooling of household head	8.27	5.01	8.62	5.29	0.17
Number of household members	6.88	3.49	6.52	3.13	0.01
Household grows cash crops (dummy=1 if yes)	0.11	0.31	0.07	0.25	0.00
Total fertilizer used per hectare (in kg)	54.12	104.31	48.82	128.23	0.01
Maize harvest (kg)	2003.31	4578.58	1492.63	3053.57	0.00
Maize yield	1310.81	918.18	1455.65	990.61	0.00
Household asset index	0.17	0.18	0.13	0.14	0.00
Hectares cultivated by household	2.42	2.60	1.91	1.87	0.00
Hectares cultivated by household for maize	1.22	1.45	0.95	1.16	0.00
Hectares cultivated by household for staple crops	0.18	0.43	0.27	0.64	0.00
Hectares cultivated by household for cash crops	0.65	1.24	0.31	0.76	0.00
Share of small farms (<1.42 hectares)	0.45	0.50	0.52	0.50	0.00
Share of big farms (1.42 to 20 hectares)	0.55	0.50	0.48	0.50	0.00
Observations	1,107		9,158		

	Smallholder socio-economic characteristics (2011-2013)				
	Wards with large-scale farms		Wards without large-scale farms		
	Mean	SD	Mean	SD	p-value
Age of household head	44.95	14.89	44.80	14.51	0.73
Years of schooling of household head	4.77	3.97	4.51	3.89	0.04
Number of household members	7.15	3.66	6.56	2.99	0.02
Household grows cash crops (dummy=1 if yes)	0.20	0.40	0.09	0.29	0.00
Total fertilizer used per hectare (in kg)	120.33	140.36	125.51	155.46	0.59
Maize harvest (kg)	4528.63	7635.83	2900.69	5369.45	0.70
Maize yield	1758.47	1148.64	1804.21	1214.61	0.21
Household asset index[16]	0.21	0.20	0.14	0.14	0.00
Hectares cultivated by household	3.30	3.02	2.16	2.23	0.00
Hectares cultivated by household for maize	2.04	2.20	1.33	1.58	0.00
Hectares cultivated by household for staple crops	0.03	0.24	0.13	0.52	0.00
Hectares cultivated by household for cash crops	0.72	1.06	0.26	0.67	0.00
Share of small farms (<1.42 hectares)	0.30	0.46	0.48	0.50	0.00
Share of big farms (1.42 to 20 hectares)	0.70	0.46	0.52	0.50	0.00
Observations	1.321		11.015		

Sources: Population and population density from CSO ward shapefiles, poverty headcount from de la Fuente (2015). The poverty head count is the proportion of the population that lives below the national poverty line which is valued at the cost of the national food basket in 2010 (ZMW 96,366) All other data is sourced from the PHS on Small and Medium Sized Agricultural Holdings.

[16] The asset index is constructed from a linear index of households' physical assets whose weights have been obtained using a principal components analysis. It includes the household's ownership of assets such as ploughs, harrows, tractors, ox-carts, vehicles, water pumps, cattle and livestock.

Moreover, these households own more assets and have a higher share of farms that are larger than the median smallholder farm of 1.42 hectares. Interestingly, we observe that smallholders in wards without large-scale farms not only catch up with regards to fertilizer use but even exceed the amount of fertilizer used by smallholders in wards with large-scale farms in 2011-2013.This high amount of fertilizer usage is not commensurate with maize yields, as maize yields tend to be higher in wards without large-scale farms.

Examining the trends over time, we observe a drastic increase in fertilizer use and maize harvest. We further observe that both smallholders in wards with large-scale farms and smallholders in wards without large-scale farms increase the area that they cultivate. A striking insight concerns the share of small and big farms (we compare smallholders that are smaller and larger than the median farm size of 1.42 hectares): while the share of big farms increases for both sets of smallholders between the two time periods, the increase in wards with large-scale farms is particularly striking as we remain with only 30 percent of farms below 1.42 hectares.

A first descriptive overview on large-scale farms in Zambia and the analysis of local geographical contexts shows that some of the commonly held perceptions do not hold for Zambia: we observe that large-scale farms are not located on idle land but in wards that are well connected to infrastructure, that already have some land under large-scale cultivation and that have significant amounts of tree cover and good soil quality. In addition, we discover that smallholders in wards hosting large-scale farms tend to have larger farms, focus more on cash crops and have higher yields than their counterparts in wards without large-scale farms. Over time, we see huge increases in fertilizer use and yields in both types of wards. Strikingly, the share of small farms decreases at a rapid rate in wards hosting large farms.

2.4 Effects of large-scale farms on smallholder households

2.4.1 Hypotheses

In this section we derive three main hypotheses that are based on the literature on the impacts of large-scale farms on surrounding smallholder communities. First, we are interested in examining how the presence of large-scale farms in a ward affects the area cultivated by smallholders. If smallholders do not have legally recognized land rights, the arrival of large-scale farms within their community may be accompanied by a heightened sense of uncertainty, land scarcity or tenure insecurity (Cotula, 2011; Sipangule, 2017). The area cultivated by smallholders may be negatively affected by the presence of large-scale farms if large-scale farms displace smallholders and/ or if they heighten land scarcity and tenure insecurity. We would therefore expect a negative relationship between large-scale farms and smallholders' area cultivated (H1: a).

For the case of Mkushi in Central Zambia, Chu (2013) shows that large-scale farm investors prefer to acquire titled state land within already established commercial farming areas over displacing smallholders from communal land. This suggests that in many cases, large-scale farms do not expand to smallholder land. This in turn, limits the negative effects on smallholder area cultivated as outlined in hypothesis H1: a. Taking these considerations into account, we posit that if large-scale farms acquire land from markets that are not accessible to smallholders, the expansion of large-scale farms in a ward will not affect the area cultivated by smallholders. Thus we do not expect an effect on smallholders cultivated area (H1: b).

Lastly, large-scale farms may speed up the existing trend of land consolidation (Jayne et al., 2014; Jayne et al., 2016) and contribute to an expansion in the area cultivated by smallholders. Matenga and Hichaambwa (2017) provide evidence for this in a study where they compare a large-scale plantation, a medium to large-scale commercial farming area and an out-grower scheme that supplies sugarcane to a large-scale farm for processing. They find that the out-grower scheme leads to the agglomeration or pooling of family land into consolidated land blocks. For the case at hand, we expect that if some smallholders reduce their area cultivated and medium-scale farmers expand, the average area cultivated by smallholders would rise. Furthermore, if the presence of large-scale farms in a ward results in positive spill-overs for smallholders, smallholders may respond to these spill-overs by increasing their area cultivated (H1: c).

The effects outlined in our threefold hypothesis could be occurring simultaneously, thus making the direction of the net effect on smallholders' area cultivated dependent on which effect (H1: a, H1: b or H1: c) is more dominant.

Second, we test whether the presence of large-scale farms increases smallholders' access to fertilizer. Studies conducted in other sub-Saharan African countries, find that smallholders benefit from the increased access to agricultural infrastructure and inputs provided by large-scale farms. For instance, Deininger and Xia (2016) show that smallholders living within a 50 kilometer radius of large-scale farms in Mozambique have increased access to agricultural technologies in the short term. Similar results that hint at positive spillovers on fertilizer, yields and improved seed use in Ethiopia have been observed by Ali et al. (2016).

In Zambia, smallholder access to fertilizer is largely determined by the Farmer Input Support Program (FISP). The FISP – formerly known as the Farmer Support Program (FSP) – is a government subsidy that was introduced in 2002 with the initial goal of increasing private sector participation in agricultural input markets. A second goal of increasing household food security and incomes was adopted in 2009/2010 when the FSP was reformed to the FISP (Resnick and Mason, 2016). In spite of its growth enhancing and poverty reducing objectives, the FISP has resulted in the crowding out of private sector fertilizer supplies and in reductions in the total amount of fertilizer available for smallholders in some regions of Zambia (Xu et al., 2009).

Taking the FISP into account, we posit a second twofold hypothesis: First, large-scale farms may increase smallholders' access to fertilizer, if there are no distortionary effects caused by the FISP (H2: a). Second, if the subsidy program leads to a crowding out of the private sector, we do not expect smallholders' access to fertilizer in wards with large-scale farms to increase (H2: b).

Lastly, we investigate how smallholders' maize yields are affected by the increasing presence of large-scale farms in wards. We select maize yields as our outcome variable as maize is a staple crop grown by all smallholders in our sample. We expect that learning effects, increased access to infrastructure and agricultural technologies that arise from the presence of a large-scale farm in a ward increase smallholders' investments at the intensive margin and causes them to increase their maize yields (*H3*). However it is likely that these yield enhancing effects may be undermined if large-scale farms have adverse environmental effects on smallholders. For instance, Mujenja and Wonani (2012) show that large-scale farms are responsible for the emission of toxic substances into the air, water and soil. In addition, they find that large-scale farms contribute to the contamination of ground water through the excessive use of chemical fertilizers and aerial pesticide sprays. Johansson et al. (2016) find that land acquisitions heavily draw on freshwater resources and therewith overconsume surface and ground water.

2.4.2 Estimation strategy

We adopt a difference–in-differences approach that compares the three agricultural outcomes outlined above for smallholders in wards with large-scale farms to that of smalholders in wards with no such farms. More specifically, we compare the difference in the change in the hectares cultivated by smallholders, maize yields or access to fertiliser, between the years 2003 to 2006 and 2011 to 2013 for smallholder households. Our decision to examine changes before and after these two periods is motivated by the occurrence of the 2007-2008 food price crisis as well as by the availability of PHS data. As pointed out by several scholars and confirmed by Figure 1, the period directly after the 2007-2008 food price crisis was exceptional in that it led to an increase in foreign–owned large-scale farms. Thus it is reasonable to study the period directly before and after this shock. We pool the data into two time periods to ease the intepretability of the results. This approach has also been adopted by others using multiple cross-sectional data, see for instance (Abramitzky and Lavy, 2014). All wards that have hosted large-scale farms since the year 2003 are considered for the analysis. The year 2003 is selected as the start date because ward-level data is not available for earlier PHS datasets.

We thus estimate:

$$Y_{iwt} = \alpha + \beta_0 T_{wt} t + \beta_1 T_{wt} + \beta_2 t + \beta_3 X_{iwt} + \beta_4 y_t + \beta_5 w_w + \varepsilon_{iwt}$$

Where Y_{iwt} represents the logs of hectares, first cultivated for all crops, and later for maize only, maize yields or access to fertilizer by a smallholder household i in a ward w at time t. The time dummy t is equal to 1 for the years 2011-2013 and 0 for the earlier years. $T_{wt}t$ which is the main explanatory variable of interest is an interaction term between the treatment dummy T_{wt} and t. X_{iwt} is a vector of household and ward-level control variables, $y_t$are year dummies and w_w represents ward-level fixed effects. ε_{iwt} is the error term.

2.4.3 Econometric considerations

The difference-in-differences strategy we adopt does not account for selection bias that may arise due to the non-random location of the large-scale farms. If the location of the large-scale farms is partially determined by smallholders' agricultural outcomes this would bias the results. One way to correct this bias would be through the use of propensity score matching that would match the observed pre-treatment characteristics of similar smallholders across wards with and without large-scale farms. However, the dataset at hand does not allow us to perform such a matching strategy as it does not contain sufficient pre-treatment variables that simultaneously influence the location of large-scale farms and smallholders' agricultural outcomes (Caliendo and Kopeinig, 2008). Since the analysis of the local geographical contexts of large-scale farms in the previous section reveals that infrastructure and soil quality are more important determinants of large-scale farm locations than smallholders' agricultural outcomes we are confident that selection bias is not a major problem for our analysis.

Furthermore, endogeneity bias may arise because smallholders in wards with large-scale farms are on different trajectories than those in wards without large-scale farms. This would violate the parallel trends assumption associated with difference-in-differences analyses (Angrist and Pischke, 2008). A common approach adopted in the literature is to graph the trajectories of the treatment and control group to confirm that they followed a common underlying trend prior to the intervention (Hastings, 2004). Taking this approach, Figures 2.A.1-2.A.3 in the appendix show that the maize harvested, fertilizer used and hectares cultivated by smallholders in the treatment and control groups were on parallel trajectories prior to 2007-2008 food price crisis.

Moreover, the use of ward–year fixed effects enables us to wipe out any time invariant variables that would otherwise bias the results.

2.4.4 Results

First, we examine whether the increasing presence of large-scale farms in a ward reduces the areas cultivated by smallholders (*H1*). Table 2.3 reports the results of the difference-in-differences estimation. The first two columns show the impacts of large-scale farms on the total area cultivated by smallholders while Columns 3 and 4 show how the area cultivated for maize by smallholders is affected by large-scale farms. The main explanatory variable of interest – the interaction between the treatment and time variable (Treat_time) - shows that large-scale farms have positively and significantly affected the area cultivated by smallholders. In the full regression models where we control for the household heads' characteristics (columns 2 and 4), we observe that the total area cultivated and the area cultivated for maize increase by 15 and 13 percent respectively. This result is statistically significant for all smallholders at the 1 percent level. Over time, we can see that the area cultivated significantly increases for all smallholders. The total area cultivated increases by 6 percent while the area cultivated for maize increases by 33 percent (columns 2 and 4). This is in line with the descriptives statistics in Table 2.2 that also indicate a rise in area cultivated.

Table 2.3. Large-scale farms and smallholders' cultivated area.

VARIABLES	(1) Log all hectares	(2) Log all hectares	(3) Log maize hectares	(4) Log maize hectares
Treat_time	0.231***	0.154***	0.164***	0.131***
	(0.041)	(0.040)	(0.041)	(0.041)
Time	0.097***	0.056***	0.343***	0.332***
	(0.023)	(0.021)	(0.023)	(0.022)
Age of household head		0.042***		0.038***
		(0.002)		(0.002)
Age of household head squared		-0.000***		-0.000***
		(0.000)		(0.000)
Female household head		-0.303***		-0.261***
		(0.014)		(0.015)
Years of schooling		0.008***		0.013***
		(0.001)		(0.001)
Asset index based on pca		2.236***		2.100***
		(0.042)		(0.044)
Household grows cash crop		0.164***		-0.050**
		(0.020)		(0.020)
Constant	0.344***	-1.005***	-0.450***	-1.733***
	(0.017)	(0.051)	(0.017)	(0.053)
Observations	22,601	19,960	22,601	19,960
R-squared	0.011	0.201	0.030	0.180
Number of ward_id_2010	349	349	349	349
Year FE	Yes	Yes	Yes	Yes
Ward FE	Yes	Yes	Yes	Yes

Standard errors are reported in parentheses. Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

Table 2.4 further examines whether this result also holds for heterogeneous groups of smallholders – smallholders that cultivate small farms (below the median farm size of 1.42 hectares) and smallholders that cultivate big farms (between 1.42 and 20 hectares) – and for the area cultivated for other crops than maize. We observe that the presence of large-scale farms in a ward significantly increases the total area cultivated for both small and large farms by 9 and 8 percent (columns 1 and 2).

Table 2.4. Large-scale farms and smallholders' area cultivated for different crops

VARIABLES	(1) All (small farms)	(2) All (big farms)	(3) Maize (small farms)	(4) Maize (big farms)	(5) Staple (small farms)	(6) Staple (big farms)	(7) Cash crop (small farms)	(8) Cash crop (big farms)
Treat_time	0.090*	0.080**	0.096*	0.003	-0.200*	-0.073	-0.198**	0.030
	(0.053)	(0.033)	(0.055)	(0.045)	(0.117)	(0.088)	(0.079)	(0.100)
Time	-0.002	0.063***	0.188***	0.413***	-1.074***	-1.148***	0.190***	0.101*
	(0.024)	(0.019)	(0.025)	(0.026)	(0.052)	(0.051)	(0.036)	-0.058
Age of household head	0.025***	0.012***	0.020***	0.015***	0.010**	0.008	0.002	0.017***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)	(0.005)	(0.003)	(0.006)
Age of household head squared	-0.000***	-0.000***	-0.000***	-0.000***	-0.000*	-0.000	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female household head	-0.170***	-0.085***	-0.152***	-0.073***	-0.005	-0.049	-0.158***	-0.252***
	(0.014)	(0.014)	(0.014)	(0.020)	(0.030)	(0.039)	(0.021)	(0.044)
Years of schooling	0.003**	0.006***	0.008***	0.011***	-0.014***	-0.017***	-0.005***	-0.007**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
Asset index based on pca	0.944***	1.236***	0.738***	1.313***	0.110	-0.058	0.907***	1.587***
	(0.084)	(0.032)	(0.087)	(0.044)	(0.184)	(0.087)	(0.125)	(0.098)
Grows cash crop	0.198***	0.020	-0.142***	-0.133***	0.069	0.042	2.313***	1.274***
	(0.031)	(0.014)	(0.032)	(0.020)	(0.069)	(0.039)	(0.047)	(0.044)
Constant	-1.011***	0.447***	-1.572***	-0.628***	-3.125***	-2.855***	-4.426***	-3.340***
	(0.053)	(0.049)	(0.055)	(0.067)	(0.116)	(0.132)	(0.078)	(0.150)
Observations	9,761	10,199	9,761	10,199	9,761	10,199	9,761	10,199
R-squared	0.054	0.162	0.043	0.148	0.062	0.071	0.239	0.129
Number of ward_id_2010	349	344	349	344	349	344	349	344
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ward FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors are reported in parentheses. Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

Examining how the area cultivated for different crops is affected, we observe that smallholders cultivating smaller farms in wards with large-scale farms increase the area of land cultivated for maize by 10 percent (column 3) but decrease the area cultivated for other staples (millet, cassava, rice, and sorghum) and cash crops (tobacco, cotton, sunflower) (columns 5 and 7). This suggests that smallholders with smaller farms favor the cultivation of maize. In contrast, we do not observe any significant crop specific effects for smallholders cultivating bigger farms but find positive signs for maize and cash crops.

Taken together, we find evidence of an increase in the area cultivated by smallholders, supporting hypothesis H1:c. The area cultivated for all crops and for maize is larger for smallholders that are located in wards with large-scale farms. Moreover, we observe that the presence of large-scale farms in a ward leads smallholders to switch the allocation of land from the cultivation of traditional staples and cash crops to maize

Next, we examine whether the presence of large-scale farms in a ward over time increases smallholders access to inorganic fertilizer, or whether it has no effect on fertilizer use (H2: a and H2: b). Table 2.5 reports the results. The variable of interest (Treat_time) has a negative sign for all smallholders as well as for those smallholder with smaller and those with bigger farms. Only the co-efficient for smallholders with small farms is statistically significant.[17] This negative finding is in line with the descriptives presented in Table 2.2 that hint at smallholders in wards without large-scale farms overtaking those in wards with large-scale farms with regards to fertilizer use. The negative result could also be indicative of the crowding-out effect of private fertiliser suppliers in regions that have large-scale farms.

[17] Regressions were also conducted separately for the two most commonly used inorganic fertilizers in Zambia i.e. basal and top dressing fertilizer Burke et al., (2016). However similar negative and insignificant results were obtained for the impact of large-scale farms on smallholders' access to these fertilizer types.

Table 2.5. Large-scale farms and smallholders' fertilizer access

VARIABLES	(1) Fertilizer (all farms)	(2) Fertilizer (small farms)	(3) Fertilizer (big farms)
Treat_time	-0.016	-0.062*	-0.026
	(0.020)	(0.036)	(0.025)
Time	0.377***	0.353***	0.400***
	(0.011)	(0.016)	(0.014)
Household received FISP subsidy in 2006	0.584***	0.638***	0.521***
	(0.020)	(0.032)	(0.026)
Female household head	-0.042***	-0.022**	-0.017
	(0.007)	(0.009)	(0.011)
Total hectares cultivated per household	0.028***	0.180***	0.015***
	(0.001)	(0.011)	(0.002)
Age of household head	0.004***	0.001	0.000
	(0.001)	(0.001)	(0.001)
Age of household head squared	-0.000***	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Years of schooling	0.008***	0.008***	0.008***
	(0.001)	(0.001)	(0.001)
Asset index based on pca	0.271***	0.309***	0.278***
	(0.024)	(0.057)	(0.026)
Household grows cash crop	-0.033***	-0.052**	-0.051***
	(0.010)	(0.021)	(0.011)
Constant	0.073***	-0.014	0.217***
	(0.026)	(0.036)	(0.037)
Observations			
R-squared	19,960	9,761	10,199
Number of ward_id_2010	0.307	0.343	0.258
Year FE	349	349	344
Ward FE	Yes	Yes	Yes

Standard errors are reported in parentheses. Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

As discussed in the previous section, the FISP is a major determinant of smallholders' fertilizer access. Households that received fertilizer from the FISP in

2006 had approximately 52 to 64 percent more access to fertilizer as shown by a dummy introduced in our regressions.[18]

Table 2.6. Large-scale farms and smallholders' maize yields

VARIABLES	(1) Log maize yield (all farms)	(2) Log maize yield (small farms)	(3) Log maize yield (big farms)
Treat_time	0.229***	0.215	0.170**
	(0.071)	(0.136)	(0.080)
Time	-0.177***	-0.153**	-0.172***
	(0.039)	(0.063)	(0.048)
Age of household head	0.005	0.010*	0.001
	(0.004)	(0.006)	(0.005)
Age of household head squared	-0.000**	-0.000**	-0.000
	(0.000)	(0.000)	(0.000)
Female household head	-0.116***	-0.149***	-0.083**
	(0.025)	(0.036)	(0.036)
Years of schooling	0.008***	0.004	0.011***
	(0.002)	(0.003)	(0.003)
Access to Fertilizer (1=yes)	0.601***	0.668***	0.509***
	(0.025)	(0.039)	(0.032)
Asset index based on pca	1.119***	1.367***	1.168***
	(0.084)	(0.227)	(0.087)
Household grows cash crop	0.029	-0.058	0.055
	(0.035)	(0.082)	(0.036)
Hectares cultivated per household	-0.040***	-0.064	-0.030***
	(0.005)	(0.045)	(0.005)
Constant	6.649***	6.579***	6.664***
	(0.090)	(0.137)	(0.121)
Observations	18,872	9,294	9,578
R-squared	0.073	0.059	0.091
Number of ward_id_2010	349	348	344
Year FE	Yes	Yes	Yes
Ward FE	Yes	Yes	Yes

Standard errors are reported in parentheses. Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

[18] The data set only provides information on the distribution of the FSP across smallholders for the year 2006 and not the whole study period.

Lastly, we examine whether smallholders' maize yields are affected by the presence of large-scale farms. Table 2.6 shows that maize yields for all smallholders significantly rise by 23 percent if they are located in a ward with a large-scale farm. Columns 2 and 3 split the sample into smaller and bigger smallholder farms. For both groups of smallholders, we find positive signs, but only the results for bigger farms are statistically significant at the 5 percent level.

2.4.5 Robustness checks

We conduct several robustness tests to test the validity of our results. First, we check the specification: rather than pooling the data sets into a before and after period as in the previous set of regressions, we now interact the treatment variable with each year following the 2007-2008 food price crises. The three new outcome variables of interest are reported as Treat_2011, Treat_2012 and Treat_2013 in Table 2.A.2. The first two columns show the total areas cultivated by smallholders and the total area cultivated for maize, the third column shows the results for maize yields. As can be seen in Table 2.A.2, using interactions between the individual years and treatment variable does not considerably change the results from the ones presented for hectares cultivated and maize yields in Tables 2.3 and 2.6. For instance, smallholders in wards with large-scale farms experience an increase in total areas cultivated of 12 to 17 percent over the three years which does not diverge from the 15 percent increment reported in column 2 of Table 2.3.

Second, we check our sample: as described in the previous sections, Zambia has had a long history of large-scale agriculture that dates back to before 2003. In Table 2.A.3, we check whether the results obtained also hold if we account for the fact that large-scale farms existed prior to 2003 by introducing a dummy for wards that hosted large-scale farms prior to 2003 that we interact with the time variable to obtain a new outcome variable (All_treat_time). The results highlight that large-scale farms still affect smallholders' area cultivated and maize yields in a similar way although the effect sizes are smaller.[19]

Lastly, we examine whether analyzing the impacts of large-scale farms on the quantity of fertilizer applied per hectare yields different results compared to the fertilizer dummy used in Table 2.5. Again, all signs reported in Table 2.A.4 are negative suggesting a decrease in fertilizer usage in those wards hosting large-scale farms. For smallholders cultivating big farms, we even get statistically significant results (at the 5 percent level, column 3).

2.5 Discussion and conclusion

The emergence of LSAIs in the Global South is widely discussed and Zambia is a well-sought after target country. Based on a census of large-scale farms with ward locational information, we are able to paint a comprehensive picture of large-scale farms in Zambia. This unique data set allows us to analyze the local geographical contexts of wards targeted by large-scale farms. We investigate these areas and have sufficient evidence to dismiss the 'idle' land narrative: We find that land targeted by investors is close to infrastructure and markets. Moreover, large-scale farms are often established in areas with a tradition in large-scale farming as evidenced by the agglomeration of large-scale farms in certain wards. This confirms that large-scale farms are typically set up in close proximity to smallholders, and that the question of how small and large farms interact is crucial. To better understand the impacts of large-scale farms on smallholders, we derive several hypotheses that are tested using a difference-in-differences estimation with ward and year fixed effects.

This analysis yields three main results: First, we find that smallholders located in wards with large-scale farms tend to increase the area cultivated. Interestingly we

[19] We also run separate regressions with these specifications for smallholders cultivating small and big farms and find results similar to the ones reported in Tables 2.5, 2.6 and 2.7, albeit with different effect sizes.

also observe that smallholders that cultivate small areas of land and are located in wards that host large-scale farms instead reduce the areas of land dedicated to growing staples and cash crops in order to expand their maize production.

Given our threefold hypothesis, we expect multiple dynamics to simultaneously affect the relationship between large-scale farms and smallholders' area cultivated. We find a positive relationship which can be explained in two ways: first, it is likely that the rise of medium-scale farms may be driving our result. Assuming that medium-scale farms are likely to target the same regions as large-scale farms, we cannot rule out that the increase in area cultivated by smallholders is partially driven by a process of land consolidation during which less efficient smallholders sell or rent land to medium-scale farmers (Jayne et al., 2016). In fact, our descriptive statistics confirm a general trend of a rising medium-scale agricultural sector and shrinking number of land poor smallholders that has been found in the literature (for instance Anseeuw 2016 and Jayne et al., 2016). As we do not have smallholder panel data, we cannot follow changes in smallholders' landholdings over time. Thus, in this case of a positive relationship between large-scale farms and smallholders' area, we cannot say with certainty what drives our results. Second, we do not find any support for the hypothesis that large-scale farms increase smallholders' access to fertilizer as has been found to be the case for neighboring Mozambique (Deininger and Xia, 2016). However, one should note that the results on fertilizer are to be interpreted with caution as the FISP is a major determinant of smallholders' fertilizer use. Albeit insignificant, our finding that fertilizer access decreases in wards where large-scale farms are active is unexpected. This could hint at the crowding-out of private sector fertilizer suppliers in these regions; however we lack sufficient data to say this with certainty. Further research is required to better understand these mechanisms.

Third, we find yield increases in wards with large-scale farms. Based on the literature, we assume that learning effects, increased access to infrastructure and agricultural technologies outweigh any negative impacts associated with large-scale farms. The positive results may also be explained by the fact that smallholders cultivating larger areas of land rent or purchase land cultivated by smaller smallholders and produce more efficiently – especially given that the result is only statistically significant for bigger smallholders.

We cannot capture the trade-offs between these different effects in our analysis. It is highly likely that both positive and negative effects go hand in hand. For instance, an increase in smallholder productivity as evidenced by higher yields might be accompanied by adverse environmental effects. Moreover, it is not clear whether this effect would last in the long term as negative environmental impacts such as soil degradation may compromise smallholders' productivity. Hence, we argue that effects have to be considered and evaluated at large. Policy makers and investors should be transparent about the fact that investment projects are likely to be accompanied by both favorable and less favorable effects.

We close this analysis with some ideas for future research. First, more comprehensive and longitudinal smallholder data would allow us to include more outcome variables that highlight the linkages between large-scale farms and smallholders. Data that allows us to separately estimate the impacts of medium- and large-scale farms would especially be useful in disentangling the mechanisms through which smallholder outcomes are affected. Such data would also provide us with more insights on the trend of land consolidation that is taking place simultaneously. Furthermore, detailed data on large-scale farm labor would enable us to analyze the spatial and temporal dimensions of employment effects of large-scale farms on smallholders in their vicinities. For instance, we would expect that smallholders are employed in the early project stages but as the years of operation of large-scale farms increase, mechanized methods reduce the associated employment effects. Employment effects are also expected to be stronger for smallholders living in the direct proximity of large-scale farms compared to those further away. In addition, our data does not enable us to capture any environmental effects that may accompany the clearing of land for agriculture, the increased application of inorganic fertilizers and pesticides as well as the increased pressure on ground water levels by large-scale farms. Moreover, better data on the investment projects would allow for a clearer distinction between the crops cultivated by investors as well as the influence from their countries of origin and other investor traits. Finally, better spatial data that includes the exact geographic coordinates of smallholders and large-scale farms would be helpful in measuring how the effects on smallholders vary with the distance to large-scale farms.

2.6 Appendix

Figure 2.A.1. Parallel trends (hectares cultivated)

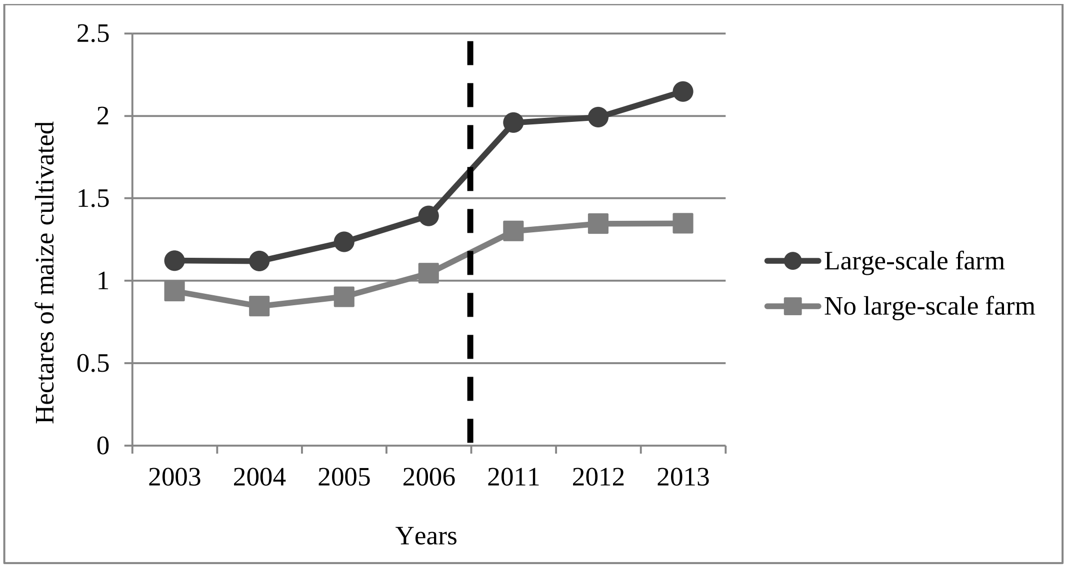


Figure 2.A.2. Parallel trends (fertilizer)

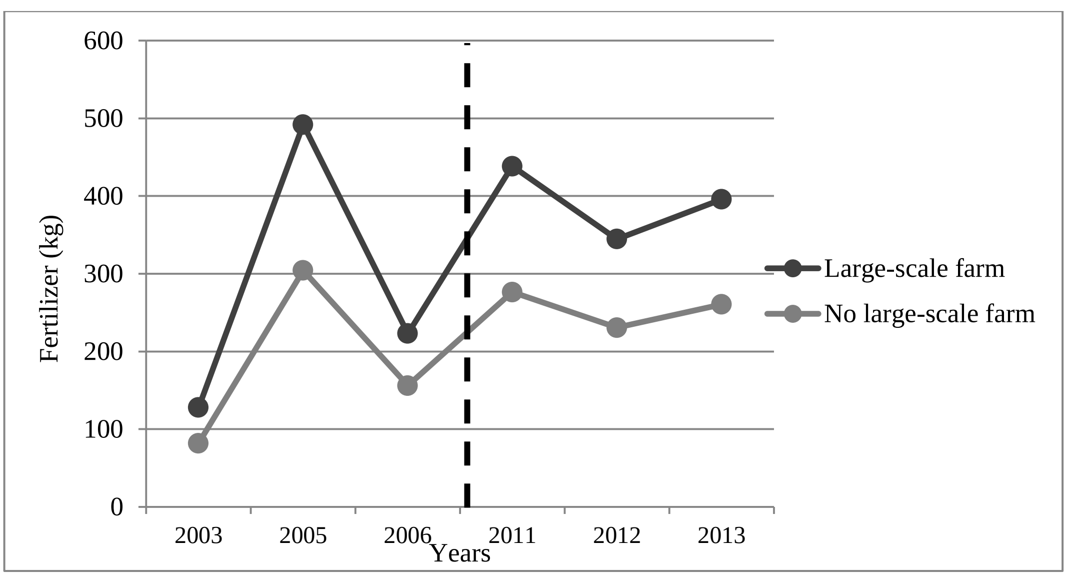


Figure 2.A.3. Parallel trends (maize yields)

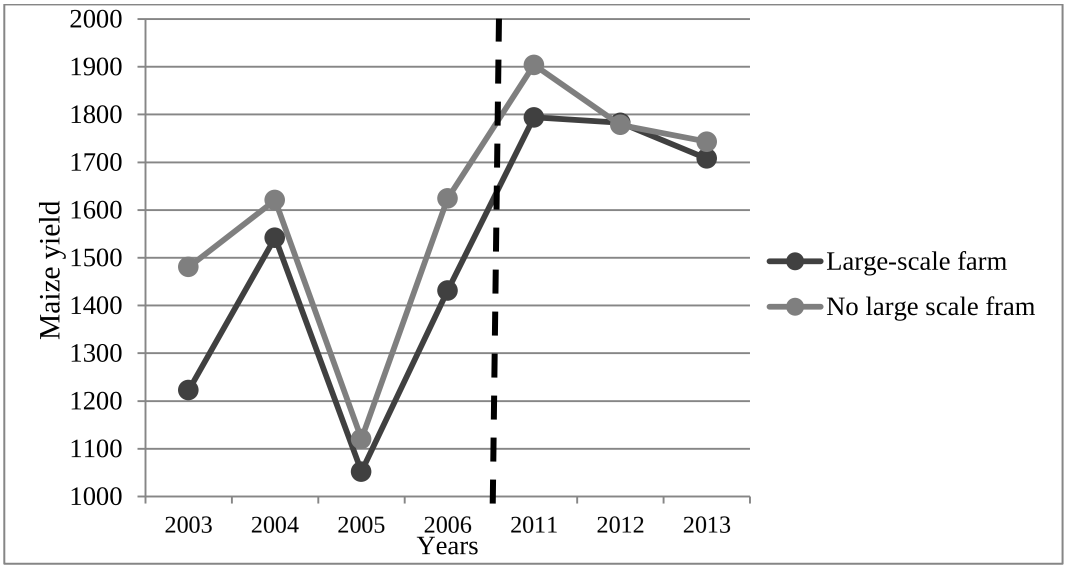


Table 2.A.1. The distribution of hectares cultivated by smallholders

	Mean	Standard Deviation	Median	Share
2002/2003				
	Mean	**Standard Deviation**	**Median**	**Share**
0-5 hectares	1.64	1.07	1.4	93.06
5-10 hectares	6.7	1.17	6.48	5.91
10-15 hectares	12.44	1.34	12.76	0.79
15-20 hectares	18.05	1.65	18.32	0.24
2003/2004				
	Mean	**Standard Deviation**	**Median**	**Share**
0-5 hectares	1.62	1.04	1.42	93.92
5-10 hectares	6.44	1.18	6.07	5.41
10-15 hectares	11.36	0.98	11	0.52
15-20 hectares	17.5	1.35	18	0.16
2004/2005				
	Mean	**Standard Deviation**	**Median**	**Share**
0-5 hectares	1.54	1.06	1.25	94.69
5-10 hectares	6.61	1.23	6.2	4.59
10-15 hectares	11.55	1.39	11.07	0.57
15-20 hectares	17.24	1.68	16.52	0.15
2005/2006				
	Mean	**Standard Deviation**	**Median**	**Share**
0-5 hectares	1.41	1.03	1.13	92.83
5-10 hectares	6.8	1.4	6.34	5.36
10-15 hectares	11.89	1.26	11.87	1.58
15-20 hectares	16.99	1.43	17	0.24
2010/2011				
	Mean	**Standard Deviation**	**Median**	**Share**
0-5 hectares	1.57	1.11	1.25	92.21
5-10 hectares	6.68	1.34	6.48	6.44
10-15 hectares	11.86	1.43	11.4	0.97
15-20 hectares	16-56	1.35	16.06	0.38
2011/2012				
	Mean	**Standard Deviation**	**Median**	**Share**
0-5 hectares	1.66	1.15	1.38	89.35
5-10 hectares	6.7	1.18	6.48	8.73
10-15 hectares	11.87	1.3	11.56	1.52
15-20 hectares	16.69	1.3	16.5	0.40
2012/2013				
	Mean	**Standard Deviation**	**Median**	**Share**
0-5 hectares	1.71	1.16	1.42	90.46
5-10 hectares	6.64	1.27	6.25	7.70
10-15 hectares	12.35	1.31	12.18	1.44
15-20 hectares	17.54	1.54	17.81	0.40

Table 2.A.2. Maize yields and area cultivated and (yearly treatment)

VARIABLES	(1) Log all hectares	(2) Log maize hectares	(3) Log maize yield
Treat_2011	0.168***	0.107*	0.221**
	(0.055)	(0.057)	(0.098)
Treat_2012	0.176***	0.138***	0.219**
	(0.050)	(0.052)	(0.089)
Treat_2013	0.123**	0.143***	0.245***
	(0.049)	(0.051)	(0.086)
Age of household head	0.042***	0.038***	0.005
	(0.002)	(0.002)	(0.004)
Age of household head squared	-0.000***	-0.000***	-0.000**
	(0.000)	(0.000)	(0.000)
Female household head	-0.303***	-0.261***	-0.116***
	(0.014)	(0.015)	(0.025)
Years of schooling	0.008***	0.013***	0.008***
	(0.001)	(0.001)	(0.002)
Access to Fertilizer (1=yes)			0.601***
			(0.025)
Asset index based on pca	2.237***	2.100***	1.119***
	(0.042)	(0.044)	(0.085)
Household grows cash crop	0.163***	-0.050**	0.030
	(0.020)	(0.020)	(0.035)
Total hectares cultivated per hh			-0.040***
			(0.005)
Constant	-1.005***	-1.733***	6.648***
	(0.051)	(0.053)	(0.090)
Observations	19,960	19,960	18,872
R-squared	0.201	0.180	0.073
Number of ward_id_2010	349	349	349
Year FE	Yes	Yes	Yes
Ward FE	Yes	Yes	Yes

Standard errors are reported in parentheses. Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

Table 2.A.3. Maize yields and area cultivated and (Farms before 2003)

VARIABLES	(1) Log all hectares	(2) Log maize hectares	(3) Log maize yield
All_treat_time	0.106***	0.074**	0.125**
	(0.034)	(0.036)	(0.061)
Time	0.057***	0.336***	-0.169***
	(0.022)	(0.022)	(0.039)
Age of household head	0.042***	0.038***	0.005
	(0.002)	(0.002)	(0.004)
Age of household head squared	-0.000***	-0.000***	-0.000*
	(0.000)	(0.000)	(0.000)
Female household head	-0.303***	-0.261***	-0.116***
	(0.014)	(0.015)	(0.025)
Years of schooling	0.008***	0.013***	0.008***
	(0.001)	(0.001)	(0.002)
Access to Fertilizer (1=yes)			0.601***
			(0.025)
Asset index based on pca	2.235***	2.100***	1.118***
	(0.042)	(0.044)	(0.085)
Household grows cash crop	0.164***	-0.049**	0.031
	(0.020)	(0.020)	(0.035)
Total hectares cultivated per household			-0.039***
			(0.005)
Constant	-1.007***	-1.735***	6.646***
	(0.051)	(0.053)	(0.090)
Observations	19,960	19,960	18,872
R-squared	0.201	0.180	0.072
Number of ward_id_2010	349	349	349
Year FE	Yes	Yes	Yes
Ward FE	Yes	Yes	Yes

Standard errors are reported in parentheses. Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

Table 2.A.1. Large-scale farms and fertilizer per hectare

VARIABLES	(1) Log fertilizer/ha (all farms)	(2) Log fertilizer/ha (small farms)	(3) Log fertilizer/ha (big farms)
Treat_time	-0.343	-0.503	-0.493**
	(0.212)	(0.403)	(0.248)
Time	3.753***	3.549***	3.938***
	(0.108)	(0.169)	(0.138)
Household received FISP subsidy in 2006	5.426***	6.161***	4.634***
	(0.202)	(0.332)	(0.249)
Female household head	-0.460***	-0.323***	-0.144
	(0.074)	(0.104)	(0.108)
Total hectares cultivated per hh	0.210***	1.725***	0.105***
	(0.015)	(0.125)	(0.016)
Age of household head	0.038***	0.012	0.011
	(0.011)	(0.016)	(0.015)
Age of household head squared	-0.000***	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Years of schooling	0.098***	0.098***	0.091***
	(0.007)	(0.010)	(0.009)
Asset index based on pca	3.324***	3.900***	3.446***
	(0.240)	(0.619)	(0.254)
Household grows cash crop	-0.429***	-0.597***	-0.578***
	(0.100)	(0.227)	(0.106)
Constant	-4.137***	-4.919***	-2.957***
	(0.264)	(0.390)	(0.364)
Observations	18,146	8,649	9,497
R-squared	0.202	0.176	0.202
Number of ward_id_2010	348	348	343
Year FE	Yes	Yes	Yes
Ward FE	Yes	Yes	Yes

Standard errors are reported in parentheses. Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

3 Social capital and large-scale agricultural investments: An experimental investigation[ζ][ψ]

3.1 Introduction

The aftermath of the global commodity price spike of 2007-2008 has been characterized by a high demand for large tracts of agricultural land in developing countries. The Land Matrix Observatory reports more than 1,000 concluded international deals and more than 40 million hectares (an area greater than the size of Germany) that have been acquired by investors since the year 2000.[20] Particularly in many African countries, farm land has been sought after due to a number of reasons that include speculation on high profits to be earned from investing in low productive and underutilized lands, widespread perceptions of land abundance as well as attractive investment incentives offered by host governments (Deininger et al., 2011; Collier and Venables, 2012). This increase in the demand for agricultural land has come to be known in the media by the more contentious terms 'land grab',

[ζ] This chapter has been co-authored with Menusch Khadjavi and Rainer Thiele. It has been accepted for resubmission at *The Economic Journal*. It has also been published as an International Growth Centre and Kiel Institute Working Paper.
[ψ] Funding from the International Growth Centre at the London School of Economics and Political Science under the project number 1-VRS-VZMB-VXXXX-89311 is gratefully acknowledged.
[20] For more information, see www.landmatrix.org. The Land Matrix Observatory is a database which was set up by partners such as the International Land Coalition, Centre de Coopération Internationale en Recherche Agronomique pour le Développement, the Centre of Development and Environment at the University of Bern, the German Institute of Global and Area Studies and the German Corporation for International Cooperation.

'new scramble for Africa' and 'global land rush' (Cotula et al., 2009; Cuffaro and Hallam, 2011). In the last years, a fairly large body of literature has been dedicated to understanding what triggered the rise in large -cale agricultural investments (LSAIs) (Zoomers, 2010; Arezki et al. 2015), how they can be governed (Margulis et al., 2013; Nolte 2014), and whether they are beneficial or detrimental for the countries that host them (Cotula et al., 2009; von Braun and Meinzen-Dick, 2009).

A key insight that has emerged from this literature is that there are spill-over effects that arise from LSAIs to surrounding smallholder settlements (Deininger et al., 2016). The effects on these communities may either be positive – for example, through employment creation and infrastructural development – or negative – through displacements, increased land tenure insecurity and heightened perceptions of increased land scarcity. With recent improvements in data quality, empirical works (Baumgartner et al., 2015; Deininger et al., 2016; Sipangule and Lay, 2015) have analyzed the spill-over effects of these investments on the rural communities that surround them.

So far, this literature has focused on how directly observable outcomes such as income, agricultural productivity, employment and land accessibility are affected by LSAIs. However, to the best of our knowledge no systematic research has been conducted on the implications of LSAIs on other important outcomes such as social capital that are more difficult to measure or directly observe. The materialization of LSAIs in the vicinity of smallholder communities may affect smallholders' social capital levels by exposing them to market-oriented forms of agricultural production that are based on strong property right systems and profit-making incentives. This form of agriculture greatly differs from smallholder agriculture that is less productive and subsistence-orientated.

This chapter contributes to filling the existing gap in the literature by using experimental methods to analyze how the establishment of LSAIs affects the social capital of smallholders living within their vicinities. Our approach of identifying the impacts of large-scale agricultural investments builds on the experimental economics literature on social capital in developing countries (Glaeser et al., 2000; Karlan, 2005; Bouma et al., 2008; Braaten, 2014). Within this literature, a broad definition of social capital is used to encompass trust, norms of reciprocity, and group interactions that are possible via densely connected social networks (Putnam 1993, Knack and Keefer, 1997; Woolcock, 1998; Ostrom, 2000; Durlauf and Fafchamps, 2005).

We are specifically interested in understanding how the levels of intra-village trust and reciprocity of smallholders are affected after a LSAI is set up within their proximity. For this purpose, we employ an artefactual field experiment using the sequential Prisoner's Dilemma (Clark and Sefton, 2001; Khadjavi and Lange, 2013). We conduct the field experiment in 13 randomly selected villages close to two LSAIs in Zambia, and take 16 similar randomly selected villages further away from the investments as the control group. Zambia makes a compelling case study as it is a major destination of LSAIs and has a land governance structure that is fairly representative of many other sub-Saharan African countries. The experiment is set up such that half of the smallholders included in the sample act as first movers who make trust-based decisions and the other half take the role of second movers who have a choice between reciprocal, altruistic or selfish decisions. We thereby essentially measure the extent of unconditional cooperation of the first movers and conditional cooperation of the second movers. We complement our analysis with a natural field experiment in which we observe the governance of public goods, i.e., how solar systems that are bestowed as public goods to the villages in our study are administered and maintained.

Our results from the Prisoner's Dilemma indicate significantly higher levels of (first-mover) cooperation in the villages close to LSAIs. While we do not find any difference for (second-mover) conditional cooperation between the two groups of villages per se, we do find that smallholders who have worked on LSAIs show significantly higher propensities both to cooperate when they are first movers and to reciprocate cooperative behavior (or the lack of it) when they act as second movers in our experiment. The natural field experiment indicates a higher propensity to share the public good in villages closer to the LSAI, which further substantiates our main result. It also reveals a significant positive correlation between the levels of trust in a community and the levels of public good governance.

A combination of quantitative and qualitative insights reveals that two mechanisms are driving our results. First, the spatial proximity to LSAIs creates what Lyons et al. (1998) refer to as the *communal coping effect*. Smallholders in the villages close to the investment site are uncertain about how they will be affected by the outsider and band together. Second, the *reputation effect*, as outlined by Arrow (1972), leads smallholders who have worked on LSAIs to develop greater levels of trust and reciprocation of cooperative behavior. The magnitude of this reputation effect increases with the duration of the employer-employee relationship. These findings are in line with the literature that shows that integrating small-scale societies into market-orientated settings induces norms of cooperation that result in higher payoffs in experimental games (Henrich et al., 2001).

The remainder of this chapter is organized as follows. Section 3.2 discusses markets and their influence on social capital. Section 3.3 explains the choice of the study sites and their representativeness. Section 3.4 describes the experimental design. The hypotheses and results are presented in section 3.5. Finally, section 3.6 concludes.

3.2 Markets and their influence on social capital

The debate on markets and their influence on the evolution of moral values and preferences is a long-standing one that has intrigued researchers in the social sciences (Bowles, 1998). This debate has resulted in two contending camps. The first camp advocates the role of markets in fostering norms of cooperation, while the second camp points out the erosion of morals and values that are associated with an increase in market accessibility (Hirschman, 1982).

Early works dating back as far as the mid-eighteenth century by French political philosopher Montesquieu describe commerce as a civilizing force that is linked the to the formation of 'gentle manners' such as assiduity, discipline, honesty, punctuality, prudence and reliability (Hirschman, 1982). Hirschman (1982) refers to this effect as the *doux-commerce* thesis and argues that the spread of commerce leads men to become more cautious about arousing adverse judgment from present and future acquaintances. Today, the doux-commerce thesis is still advocated by economists who argue that the market nourishes virtues of honest behavior, civility and cooperation (McCloskey, 2006; Fourcade and Healy, 2007). Commercial society is thought to make people more cooperative by binding them together and reducing social tensions. Engagement in frequent economic interactions associated with markets also leads one to place a higher importance on developing one's credibility and reputation (Arrow, 1972; Fourcade and Healy, 2007).

Studies analyzing the determinants of social preferences across 15 small-scale societies find that higher levels of aggregate market integration are associated with increased cooperation or altruism, which is measured by positive offer sizes in ultimatum games (Henrich et al., 2001; Henrich et al., 2004). One of these studies conducted amongst a pastoral group in Northern Kenya by Ensminger (2004) reveals that market integration – measured by the presence or absence of wage/trade income – leads to more fair offer sizes (50-50 splits) in the ultimatum and dictator games. In line with the doux-commerce thesis, Ensminger (2004) suggests that subjects participating in the labor and service markets place a higher value on the importance of reputation and behaving fair-mindedly, which is reflected in the results of the one shot games.

Other studies conducted within this cross-cultural context arrive at a similar conclusion. Tracer (2004) compares two villages in rural Papua New Guinea and finds that the village with less market integration has a higher distribution of low offers in the ultimatum game. In addition, doing a within village comparison reveals that those with higher market integration proxies such as thatched roofs and wage employment have higher offers even though the small sample size used in the study makes more research necessary. A follow up study uses more refined measurements of market integration, i.e. the percentage of calories purchased in the market, to replicate the results of the earlier studies and finds that fairness increases with a population's degree of market integration (Henrich et al., 2010; Ensminger and Henrich, 2014).

While the studies discussed above support the hypothesis that markets have a positive effect on cooperative behavior, a large body of literature whose roots can be traced to Marx's work on capitalism argues that markets undermine the moral foundations of society (Hirschman, 1982). This market-based erosion of morals that Hirschman refers to as the *self-destruction* thesis arises when markets crowd out cooperation and altruism and reduce them to a narrow form of self-interest (Fourcade and Healy, 2007).

The erosion of collective goods and rise in self-interest associated with market exposure is illustrated in a qualitative study by Kajoba (1994). He shows how the advent of agricultural commercialization led to a change in the perceptions of villagers in Chinene, Zambia, who began to favor more individualized forms of land tenure. Not only did the commercialization of agriculture increase the value of land in Chinene village but it also heightened villagers' perceptions of land scarcity causing them to fence their properties and desire individual land title. In addition, Kajoba (1994) reports that the rise in self-regarding behavior amongst villagers in Chinene was accompanied by a reduction of social cohesion. An analogous process is described by Lesorogol (2005), who presents evidence showing that pastoralists living in communities that have experienced privatization of their parcels and have been brought into greater contact with markets for land engage in fewer cooperative activities on a day-to-day basis. This reduction in cooperation occurs as a result of the resettlement of households as well as the increased reliance on crop cultivation and decline in the use of communal pastoral grounds. This crowding out of cooperation is reinforced by the results of a public goods game that reveals lower contributions by the villagers that have experienced privatization.

Although the two strands of literature are at opposite poles, in practice the positive and negative effects of markets on social capital do not always have to be mutually exclusive. It may well be that market exposure results in both an increase in self-regarding behavior and increased cooperation amongst a certain group of individuals simultaneously. For instance, a recent study that analyses the effect of the formalization of land rights on community cooperation in Peru by Braaten (2014) shows that when measured as distance to markets, market integration is negatively associated with cooperation, whereas a positive and significant effect is found for income from trade that is used as a proxy for market experience. Thus based on the discussion in this section, markets may enhance, deteriorate or have an ambiguous effect on social capital.[21] The mechanisms through which market exposure affects social capital will be described in more detail in section 3.5 where we derive the hypotheses to be tested in the experimental analysis. To ensure that we are capturing the effect of market exposure in this study and not that of traditional

[21] It is important to note, however, that even in the absence of markets there may be other factors that induce norms of cooperativeness. For instance, Baland et al. (2016) and Grimm et al. (2016) provide evidence for norms of solidarity that foster mutual help and transfers across extended family members.

systems of mutual help that might arise within such a setting, the next section explains our choice of study area and the design of the field experiments.

3.3 Choice of country and study sites

Zambia is a compelling case to study for two major reasons. First, it is an important destination of LSAIs. Between 2003 and 2011, 34 LSAIs expressed an interest in 1,588,916 hectares of agricultural land (Harding et al., 2016). A third of this land was previously cultivated by smallholders (Harding et al., 2016). This indicates that it is not uncommon for LSAIs to operate within the proximity of smallholders. Second, Zambia has a dual land governance structure that is fairly representative of many other sub-Saharan African countries. Land in regions cultivated by smallholders is governed under a customary system of tenure that assigns authority to chiefs and local headwomen or –men who act as custodians of the land on behalf of the chiefs. Within this system, formal property rights are a rarity. By contrast, land cultivated by LSAIs is almost always titled and follows a formal land governance system. The rise in the number of LSAIs, particularly in regions that border customary land, increases smallholder exposure to formalized market orientated systems of agriculture. LSAIs have also been established in the proximity of smallholder communities in other sub-Saharan African countries that allow for both titled and customary land tenure system such as Ethiopia (Baumgartner et al., 2015; Ali et al., 2016), Ghana and Kenya (Nolte and Väth, 2015) and Nigeria (Adewumie et al., 2013; Osabuohien, 2014).

We conducted the artefactual field experiment[22] from mid-August to the end of September 2015 in two commercial farming areas in Mumbwa and Mkushi districts. The LSAI in Mumbwa is leased by Amatheon Agri and covers an area of nearly 30,000 hectares. Currently the farm only operates 3000 hectares of this land. The

[22] The term was coined by Harrison and List (2004). Such experiments are also commonly referred to as 'lab-in-the-field experiments' and 'extra-lab experiments' (Charness et al., 2013).

LSAI in Mkushi, which is operated by Chobe Agrivision, consists of 6 different farms which together account for an area of 4,000 hectares. Both farms operate within formalized institutional settings; they acquired titled state land for their establishments and are foreign owned. The farm in Mkushi began its operations in 2010 while the one in Mumbwa has been operational since 2012. The key distinction between the two farms is the extent of land commercialization prior to the establishment of the LSAIs. The land in Mumbwa forms part of the Big Concession farming scheme and despite being titled, it remained largely underdeveloped (greenfield investment) until the commercial farm was set up. On the contrary, the LSAI in Mkushi falls within the Mkushi farm block that has a long history of commercial farming; the land for the farm was acquired from established commercial farms (brownfield investment) (Chu, 2013).

In terms of the size of land and crops cultivated, the two LSAIs included in this study are very similar to 13 other operational LSAIs listed by the Land Matrix (see Table 3.A.1 in the appendix).[23] The farms operated by Amatheon Agri and Agrivision Africa both cultivate maize, wheat and soya beans; at least one of these crops is also cultivated in all but two of the other LSAIs operational in Zambia.

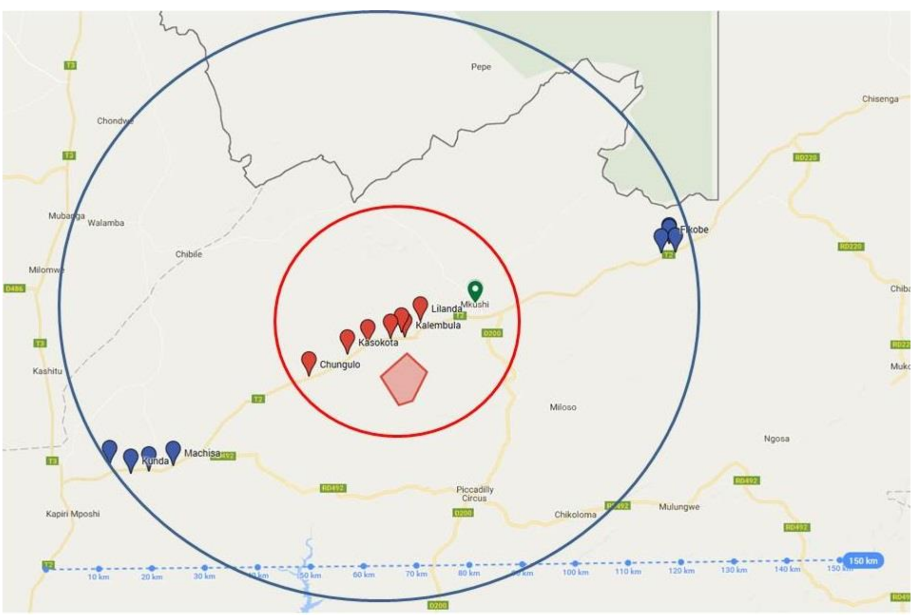
Amatheon Agri has been contracted the largest amount of land (38,760 hectares) but in terms of the area cultivated (3,000 hectares) it does not differ greatly from Agrivision Africa or the other LSAIs operational in Zambia. In addition, the LSAIs selected for this study are similar to most of the other operational LSAIs in that they only began their operations after the peak in demand for agricultural land that occurred in 2008/2009. These similarities make us confident that the results we obtain are not only confined to our study area but hold equally important lessons for other operational LSAIs administered in a similar way.

[23] The Land Matrix reports another 1700 hectare LSAI, Ambika, that has been established in Mkushi. Its approximate location (sourced from the Land Matrix) has been illustrated in Figure 3.1a. Ambika is located within the 15 kilometer radius of Chobe Agrivision.

Our choice of these two farming areas was not only motivated by selecting LSAIs that are representative at the national level but also by other key criteria such as: identifying farms that are both located in the same province, situated close to main roads and are similarly close to Zambia's capital city Lusaka.

After the locations of the two LSAIs were identified, village lists and maps of the regions surrounding these farms were obtained from the Zambian Central Statistical Office (CSO) in Lusaka. These maps were essential for the randomization process employed in selecting villages. 29 randomly selected villages located close to a main road were sampled, out of which 15 villages were located in Mkushi District and 14 were in Mumbwa District.[24] Altogether, we conducted the experiment with 932 smallholders in these villages. Figures 3.1a and 3.1b illustrate the study locations.

Figure 3.1a. Randomly selected villages in the Mkushi Region

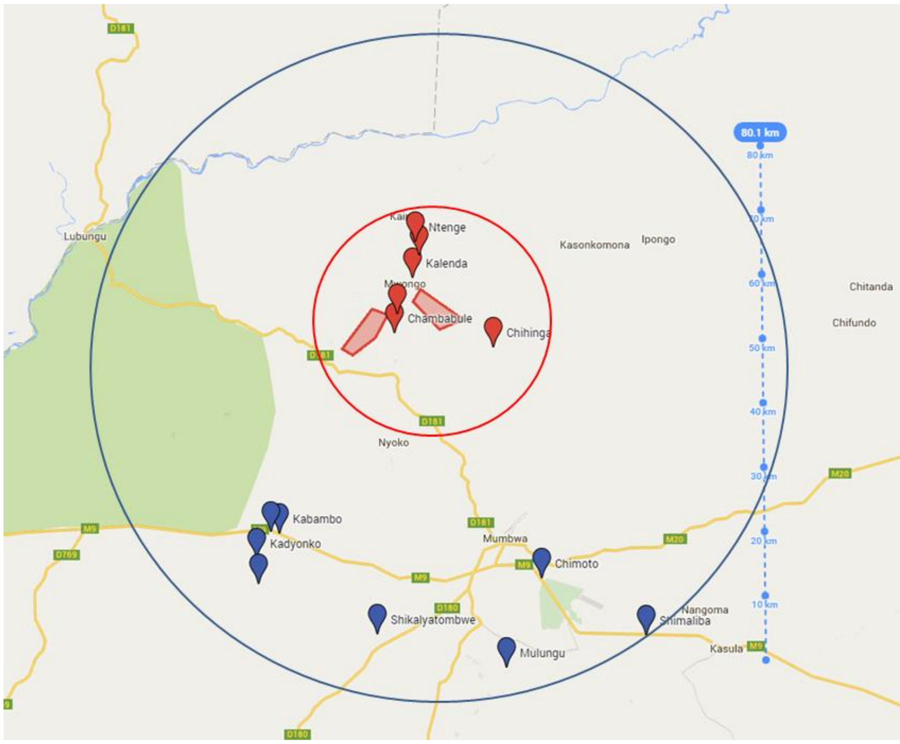


Note: The red polygons depict the locations of the commercial farming areas; the red pins indicate the locations of the _near villages while the blue pins show the _further villages. The green pin depicts the approximate location of another farm in Mkushi reported by the Land Matrix (see Table 3.A.1).

Source: authors' own and Land Matrix data. Map created using Google Map Maker.

[24] We selected villages close to a main road to avoid any distorting effects caused by proximity to markets and infrastructure.

Figure 3.1b. Randomly selected villages in the Mumbwa Region



Note: The red polygons depict the locations of the commercial farming areas; the red pins indicate the locations of the _*near* villages while the blue pins show the _*further* villages.

Source: Authors' own data. Map created using Google Map Maker.

We compare the social capital of villages in the proximity of the two LSAIs with counterfactual villages that do not have LSAIs. In each district, we randomly selected villages (_*near*) within a 15 kilometer radius from the large-scale farms as well as villages *(_further)* located in a 50 to 70 kilometer radius around the center of the large-scale farms. Extra caution was taken to ensure that the villages located further away where not located close to other large-scale farms. The radii were calibrated in order to have villages from which smallholders could walk to work in the LSAI on a daily basis (_*near* villages) and to have villages in the same region while ruling out this everyday-contact (_*further* villages). Table 3.1 reports summary statistics of the villages located further and close to the investments.

The summary statistics clearly bear out that proximity to LSAIs matters. As expected, villages within the 15 kilometer radius have a significantly larger amount of workers employed on LSAIs – the share of LSAI workers in *_near* villages is more than double that in *_further* villages – and a lower number of villagers that are smallholders. Not surprisingly, households in *_further* villages sell some of their agricultural produce as there is no other dominant employer or source of income generation in their proximity.[25] By contrast, with the exception of the age and marital status of the household head, all relevant village-level socio-demographic characteristics are balanced and do not differ significantly. The asset-index, intensity of night lights and hectares cultivated by villagers do not indicate that *_near* villages are wealthier than *_further villages* despite the employment opportunities offered by the LSAI in the *_near* villages.[26] Furthermore, there is also no indication of differences in soil quality that might drive our results. We obtained soil samples in all the villages in our study (including signed agreements for the extractions from each headwoman or -man). The soil samples were analyzed by the Zambia Agriculture Research Institute, the official research institute of the Ministry of Agriculture in Zambia.[27] Pairwise correlations of villages being *_near* a LSAI or *_further* and each of the nine soil quality indicators do not yield any significant differences. Finally recall that we only selected villages close to a main road to rule out any systematic differences in access to infrastructure and markets. As a result, we are confident that our randomization strategy was successful in matching similar villages that only differ in terms of their proximity to LSAIs.

[25] These households do not take their agricultural produce to the markets in towns but instead sell it on the roadside to traders and passersby.

[26] Our proxy for wealth is derived from an asset index that is constructed from a linear index of households' physical assets whose weights have been obtained using a principal components analysis (Filmer and Pritchett, 2001). We opt in favor of an asset index since income based measures in such settings are typically associated with reporting bias. In addition, we use night lights data for the year 2013 as a proxy for the level of economic activity in the villages. The use of night lights data has gained prominence in recent empirical literature estimating economic growth (Henderson et. al., 2012).

[27] The soil samples were tested for their levels of organic carbon, calcium chloride and pH. They were also tested for trace elements of potassium, phosphorous, sodium, calcium, magnesium, zinc and iron. Figure 3.A.2 in Appendix 3.7 presents correspondence with the institute.

Table 3.1. Village-level summary statistics.

	_near villages		*_further* village		
Variable	**Mean**	**SD**	**Mean**	**SD**	**p-values**
Male	0.54	0.15	0.47	0.12	0.12
Household head	0.46	0.09	0.49	0.13	0.32
Married	0.67	0.09	0.57	0.15	0.05
Age (in years)	35.07	2.46	41.11	5.25	0.00
Migrated after LSAI was set-up	0.20	0.16	0.16	0.13	0.61
Years of education	6.56	1.08	6.52	0.86	1.00
Literacy (with 5 being the highest level)	2.68	0.39	2.65	0.38	0.93
Asset index	0.42	0.03	0.41	0.10	0.46
Night lights (5km buffer)	0.00	0.00	0.02	0.07	0.37
Land title	0.35	0.29	0.31	0.29	0.66
Acquired plot from chief	0.44	0.23	0.53	0.32	0.51
Inherited plot	0.25	0.16	0.27	0.19	0.83
Purchased plot	0.21	0.19	0.13	0.16	0.15
Hectares cultivated	4.95	2.17	5.11	1.96	0.83
Household sells crops	0.68	0.16	0.82	0.10	0.03
LSAI worker	0.52	0.26	0.24	0.18	0.00
Smallholder	0.71	0.17	0.84	0.10	0.04
LSAI requested land in the village	0.18	0.40	0.15	0.38	0.86
Ethnic groups in village	8.46	3.31	8.00	2.92	0.67
Population in village	570.43	1078.00	234.91	312.60	0.68
Village size (hectares)	413.00	579.19	1112.56	2069.41	0.90
Village has public good[28]	0.77	0.44	0.63	0.50	0.41
Individuals	445		487		
Number of villages	13		16		

Note: The p-values are based on two-sided Mann-Whitney tests on the village-level. The asset index includes information on the households' possessions of livestock holdings, radios, agricultural equipment, transportation, as well indicators of the quality of housing.

[28] While the LSAIs engage in small-scale corporate social responsibility (CSR) activities within the communities such as the improvement of school infrastructure, we do not find a difference in public goods between the two village groups. Nolte and Subakanya (2016) provide more information about CSR activities of the two LSAIs.

A potential problem for our empirical analysis is that the locations of the large-scale farms were not randomly selected. Being market-oriented, they are established in regions where the LSAI owners expected to yield high returns from their investments. This non-random location may give rise to biased estimates if the social capital of surrounding communities is a determinant of where LSAIs are established. Note that the share of villages which were approached by LSAIs for land is low and similar in both village groups (approx. 17 percent). This shows that the *_further* villages are a good counterfactual since the LSAIs could equally have been established close to the *_further* villages.

Moreover, the Zambian Development Agency (ZDA) facilitates land acquisition through the local government, traditional leaders and Commissioner of Lands. They allocate land to investors based on a detailed project proposal with clear indication of the agriculture activities they intend to implement and associated requirements regarding irrigation, types of crops or livestock, land size, location, et cetera. Among the criteria the ZDA's land allocation agencies apply for identifying suitable land are topographic and soil characteristics as well as prevailing land tenure systems. Criteria that might be regarded as proxies of social capital in surrounding communities do not play a role in the allocation of land for investments, rendering a bias due to non-random selection of LSAI locations unlikely.[29]

Still, we are aware that our approach is not without problems when it comes to identifying the causal effects of LSAIs on social capital. In particular, we lack information on pre-investment levels of social capital in the villages. To get around the lack of data on pre-investment levels of social capital, we use spatial data to

29 Interviews were conducted with the Investment Promotion Officer at the ZDA and confirmed in talks with the Director of Policy and Planning, ZDA. More information about our correspondence with the ZDA is available upon request. In addition, Nolte and Subakanya (2016) provided us with responses from the managers of the large-scale farms in our study. The explanations for how and why the exact locations were acquired do not indicate any proxies for social capital either.

compare village characteristics that could have potentially influenced social capital prior to the establishment of the LSAIs.

Table 3.2. Pre-investment characteristics across _*near* and _*further* villages

	_near villages		_further villages		
Variable	**Mean**	**SD**	**Mean**	**SD**	**p-values**
Night lights 2000 (pixel)	0.00	0.00	0.00	0.00	-
Night lights 2000 (5 km buffer)	0.00	0.00	0.00	0.00	-
Population density (pixel)	5.54	0.52	5.50	0.52	0.85
Population density (5 km buffer)	5.54	0.51	5.50	0.52	0.74
Mean monthly rainfall (pixel)	80.05	5.59	81.29	3.32	0.47
Mean monthly rainfall (5 km buffer)	80.18	5.73	81.26	3.05	0.51
Elevation (pixel)	1250.63	140.12	1213.85	28.82	0.83
Elevation (5 km buffer)	1252.24	132.78	1221.39	28.56	1.00
Mean monthly maximum temperature (pixel)	30.08	1.32	30.47	0.49	0.98
Mean monthly maximum temperature (5 km buffer)	30.08	1.25	30.42	0.50	0.86
Distance to nearest road	1.54	2.14	0.49	0.61	0.20
Distance to nearest water line	1.79	1.83	1.97	1.13	0.33
Distance to nearest rail	63.82	65.45	71.90	77.57	0.20

Note: All datasets were collected prior to the establishment of the LSAIs. The night lights data for the years 2000 and 2013 are sourced from the National Oceanic and Atmospheric Association's National Centre for Environmental Information (NOAA-NCEI) available at: ngdc.noaa.gov/eog/dmsp/downloadV4composites.html. The 2000 data is obtained by calculating the average of the two 'Average Visible, Stable Lights & Cloud Free Coverages' data files. The population density data is from the year 2000 and was compiled by the Center for International Earth Science Information Network (CIESEN). The precipitation and temperature data are sourced from the WorldClim database. They show the mean monthly maximum temperature and precipitation for the period between 1960 and 1990. The elevation data is from the Consultative Group on International Agricultural Research- Consortium for Spatial Information (CGIAR-CSI), SRTM30 dataset collected in 2000. The distance variables are vectors lines that were originally compiled for the Digital Chart of the World in 1992. All grid data have a high resolution of 30 seconds. The elevation, land cover, roads, railroads, water line, climate and population density data were all downloaded from the DIVA-GIS website: www.diva-gis.org/gdata.

Table 3.2 shows that there are no significant differences across the _*near* and _*further* villages in the intensity of night lights the year 2000 (our proxy of prior economic activity), monthly rainfall, temperature, population density, elevation as well as distance to roads, railroads and water lines. Analyzing these pre-investment variables makes us more confident that the *_near* and *_further* villages were quite similar prior to the investments.

Naturally, the ideal identification strategy would take the form of a field experiment with a panel dimension that would install and manage a considerable number of 4,000 hectare-large LSAIs in random locations around the country. It would measure social capital in communities in the proximity of and other communities further away from these randomly selected sites before and a number of years after the installation and continuous operation of these farms. Yet, such a difference-in-differences field experiment would be very costly and would arguably not stand a thorough cost-benefit analysis. For this reason, we regard our approach as a worthwhile option that is cost effective and allows at least a tentative causal interpretation of the link between the establishment of LSAIs and social capital in neighboring village communities.

3.4 Experimental design and procedures

In line with the literature on social capital we opted for the use of experimental methods to measure our outcomes of interest. For instance, in their seminal contributions, Glaeser et al. (2000) and Karlan (2005) use the trust game to measure social capital, consisting of trust and reciprocity (also referred to as 'trustworthiness').[30] Taking our study setting into account, we simplified the game and elicited unconditional and conditional cooperation through the use of the sequential Prisoner's Dilemma (Clark and Sefton, 2001; Khadjavi and Lange, 2013).[31]

[30] Eckel and Wilson (2004), Kosfeld et al. (2005) and Houser et al. (2010) investigate the relationship between trust and risk in social dilemma games. All studies provide supportive evidence that these games do not merely measure risk preferences, but a genuine preference for trust.

[31] The battery of our lab-in-the-field experiments also included a sender-receiver cheap-talk game (Gneezy, 2005) and a competition game (Gneezy et al., 2009). Those two games were played *after* the sequential Prisoner's Dilemma and were not pre-announced. They should therefore not have any

Given our context in rural Zambia involving a high number of illiterate participants, we decided in favor of the binary sequential Prisoner's Dilemma (PD). This was done to establish the highest level of simplicity of the game while still being able to measure cooperation.[32] The game was played one-shot and designed in a simple graphical manner that enabled villagers with low levels of literacy to understand the procedure.[33]

After receiving general introductory instructions, participants were randomly assigned to two groups of first or second movers by drawing a black or a green numbered ID card from a bag. The two groups were then spatially separated with adequate distances and sight-barriers such as huts, trees and bushes to prevent both verbal and non-verbal communication between the groups. Each group was accompanied by two Zambian research assistants (always one male and one female). The instructions for the Prisoner's Dilemma were then presented to the respective group and read aloud by the same research assistants throughout all experiments.[34]

In the black group, individuals made the first decision (move) to cooperate or defect. Figure 3.2 illustrates the decision sheet that members from the black group received. The individuals in the green group made two decisions which were contingent on the first mover's choice. The results from the first movers determine the level of

influence on the data reported in this chapter. We aim to discuss these games in future companion papers.

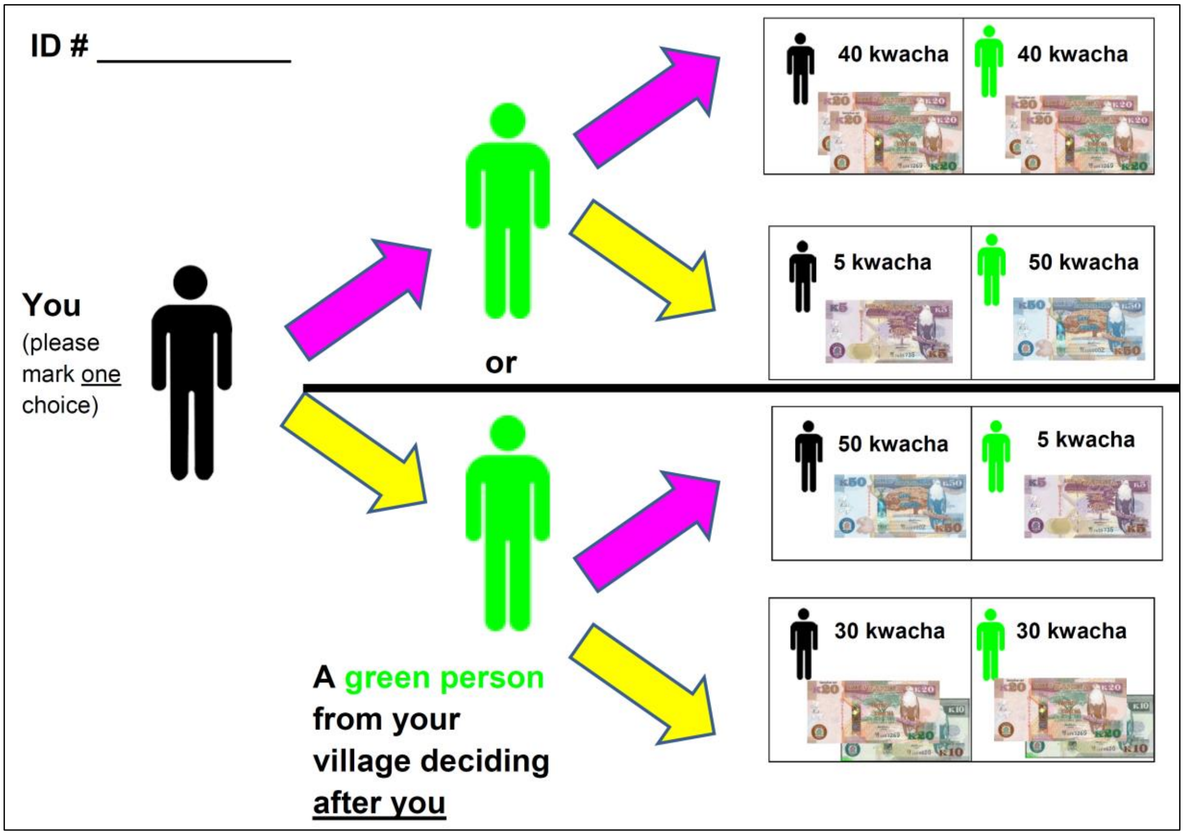
[32] Nearly 25 percent of the participants reported that they are not able to read or write.

[33] We carried out pilot tests and included control questions to test the efficacy of the instruments. These additional measures assured us that even those participants that are illiterate were able to follow our experiment.

[34] Although English is the official language in Zambia, regional languages are spoken more frequently in rural settings. To ensure that all participants understood their tasks, the instructions were administered in Bemba in Mkushi and Nyanja in Mumbwa. As a way of testing that the original meanings of the instructions were maintained across the experiments, we had the instructions translated into Bemba and Nyanja from English and retranslated into English by two separate, uninvolved parties. This is the standard validation procedure (see Brislin, 1970). Instructions in English are provided in the appendix 3.8 Instructions in Bemba and Nyanja are available upon request.

unconditional cooperation of the villagers, while the results from the second movers indicate strategies such as conditional cooperation, payoff maximization or altruism.

Figure 3.2. Decision sheet for black group members as the first mover in the PD.



To ensure that illiterate individuals were able to make incentivized decisions, the decisions were based on easily identifiable colors (*Pink* or *Yellow*) and the possible payoffs from a decision were represented by pictures of the associated banknotes. Participants could earn between 5 and 50 Zambian Kwacha depending on their decisions: 40 Kwacha for each player was the payoff in case of mutual cooperation, 30 Kwacha for each player in case of mutual defection, while 50 Kwacha was the 'temptation payoff' and 5 Kwacha was the 'sucker payoff'. The payoffs were calibrated so that participants could earn a fee that is approximately equivalent to the weekly income of LSAI workers in the region.[35] The payments were made to villagers after their participation in all parts of the study (this includes individual ex-post surveys and leisure time between the activities) that lasted approximately four hours. Including a show up fee of 5 Kwacha, participants earned 119.72 Kwacha on average (13.30 USD). Hence, the stakes in our experiment can be regarded as fairly large.

To make a decision, each participant's ID number was called by a research assistant and the participant was led to an isolated area to make her or his choice (pink or yellow). When called, participants were allowed to ask the research assistants questions about the instructions before making their decisions. After the decisions had been made the research assistants posed control questions to the participants to test for understanding of the instructions. During the decision making process another research assistant stayed with the group of participants that had not been called out to ensure that participants did not communicate before their numbers had been called out. After participants had made their decisions, they were asked to go to a second waiting area.

Importantly, the research assistants were not informed about the research questions during the data collection phase of the study to avoid biases. They were only debriefed after the collection of data in the last village at the end of September 2015.

Before each session (there was always only one session per village to avoid information spill-overs), we visited each randomly selected village to request permission from the village headman (or headwoman) and to seek his (her) assistance in recruiting villagers to participate in the study. The village headmen and –women were informed about the nature of the experiment (but not the research questions), the duration of the study, the average expected earnings and that participation in the study was voluntary. We also presented a letter of support from

[35] Approximations of the weekly and daily wages of LSAI workers were obtained from interviews with LSAI workers and smallholders during the pilot phase of the study in July 2015.

the provincial government that encouraged our research (see Figure 3.A.1 in the appendix). We stressed that only individuals from the respective village are allowed to participate, that we need at least 20 individuals per village, that there is no upper limit to the amount of participants from a given village and that the average payment does not decrease with the number of participants. Refraining from setting an upper bound and randomizing at the individual level was crucial to avoid selection issues since village censuses were unavailable. Only adults (people over the age of 16 that were eligible for the National Registration Card) were allowed to participate in the experiment due to its monetized nature.

Throughout the experiment and thereafter the identity of the matched players from the differently colored groups were kept anonymous. After the experiment was completed, the participants' decisions from the green and black groups were randomly matched.

The information collected in the experiment was supplemented with data from community and household surveys that were conducted after the experiments. The community questionnaire – only answered by village headmen or –women – gathered information on institutional arrangements, land tenure systems, soil quality and interactions with outsiders.[36]The household questionnaire gathered information on socio-demographic characteristics, social networks and land tenure arrangements. This information is mainly used to control for possible confounding factors in the subsequent empirical analysis.

3.5 Hypotheses and results

We first develop a set of hypotheses as to how – and through which mechanisms – the exposure to LSAIs might affect the social capital of local communities in their

[36] In four cases where the headman was absent, the community questionnaires where answered by the deputy village headman, chairperson or school head teacher.

vicinity (section 3.5.1). Against the background of these hypotheses, we present the results of our experimental investigation, first discussing first-mover behavior in the sequential Prisoner's Dilemma (section 3.5.2), and then analyzing different strategies of second movers (section 3.5.3). In a further step, we provide a tentative assessment of the mechanisms that are likely to drive our results (section 3.5.4). Finally, we discuss the outcome of the natural field experimental measure and how it compares to the lab-in-the-field experimental measure (section 3.5.5).

3.5.1 Hypotheses

As discussed above, the smallholder communities that surround LSAIs are characterized by informal institutions that are governed by traditional authorities. When LSAIs that operate using a different set of institutions are set up in the proximity of these communities, we posit that the trust and reciprocity of smallholders may be affected in the following ways:[37]

Individualism

When LSAIs are established in the proximity of a smallholder community, the increased exposure to modern agricultural techniques and the profit-seeking business model of the LSAI may raise smallholders' awareness of an individualistic lifestyle. Similar to the example of Chinene village (Kajoba, 1994), commercialization may lead to more self-regarding and individualistic behavior of smallholders who wish to utilize their land in more productive ways such as through the cultivation of

[37] Social capital of smallholders may also be affected by displacements or resettlement (Lesorogol, 2005) and through a leadership effect which may occur if the land acquisition process is opaque and causes villagers to distrust their local leaders. However these effects are unlikely to be relevant for our study. There were no displacements within the villages of our study and the leadership effect does not apply since the chiefs and not the local village headmen and –women were involved in the settlement of the LSAIs. Furthermore, immigration driven by employment opportunities on the investment farms may have an impact on villagers' social capital, but we find no significant differences in the incidence of migration between villages close to the investment farms and those further away (Table 3.1). Lastly, the statistics in Table 3.1 do not indicate any differences in the asset levels (our proxy for income levels) of villages near and further away from the LSAI, which dispels concerns of an income effect across the study villages.

cash crops. This individualistic behavior is at odds with the customary system of tenure that favors cooperation and trust amongst individuals. Thus it is possible that social capital of smallholders living in these communities might deteriorate. Consequently, we formulate:

Hypothesis 1a. *Due to a rise in individualism, the levels of cooperation in the* _near *villages are lower than in the* _further *villages.*

Communal Coping

Conversely, if smallholders perceive the materialization of a LSAI as a threat or a positive development they may bond together as a way of dealing with the new actors within their communities. This could result in more frequent community meetings or other forms of mutual cooperation that raise the social capital of the village. Lyons et al. (1998:583) introduce the notion of communal coping which occurs when "one or more individuals perceive a stressor as 'our problem'…and activate a process of shared or collaborative coping". If communal coping occurs in the villages next to the LSAIs it may lead to increased levels of intra-village cooperation amongst smallholders.

Hypothesis 1b. *Due to uncertainty from the presence of LSAIs, cooperation levels in the* _near *villages are higher than in the* _further *villages.*

Reputation

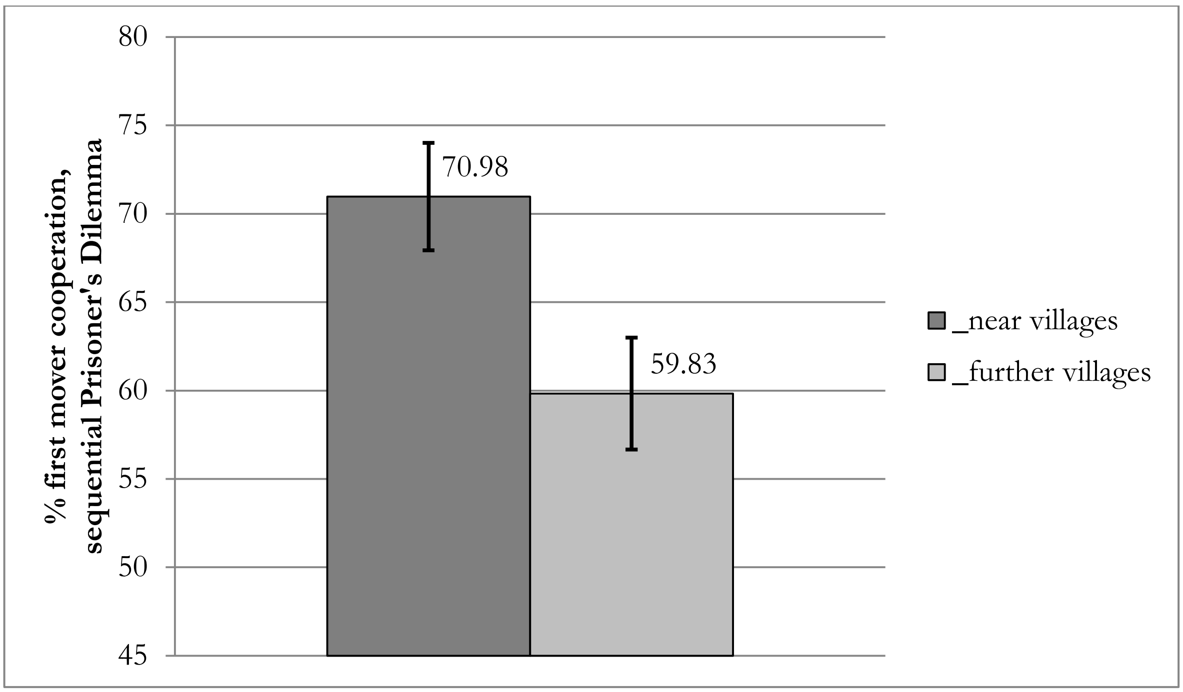
As smallholders are employed on LSAIs, they may acquire traits such as reliability, reciprocity and fairness that are necessary for the functioning of more formalized market institutions. As demonstrated by Ensminger (2004), smallholders may internalize these norms and apply them in similar settings within their communities. This will lead to an increase in the levels of trust and reciprocity among smallholders that are in direct contact with these investments.

Hypothesis 2. *Due to repeated interaction with the LSAI, cooperation levels of LSAI-employed villagers are higher than those of non-employed villagers.*

3.5.2 Results: First-mover cooperation

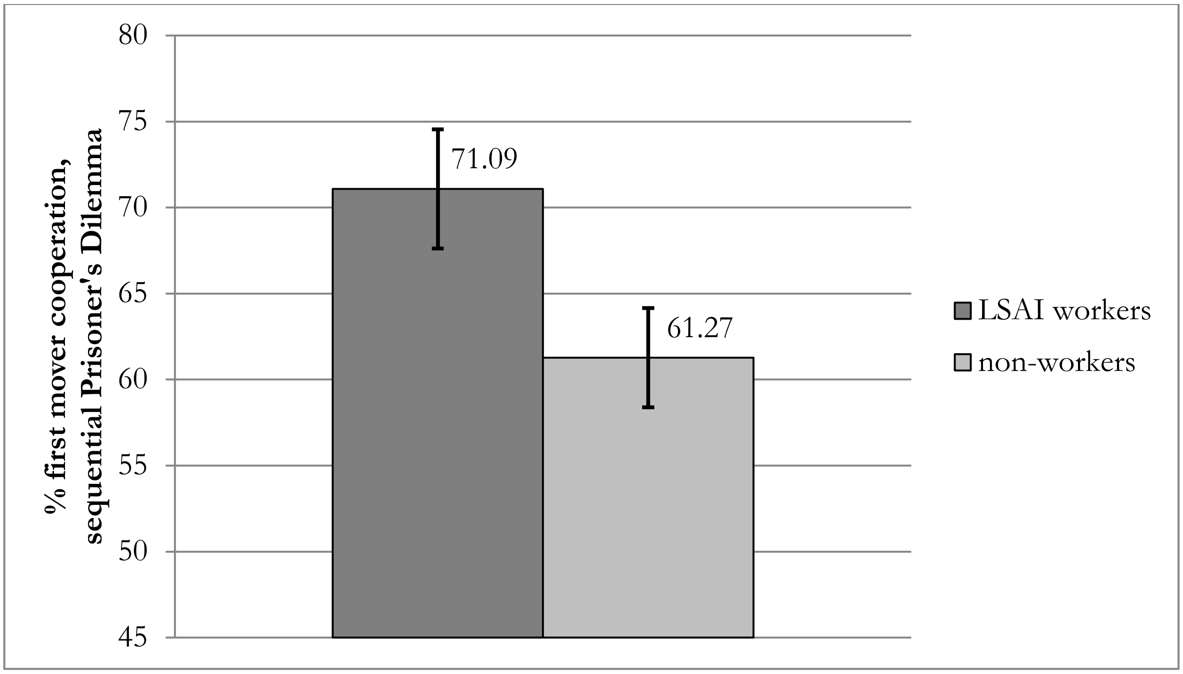
The results in Figure 3.3 indicate that smallholders living in _near villages tend to be more cooperative than those in _further villages.

Figure 3.3. Smallholder proximity and cooperation of first movers in the sequential PD



The level of first-mover cooperation in the sequential Prisoner's Dilemma is 70.98 percent in _near villages compared to 59.83 percent in _further villages. Employing a (two-sided) chi-squared test for a first-glance analysis, we find that this difference is statistically significant at p-value = 0.012. Likewise, we find a 71.09 percent propensity of LSAI workers to cooperate as first movers compared to 61.27 percent of non-LSAI workers. This difference is significant at p-value = 0.033 (chi-squared test). Figures 3.3 and 3.4 depict these differences.

Figure 3.4. LSAI workers and cooperation of first movers in the sequential PD



The first-glance result of first-mover cooperation above needs to be substantiated by a regression analysis. It is crucial that we take the structure of the data into account and control for socio-economic observables. We estimated two logit regressions, one employing a parsimonious specification and one controlling for a large set of observables, clustering the standard errors at the village level in both estimations. We present the results in Table 3.3. The estimations confirm the increase in first-mover cooperation of smallholders in villages close to LSAIs and that of LSAI workers. Even if we cluster the standard errors and control for a variety of potential confounding factors, the effects remain significant (estimation II).

Table 3.3. Regression analysis of first-mover cooperation

Independent variables	(1) I Logit regression	(2) II Logit regression
_*near* village (dummy, 1 = yes)	0.113**	0.108**
	(0.050)	(0.052)
Age (continuous)	-0.055	0.017
	(0.050)	(0.083)
Male (dummy, 1 = yes)	-0.045	-0.015
	(0.038)	(0.063)
Education in years (continuous)	-0.002	0.006
	(0.010)	(0.014)
Literacy (continuous)	-0.017	-0.023
	(0.024)	(0.031)
LSAI worker (dummy, 1 =yes)		0.116*
		(0.060)
Migrated after LSAI was set-up		0.046
		(0.095)
Own hectares (continuous)		0.003
		(0.004)
Household head (dummy, 1 = yes)		-0.055
		(0.075)
Household sells crops		0.032
		(0.063)
Village area (continuous)		0.005
		(0.013)
Land title (dummy, 1 = yes)		-0.013
		(0.060)
Ethnicity		-0.002
		(0.003)
Asset index based on pca		-0.130
		(0.257)
Region	No	Yes
Crops	No	Yes
Observations	454	366
Villages	29	29

The table presents marginal effects. The observations from the control villages are the baseline of the estimations. The standard errors in parentheses are clustered at the village level for 29 villages in all estimations. Statistical significance*** p<0.01, ** p<0.05, * p<0.1.

We therefore find evidence in favor of Hypotheses 1b and 2:

Result 1. *First-mover cooperation is significantly greater in* near_ *villages compared to* _further *villages. Communal coping may explain this result.*

Result 2. *First-mover cooperation is significantly greater for LSAI workers than for non-workers, which may point to a reputation effect.*

Note that the support for Hypothesis 1b by Result 1 does not reject Hypothesis 1a. Rather, it may be that we measure a composite effect in which the communal coping mechanism dominates.

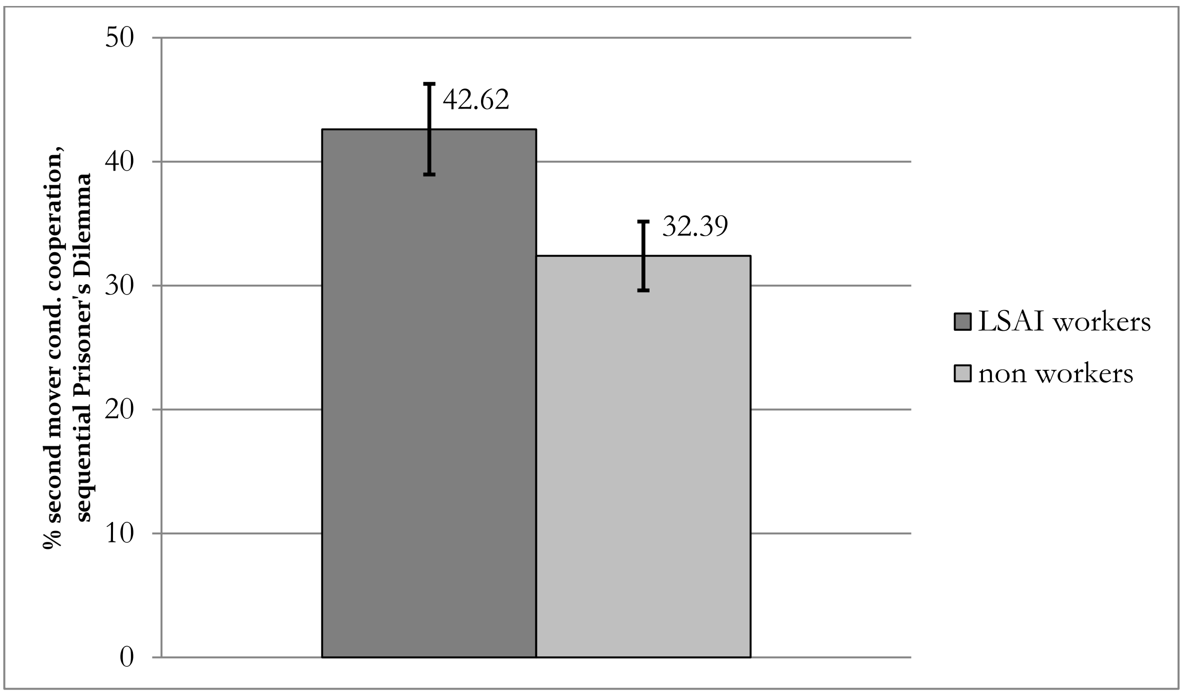
3.5.3 Results: Second-mover conditional cooperation

The decision making of the second movers in the sequential Prisoner's Dilemma involved two choices: (1) cooperation (pink choice) or defection (yellow choice) in the case of first-mover cooperation and (2) cooperation or defection in the case of first-mover defection. In order to analyze the decisions of second movers, we formulate four strategies: first, reciprocity (or conditional cooperation) when second movers answer cooperation with cooperation and defection with defection; second, payoff maximization which is characterized by defection in both cases; third, altruism which occurs when second movers cooperate in both cases; and fourth, a seemingly irrational strategy of answering cooperation with defection and defection with cooperation.

We find similar rates for all strategies in _near and _further villages; none of the differences is statistically significant. Conditional cooperation varies between 36 and 38 percent; payoff maximization varies between 29 and 31 percent, and altruism between 19 and 17 percent. The remaining 14 percent were second movers with a seemingly irrational strategy.

Thus, we do not find a direct effect of the proximity of large-scale agricultural investments on the propensity to play a certain strategy more often (i.e. null results for Hypotheses 1a and 1b for second movers). Next, we again look at whether there is any effect for LSAI workers (Hypothesis 2). We are especially interested in the propensity of conditional cooperation. Indeed, we find that the share of conditional cooperation among LSAI workers is 42.62 percent and thereby significantly greater than the share among non-workers (32.29 percent). This difference is significant at p-value = 0.025 (chi-squared test). Figure 3.5 depicts this result.

Figure 3.5. Conditional cooperation of LSAI workers and non-workers



Again, we complement our first-glance chi-squared test with a regression analysis for second movers' cooperation which mirrors the analysis for first movers. Table 3.4 provides the results.

Table 3.4. Regression analysis of second-mover conditional cooperation

Independent variable	(1) III Logit regression	(2) IV Logit regression
_*near* village (dummy, 1 = yes)	0.028	0.013
	(0.041)	(0.051)
Age (continuous)	0.002	0.002
	(0.001)	(0.002)
Male (dummy, 1 = yes)	-0.031	-0.042
	(0.058)	(0.069)
Education in years (continuous)	-0.005	-0.005
	(0.011)	(0.011)
Literacy (continuous)	-0.016	-0.009
	(0.030)	(0.032)
LSAI worker (dummy, 1 =yes)	0.082*	0.148**
	(0.048)	(0.059)
Migrated after LSAI was set-up		-0.000
		(0.061)
Household head (dummy, 1 = yes)		0.012
		(0.068)
Own hectares (continuous)		-0.001
		(0.004)
Household sells crops		0.088
		(0.056)
Village Area (continuous)		-0.009
		(0.014)
Land title (dummy, 1 = yes)		0.029
		(0.083)
Ethnicity		0.001
		(0.002)
Asset index based on pca		-0.021
		(0.169)
Region	No	Yes
Crops	No	Yes
Observations	455	380
Villages	29	29

The table presents marginal effects. The observations from the control villages are the baseline of the estimations. The standard errors in parentheses are clustered at the village level for 29 villages in all estimations. Statistical significance*** p<0.01, ** p<0.05, * p<0.1.

We find that this effect remains statistically significant and robust to changes in the regression specification (see regressions III and IV). We therefore formulate:

Result 3. *Conditional cooperation is more pronounced for smallholders who worked on a large-scale farm than for comparable smallholders.*

This finding is consistent with Hypothesis 2 and with Ensminger (2004) and Heinrich et al. (2001), who find that market integration increases cooperativeness and fair pay-offs. Recall that our descriptive statistics in Table 3.1 shows more than double the amount of smallholders with work experience on the investment farm in _*near* villages compared to _*further* villages.

Since the effect of being employed on the investment farm turned out to be particularly dominant in the case of both first mover and second mover cooperation, a natural follow up question that arises is whether the levels of cooperation vary with the duration of market exposure or employment on the LSAI.

In the individual questionnaire, we asked participants who stated that they had worked on a LSAI about the length of their employment. A pairwise correlation (and similarly a logit regression) does not yield any significant effect for first-mover cooperation. Conversely, a pairwise correlation (and a logit regression) between second-mover conditional cooperation and the length of employment yields a positive and significant effect at the 5 percent level. The propensity to conditionally cooperate is about 50 percent higher for farm workers who have been employed for more than a year compared to those who were employed less than 3 months (an increase from 30 percent to 50 percent). Figure 3.6 visualizes the effect. Hence, we find evidence that cooperation of long-term employees is significantly greater than of short-term employees. When controlling for village location, gender, age, being born in the village and years of education, the effect remains significant at the 5 percent level (the estimation results can be found in Table 3.A.3 in appendix 3.7).

Figure 3.6. Second-mover reciprocity and length of employment on the LSAI

Of course, we cannot fully rule out reverse causality. For instance, it could be that employees that are not reciprocative do not reach long-term employment and get laid off beforehand. Our finding is nevertheless in line with the reputation hypothesis that reciprocal behavior and market integration go hand in hand (Arrow, 1972; Henrich et al., 2001; Ensminger, 2004; Ensminger and Henrich, 2014).

3.5.4 Support for communal coping and reputation hypotheses

As described in the sections above, the first trip of our field research that occurred between mid-August and the end of September 2015 was conducted in a blinded manner so that neither the field research assistants nor the study respondents were aware of the central research question. In addition, neither the research support letter by the provincial government nor the questionnaires used for the study included questions on the LSAIs in order to rule out response biases.

The second round of field work was conducted in July 2016. The main aim of this visit was to collect information that would substantiate the transmission mechanisms described above. Having collected all the experimental data, we could freely engage village representatives in discussions about their interactions with LSAIs, land governance as well as the frequency of village meetings and the topics discussed without fear of biasing the results from the lab-in-the-field experiment.

To verify whether communal coping drives the results that we observe for first movers in _*near* villages, we asked each village headman (or –woman) and other community members present if there was a LSAI within walking distance of their community. In line with our expectations and own observations, only the participants from _*near* villages responded affirmatively. Within these villages, there was a general perception of uncertainty and disgruntlement mostly caused by the belief that the LSAIs did not adequately compensate their employees for the amount of work they were expected to do. Over 90 percent of the community representatives and members interviewed in the _*near* villages, indicated that they were not happy with the remuneration offered by the LSAI and that there had been at least one meeting (formal or informal) were this topic had been discussed. While the villagers from the _*further* villages also met frequently to discuss different topics, there was no topic that directly affected all community members within these villages. This indicates that perceptions of uncertainty and adversity caused by the presence of the LSAI have led the smallholders in _*near* villages to bond together. Overall, this provides support for the communal coping channel.

At first glance our main findings, i.e. LSAI workers having a greater propensity to cooperate, may appear paradoxical considering the general discontentment with the LSAIs reported above. To better understand what might be driving these results, we compare the socioeconomic characteristics of LSAI workers with other villagers that do not have any experience on LSAIs. From Table 3.5, it is clear that LSAI workers own fewer assets and have less land holdings than other villagers that have not been employed on the LSAI. This suggests that increased incomes or a sense of ‘giving back to the community' cannot be driving the cooperative outcomes observed in Tables 3.3 and 3.4.

Table 3.5. LSAI worker socioeconomic characteristics.

	Non- workers		LSAI workers		
Variable	**Mean**	**SD**	**Mean**	**SD**	**p-values**
Male	0.44	0.50	0.59	0.49	**0.00**
Household head	0.44	0.50	0.49	0.50	0.12
Age (in years)	38.48	17.55	37.58	14.96	0.94
Migrant	0.56	0.50	0.51	0.50	0.12
Years of education	6.57	3.49	6.26	3.23	0.12
Literacy (5 = highest level)	2.65	1.30	2.59	1.33	0.48
Asset index	0.43	0.18	0.40	0.15	**0.01**
Hectares cultivated	5.13	6.56	4.72	6.76	**0.01**
Individuals	569		356		

Note: Statistically significant p-values in bold. The p-values are based on two-sided Mann-Whitney tests for the continuous variables and chi-squared tests for the binary variables.

In our communication with representatives from the _*near* villages on the LSAI recruitment process and work conditions, many of the respondents indicated that the employment opportunities offered by the LSAI were low skill positions that did not require any specific expertise. They also suggested that it was not difficult to work for the LSAIs since they did not have strict recruitment criteria. Once newly employed, workers were usually first offered short term contracts which could be renewed for the next harvesting (high labor demand) season depending on their performance. Some of the key characteristics expected of the workers were that they were punctual, reliable and hard working.

From this, it is clear that although there is no strict screening process during the recruitment phase, once employed, workers are required to invest in reputation-enhancing traits if they are to secure a contract for the next harvesting season or even a permanent contract. As shown in other studies (Ensminger, 2004), it is possible that these reputation-enhancing traits are internalized by villagers as norms and applied in their natural settings. This is in accordance with our finding that cooperation increases with the length of employment on the investment farm (Figure 3.6).

3.5.5 Natural field experiment

In addition to the lab-in-the-field experimental measure, we conducted a natural field experimental measure that compared the governance of public goods across the study villages. This experiment had two objectives: (i) to provide independent evidence on the effect of LSAIs on villagers' social capital; and (ii) to validate the lab-in-the-field experiment. Narayan and Pritchett (1996:887) state that social capital at the village-level can also be measured through the "management of resources that are treated as common property within the village or among several villages, such as improved water supplies, local irrigation capabilities, and local roads". For this reason, during our first field research trip in August and September 2015, we endowed each village in our sample with a free public good that took the form of a solar system.[38]

The public good was a d.light D20 solar system. This product comes with a solar panel, a battery unit, two stationary and a portable LED lamp, two light switches and a USB port accompanied by several adaptors for mobile phone battery charging. It is manufactured to meet the needs of poor people in the developing world: it is very simple to handle and robust in extreme weather conditions. Once fully charged, the solar systems can provide lighting for 7-15 hours and can charge 4-5 simple mobile

[38] There are several reasons why this product was useful as a public good in a village setting like the one we investigated in our study. First, 98.17 percent of all participants in our study did not have access to the electricity grid. 65.63 percent reported to use battery-powered torches for lighting followed by 28.26 percent who reported using candles. This is also confirmed by the 2013 and 2000 night lights data in Tables 3.1 and 3.2. Given the very low income of individuals in our study environment and our observations, we assume that these options were not used regularly. Often these individuals did not have any source of light beyond the fireplace outside their huts. Hence, the lamps of the public good were very useful.
Likewise phone charging is very useful to the villagers. While 79.51 percent of them reported owning a mobile phone (these are almost always simple and affordable mobile phone to make phone calls or send a text message, not smartphones), most of them do not have electricity access at home. Hence, the usual way of charging mobile phones is to travel to a shop with electricity and pay for charging. It often takes several hours to reach these shops by foot. Hence, the public good can serve as a source of electricity for charging mobile phones for free and close by.

phones per day.[39] In mid-July 2016 we returned to the villages for an unannounced visit to examine the status of the solar systems.

The solar systems were bestowed in each village only after all lab-in-the-field games had been played and the administration of the household surveys was coming to an end.[40] We followed a script that amongst others stated that the solar system was provided by our research team (and our funding institution, the International Growth Centre at the London School of Economics) for free and without any obligations. We stressed that the solar system was given to the whole community and invited the respective headman or –woman to receive the solar system on behalf of the community members. We demonstrated how to operate the solar system and provided examples of the different ways in which the solar systems could be used as a public good. For instance, we suggested that the lamps could be used for village gatherings such as overnight services at the church, weddings, and funerals as well as studying in groups at night, and childbirths. In addition, we pointed out that the panel could be used by all members of the village to charge the batteries of their mobile phones for free (given the battery life and sporadic use of these simple mobile phones this was a realistic scenario). In front of all study participants, all village headmen or –women confirmed that they would use the solar system for the good of the community and acknowledged that they had understood all the information provided.

We expected heterogeneity concerning the community solar system along two dimensions. First, we were interested in how many solar systems were still present and working in the villages (and not sold, lost, stolen or broken, for instance). Second, we were interested in whether the public good nature of the community

[39] More information about the solar system is available on the product website: http://www.dlight.com/.

[40] We recorded pictures and videos of the handing over of the public goods in all villages. These media files are available from the authors upon request.

solar system was maintained almost a year after or whether it had been privatized (assumingly by the headman or –woman). Note again that there was never any announcement that we would ever return to the village which makes the anticipation of our return as a motivator highly unlikely.

Along the first dimension we were surprised to find very little heterogeneity. All but two solar systems were still present and working in the villages including all of their parts.[41] Along the second dimension we indeed found several solar systems that were privatized by the headman or –woman, while others were shared either by means of using the lamps at village gatherings, by allowing community members to charge their mobile phones for free, or both.[42] The sorting into two broad categories – privatized and shared – and into various degrees of sharing was done by interviewing multiple random individuals from the villages independently, interviewing the headmen and –women, and rating of the statements by a new set of two 'blind' research assistants who neither knew the research question nor the game outcomes from the villages.

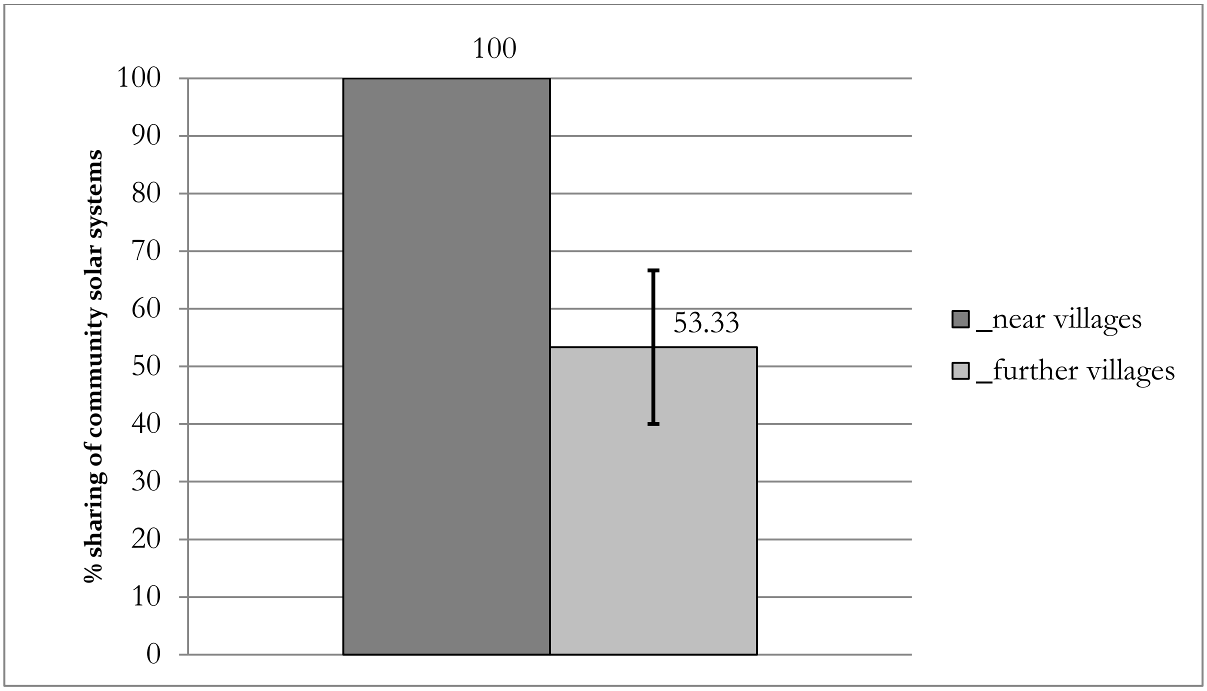
As shown in Figure 3.7, the results from this sorting into privatized and shared solar systems reveal a significant difference between *_near* and *_furthe*r villages (p= 0.011, chi-squared test test). Strikingly, sharing occurred in all *_near* villages, whereas the solar systems were privatized in almost half the *_further* villages.[43] This corroborates the findings of the lab-in-the-field experiment, even though the evidence should only be regarded as suggestive due to the low number of 25 observations.

[41] One solar system was missing and another one was damaged due to improper use (drilling into the battery). Two headmen and their families were absent, so that these observations are missing.

[42] For this comparison we are able to consider 25 of 29 villages. One solar system was damaged, another one was gone, as described above, and in two villages we were not able to interview the headman or the family due to absence.

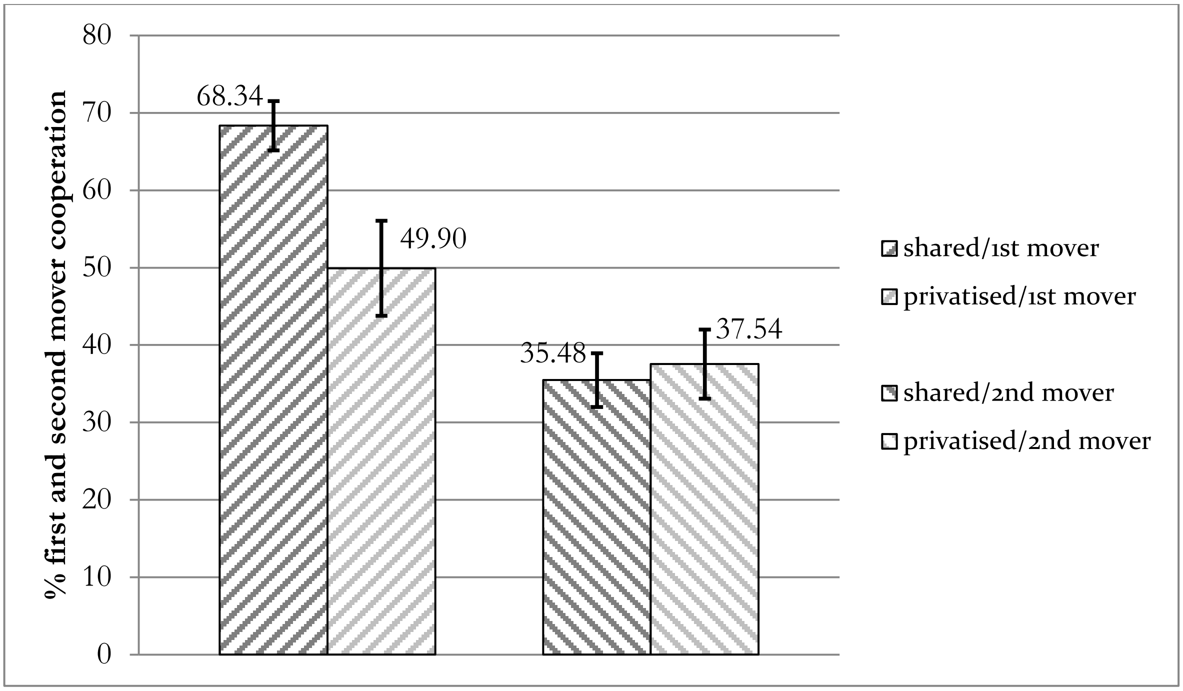
[43] Comparing the headmen characteristics in Table 3.A.2, we have no reason to believe that the headmen were significantly different across the *near* and *_further* villages. This confirms that the differences in the sharing of the solar systems are driven by village-level social capital and not village heads' characteristics.

Figure 3.7. Sharing of community solar systems and proximity to LSAIs



Next, as a simple validation exercise, we pool all villages and test for a correlation between the measures of social capital in the lab-in-the-field and the natural field experiment. It turns out that the propensity to cooperate of first-movers at the village-level indeed correlates with the extent to which solar systems are shared in the village. While the average propensity to cooperate is 49.9 percent in the 7 villages where the solar systems were fully privatized a year later, it is 68.3 percent in the 18 villages that share at least to some degree. This difference in propensities is statistically significant (two-sided Mann-Whitney test, $p = 0.0082$). The propensity to conditionally cooperate does not differ between the two categories of villages (37.5 percent for privatized and 35.5 percent for shared solar systems). Figure 3.8 provides an overview of these results.

Figure 3.8. Lab-in-the-field and natural field experiment measures



In summary, we find that our natural field experimental measure of social capital, i.e. sharing a public good, correlates significantly with one of the lab-in-the-field measures, i.e. first-mover cooperation in the sequential Prisoner's Dilemma. This is in line with literature that argues that villages with higher social capital are bound to have better communal property or public goods management (e.g. Narayan and Pritchett, 1996; Bouma et al., 2008). Our natural field experiment therefore provides some external validity for our findings from the lab-in-the-field experiment.[44]

3.6 Conclusion

The latest wave of LSAIs has prompted a growing literature that analyses the spill-over effects of these investments on communities residing in their proximity. So far this research has focused on directly observable outcomes of such investments that

[44] Similar approaches for behaviour in different domains like common pool resources, (charitable) giving and cheating are discussed by Levitt and List (2007), Stoop et al., (2012), Stoop (2014), Galizzi and Navarro-Martinez (2015), Cohn and Maréchal (2016) and Potters and Stoop (2016).

include changes in employment, input use and productivity. In this chapter, we provide first insights into the impacts of LSAIs on social capital, which is not directly observable yet highly important for economic development (Putnam, 1993; Knack and Keefer, 1997).

Using both a lab-in-the-field and a natural field experiment, we examine whether intra-village levels of cooperation among smallholders are affected by neighboring LSAIs. We formulate several hypotheses based on the literature (Arrow, 1972; Ensminger, 2004; Kajoba, 1994; Lyons et al., 1998) which argue that village communities may adjust their cooperative behavior when exposed to market-oriented systems such as those that characterize LSAIs. We indeed find evidence in favor of the communal coping and the reputation hypotheses. Smallholders in villages close to LSAIs are uncertain and jointly discuss the arrival of the investors, causing them to trust each other more than those in villages further away. Likewise, villagers who have entered an employee-employer relationship with LSAIs are more likely to trust and to reciprocate trust – an effect which intensifies with the duration of the work relationship. Our field experiment regarding the governance of a public good – a community solar system– points in the same direction of greater cooperation in communities neighboring LSAIs.

The two LSAIs selected for this study are largely representative of other LSAIs that are operational in Zambia and resemble those in other parts of Sub-Saharan Africa. Our findings may hence carry over to other countries that have similarly experienced a rise in demand for agricultural land. Future research may take a closer look at different employment modes on large-scale farms that foster positive externalities. The establishment of LSAIs constitutes only one of many examples where traditional communities are exposed to market-oriented systems in the course of economic development and structural transformation. While the overall effects of market exposure may differ from case to case, outcomes are likely to be driven by common transmission mechanisms.

3.7 Appendix: Additional figures and tables

Figure 3.A.1. The support letter from the Provincial Government

Telephone: 222421/5
Telegrams: PERMSEC: KABWE
Fax: 224256

In reply, please quote
No:...........................

REPUBLIC OF ZAMBIA
OFFICE OF THE PRESIDENT
PROVINCIAL ADMINISTRATION
CENTRAL PROVINCE
P.O BOX 80903
KABWE.

12th August 2015

TO WHOM IT MAY CONCERN

RE : INTRODUCTION LETTER

Reference is made to the subject matter above.

The Kiel Institute of World Economy, an International Centre for Research in Global Economic Affairs is conducting a study in selected areas in Chibombo, Mumbwa and Mkushi Districts. The objective of the study is to investigate the Social Capital of people living in villages and farms.

The Data Collection exercise is scheduled to commence in the last week of August 2015. A team of interviewers will visit your area and conduct group discussions with the villagers and their leaders to collect information pertaining to the study. You are requested to cooperate with the Data Collectors in order to make the research a success.

I thank you in advance for your cooperation.

Abigail K Malukutila
Assistant Secretary
For/ Permanent Secretary
CENTRAL PROVINCE

Figure 3.A.2. Correspondence with the Zambia Agriculture Research Institute

All communication should be addressed to the
DIRECTOR
Telephone: CHILANGA (+260 211) 278380 /278141/ 278130

Fax : +260 211 278130
E-mail:zaridirector@gov.zm
www.zari.gov.zm

In reply please quote:

No. *MMCR/101/13/1*

REPUBLIC OF ZAMBIA

MINISTRY OF AGRICULTURE

ZAMBIA AGRICULTURE RESEARCH INSTITUTE
MOUNT MAKULU CENTRAL RESEARCH STATION
PRIVATE BAG 7
CHILANGA

KACANA SIPANGULE
KIEL INSTITUTE FOR THE WORLD ECONOMY
HINDENBURGUFER 66
D-24105 KIEL
GERMANY

27th JULY, 2016.

Dear Madam,

REF: SOIL ANALYTICAL RESULTS

Attached are soil analytical results for the soil samples that were brought to the Soil Chemistry Laboratory for nutrient analysis.

Thank you for using the chemical testing facility of the Zambia Agriculture Research Institute for your soil analytical requirements.

Yours Faithfully,

27/07/16

H. Tembo
CHIEF AGRICULTURE RESEARCH OFFICER
For/DIRECTOR- ZAMBIA AGRICULTURE RESEARCH INSTITUTE-ZARI

Table 3.A.1. LSAIs operational in Zambia.

Name of Investor	Country of origin	Location	Hectares contracted	Crops
Lin Changming	China	Lusaka	400	Maize, Vegetables, Wheat
Hawkwood Capital LLC	United Kingdom	Choma, Kabwe, Kalomo	27087	Maize, Soya Beans, Wheat
Emvest	South Africa	Kalonga Estates	2513	Banana, Maize, Soya Beans, Wheat
Agrivision Africa (Pty) Ltd	South Africa	Mkushi	4094	Maize, Soya Beans, Wheat
AG-Zam	South Africa	Kazungula	15000	Sugar Cane
Agrivision Africa (Pty) Ltd	South Africa	Mpongwe	12822	Maize, Soya Beans, Wheat
Denbia	Denmark	Lusaka	3000	Coffee Plant, Maize, Fruit, Onion, Potatoes, Soya Beans, Sun Flower, Wheat
Amatheon Agri Holding N.V.	Germany	Kaindu (Mumbwa)	38760	Barley, Maize, Soya Beans, Wheat
Olam International Ltd.	Singapore	Kasama, Mbala, Mungwi	4380	Coffee Plant, Maize, Sun Flower
Crookes Brothers Ltd	South Africa	Mazabuka	440	Sugar Cane
InfraCo Limited	United Kingdom	Kafue	1575	Barley, Sorghum, Maize, Soya Beans, Wheat
Ambika	Russia	Mkushi	1700	Maize
Herdon Investments	United Kingdom	Chibombo	650	Sun Flower, Soya Beans
Vixers Farming	Zimbabwe	Chibombo	1200	Soya Beans
Tiso Blackstar	South Africa	Mpande	990	Maize, Soya Beans

Data downloaded on August 28, 2016 from the Land Matrix website (http://www.landmatrix.org/en/get-the-detail/by-target-country/zambia/)

Table 3.A.2. Village head characteristics

	_***near*** **villages**		_***further*** **villages**		
Variable	**Mean**	**SD**	**Mean**	**SD**	**p-values**
First mover cooperation	0.62	0.51	0.63	0.5	0.96
Second mover cooperation	0.08	0.28	0.06	0.25	0.88
No. household members	7	2.92	7.56	3.22	0.52
Age	56.31	13.84	59.31	16.5	0.48
Asset index based on pca	0.55	0.18	0.47	0.15	0.39
Household sells crops	0.75	0.45	0.81	0.4	0.69
Hectares cultivated	9.98	8.81	12.56	11.3	0.49
Land title	0	0	0.13	0.35	0.19
Male (dummy, 1=yes)	0.77	0.44	0.94	0.25	0.19
Married	0.85	0.38	0.81	0.4	0.81
Education in years	5.54	3.93	5.56	3.18	0.98
Literacy (with 5 being the highest value)	2.85	1.38	2.75	0.86	0.86
Smallholder	0.92	0.28	1	0	0.27
LSAI worker(dummy, 1=yes)	0.23	0.44	0.13	0.34	0.45
Number of headmen	13		16		

Table 3.A.3. Regression analysis of second mover conditional cooperation and length of employment

Independent Variables	(1) Logit regression	(2) Logit regression
Amount of time worker worked on farm	0.055*	0.058**
	(0.029)	(0.026)
_*near* village (dummy, 1 = yes)		-0.015
		(0.081)
Age (continuous)		-0.000
		(0.003)
Male (dummy, 1 = yes)		-0.168**
		(0.080)
Born in the village (dummy, 1 = yes)		-0.105
		(0.075)
Education in years (continuous)		0.000
		(0.011)
Observations	180	177

Note: The table presents marginal effects. The observations from the control villages are the baseline of the estimations. Statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

3.8 Appendix: Instructions

Introduction

Thank you all for taking the time to come today. Today's activities may take three to four hours. Before we begin I want to make some general comments about what we are doing here today and explain the rules that we must follow.

We will ask each of you to make decisions involving money and to answer a few questions. Whatever money you earn during the activities will be yours to keep and take home. Nobody but the researchers and you will know what you decided and earned, and money will be given in private. No other participant will learn about your decisions and earned money. We will be supplying the money. This money was given to us by the London School of Economics, a university in Great Britain, to use for research and it is not our own personal money.

Before we proceed any further, let me stress something that is very important. Many of you were invited here without knowing very much about what we are planning to do today. If at any time you find that this is something that you do not wish to participate in for any reason, you are of course free to leave whether we have started the activity or not.

We will be asking you to do three activities with other individuals in your village today. Your earnings from all three activities sums to your total earnings. You will be informed about the outcomes in the three activities and your total earnings in private at the end of all activities.

If you have heard anything about these types of activities, you should try to forget about that because each activity can be completely different. It is important that you listen as carefully as possible.

We will run through some examples of how the activities work. You cannot ask questions or talk while here in the group. This is very important. Please be sure that you obey this rule, because it is possible for one person to spoil the activities for everyone. If one person talks about the activities while others can hear it, we would not be able to carry out the activities today. Do not worry if you do not completely understand the rules as we go through them here in the group. Each of you will have a chance to ask questions in private to be sure that you understand how the activities work.

Before we explain the activities we divide you into two groups, the Green Group and the Black Group, according to the colored cards that you have drawn from the bag a moment ago. The two groups will separate, so that green-card people and black-card people cannot see or hear each other.

After we have explained the activities, you will all wait in a group. We will call you by the number on your ticket, so please listen carefully for your number. While you are waiting you can talk about anything else you want other than the activities here today.

Activity 1 – Black Group

In activity 1 you can choose between two options: Pink and Yellow. Another person from the Green Group, who is randomly matched with you, also chooses between Pink and Yellow.

You decide first and then the other person from the Green Group will decide second.

Your payment and the payment of the other person depend on your own decision and the decision of the other person:

If you choose Pink and the other person also chooses Pink, then you will receive 40 kwacha and the other person will also receive 40 kwacha.

If you choose Yellow and the other person chooses Pink, then you will receive 50 kwacha and the other person will receive 5 kwacha.

If you choose Pink and the other person chooses Yellow, then you will receive 5 kwacha and the other person will receive 50 kwacha.

If you choose Yellow and the other person also chooses Yellow, then you will receive 30 kwacha and the other person will also receive 30 kwacha.

Remember, you decide first and then the other person from the Green Group will decide second.

Please choose on the sheet of paper by marking your choice with the pen on the Pink or the Yellow arrow.

Activity 1 – Green Group

In activity 1 you can choose between two options: Pink and Yellow. Another person from the Black Group, who is randomly matched with you, also chooses between Pink and Yellow.

You will decide second; that is, the other person from the Black Group decides before you.

Your payment and the payment of the other person depend on your own decision and the decision of the other person:

If you choose Pink and the other person also chooses Pink, then you will receive 40 kwacha and the other person will also receive 40 kwacha.

If you choose Yellow and the other person chooses Pink, then you will receive 50 kwacha and the other person will receive 5 kwacha.

If you choose Pink and the other person chooses Yellow, then you will receive 5 kwacha and the other person will receive 50 kwacha.

If you choose Yellow and the other person also chooses Yellow, then you will receive 30 kwacha and the other person will also receive 30 kwacha.

You will decide second; that is, the other person from the Black Group decides before you.

Please choose on the sheet of paper by marking your two choices, one for each of the two possible scenarios, with the pen on the Pink or the Yellow arrow.

4 Market exposure makes females behave more competitively and closes the gender gap[ζ][ψ]

4.1 Introduction

Competitiveness is a key component of success in modern market economies. Firms compete for customers, employees compete for positions, politicians compete for voters, and students compete for university placements. The origins of individual competitiveness have been of great interest for economists in recent years. The literature shows that differences in competitiveness already exist among children and depend on parental backgrounds and attitudes (Almas et al., 2015; Deckers et al., 2015; Khadjavi and Nicklisch, 2015). Beyond parental influences, behavioral economic research suggests that societal arrangements influence individuals' preferences for competition, especially gender differences (Andersen et al., 2013; Buser et al., 2014; Croson and Gneezy, 2009; Niederle and Vesterlund, 2007; Gneezy et al., 2003; Gneezy et al., 2009; Leibbrandt et al., 2013; Sutter and Glätzle-Rützler, 2015).

Most changes in societal arrangements, like the extent of gender equality and market integration, happen endogenously and over a long time horizon. This feature makes it hard to identify causal effects of societal arrangements on its members' preferences. For instance, Henrich et al. (2001, 2004, 2010) and Henrich and

[ζ] This chapter has been co-authored with Menusch Khadjavi and Rainer Thiele.

[ψ] Funding from the International Growth Centre at the London School of Economics and Political Science under the project number 1-VRS-VZMB-VXXXX-89311 is gratefully acknowledged.

Ensminger (2014) provide compelling evidence that market exposure correlates with pro-social behavior in small-scale societies. With regard to gender differences, Alesina et al. (2013) show that present day norms and beliefs on gender equality are greatly influenced by the adoption of traditional agricultural practices such as the historical use of ploughs. Likewise, Gneezy et al. (2009) and Andersen et al. (2013) provide evidence on differences in competitiveness in matrilineal and patriarchal societies. Leibbrandt et al. (2013) show how work arrangements based on natural circumstances influence competitiveness while Siddique and Vlassopoulos (2017) find that ethnicity is an important determinant of competitive preferences.

All these findings yield valuable insights into the emergence and endogenous development of competitive preferences through changes in long-term societal arrangements (Bowles, 1998). The aim of this study is to complement previous findings of mostly long-term effects with an example of rather short-term effects, which is more likely to allow for a causal interpretation. One of the few studies that investigate how competitive preferences are shaped by a relatively short-run societal change is by Booth et al. (2016), who analyze how social norms for different birth cohorts in mainland China and Taiwan have been influenced by the adoption of capitalist market-oriented reforms and Marxist ideology over a period of four decades.

In this chapter, we take advantage of an exogenous change over an even shorter time period that has affected small-scale farmers in a number of developing countries: rapid market exposure through the set-up of large-scale farms. Following the triple fuel, food and financial crisis of the years 2008 to 2009, investors from multinational firms have expressed a large interest in agricultural land in developing countries. Currently more than 1000 deals that cover an area of approximately 40 million hectares (an area comparable to the size of Zimbabwe or Paraguay) have been concluded (Nolte et al. 2016). Being market-oriented, highly mechanized, and capital intense, these investments often acquire land next to small-scale farmers that typically have low productivity levels, limited access to markets, and are subsistence oriented. This situation mirrors the encounter of two classic antithetical paradigms of rural farming and development, where the small-scale farmers represent a communal peasant economy and the agricultural firm represents the modern market economy (Timmer, 1997).

To investigate how the competitive behavior of small-scale farmers is altered by the establishment of large-scale farms, we employ the lab-in-the-field experiment first used by Gneezy et al. (2009). More specifically we analyze the decisions to compete made by 442 small-scale farmers in 13 randomly selected villages located within a 15 kilometer radius of two large-scale-farms and compare them with the decisions of 484 similar small-scale farmers from 16 randomly selected villages that are located 50-75 kilometers further away from the two large-scale farms. Our central hypothesis is that exogenous market exposure that is introduced through the set-up and operation of large-scale farms leads to more competitive behavior of small-scale farmers.

The results from the lab-in-the-field experiment provide strong evidence in favor of this hypothesis. We find that female small-scale farmers that have experienced exogenous rapid exposure to market oriented agriculture are more willing to compete than those that have no such exposure. Interestingly, male small-scale farmers' competitive behavior is determined by endogenous market exposure through crop sales and not exogenous market exposure. This is likely to be due to the fact that male small-scale farmers are already exposed to factors that raise their competitiveness such as better access to assets and patrilineal norms which undermine the effect of exogenous market exposure. In communities near large-scale farms, females' competitive behavior is raised to the extent that the gender gap in competitive behavior is leveled off in communities near large-scale farms. These results are further corroborated by a comparison of the competitive behavior of children (aged 5 to 15) from the two sets of villages. We find that children living in villages close to large-scale farms are significantly more competitive than their counterparts in villages further away.

The remainder of our chapter is structured as follows: Section 4.2 provides a brief description of the study context. This is followed by an explanation of the experimental design and procedure in Section 4.3. Section 4.4 presents the main results and some robustness checks. Section 4.5 concludes.

4.2 Study context

The study was conducted in the Mumbwa and Mkushi regions of Zambia's Central Province. These two regions were selected as they both have large-scale farms that were recently set up in the proximity of small-scale farming communities. The farm in Mumbwa was allocated an area of over 30,000 hectares and cultivates nearly one tenth of this land. It began its operations in 2012. The land investment in Mkushi was set up in 2010 and consists of 6 farms that together account for approximately 4000 hectares. These farms can be considered large for a country like Zambia where more than 70 percent of farmers cultivate less than 2 hectares of land and another 23 percent cultivate plots of land that range between 2 and 5 hectares (CSO, n.d). The two large-scale farms both operate in competitive market environments and seek to become major suppliers of wheat and maize for Zambia and her neighboring countries. As a means of achieving its goal of becoming a major player in Sub-Saharan Africa's food production, the large-scale farm in Mumbwa recently expanded its farming division to incorporate livestock and is now the second largest meat company in Zambia (Amatheon Agri, 2015). The two farms are representative of other large-scale farms in Zambia and sub-Saharan Africa in a number of regards: they are similar in size, cultivate similar crops, were set up at almost the same time and target the same markets as other farms of the same magnitude (Harding, 2017; Khadjavi et al., 2017).

This competitive environment driving the two large-scale farms is in contrast to the conditions facing neighboring small-scale farmers who are mostly reliant on low–productive, rain-fed agriculture. Small-scale farmers' competition and full market participation is hindered, for instance, by their limited access to productive assets (Deininger and Olinto, 2000). Chapoto and Jayne (2011) show that in the years 2010/2011 less than 50 percent of the small-scale farming households in Central Province participated in and sold their output on maize markets. The bulk of this output (90 percent) was sold directly on small-scale farms to traders. The authors point out that there is a reasonable degree of competition to purchase maize within these villages. Villages that sell maize in Central province are visited by 7 different traders on average, which makes the environment especially competitive for traders. However, the high supply of traders per village means that the small-scale farmers do not have to compete aggressively to sell their output.

This setting makes it interesting for us to examine how the exposure to competitive, highly productive and market-oriented large-scale farms affects small-scale farmers' preferences for competition. We posit that exposure to market-oriented large-scale farms will increase small-scale farmers' individualism and willingness to participate on the market as has been found in previous research (Kajoba, 1994). Since competitive behavior can be regarded as a key ingredient to participate in market economies we expect that small-scale farmers that have been exposed to large-scale farms will become more competitive.

Moreover, we also expect that those farmers who have already had some degree of market exposure through the sale of their produce to traders will be more accustomed to competition and will hence display a higher willingness to compete. Thus, in the context of our study, we expect that market exposure, be it exogenous (through large-scale farms) or endogenous (through crop sales), increases the competitive behavior of small-scale farmers.

4.3 Experimental design and procedures

29 villages were visited between mid-August and September 2015 and again in July, 2016. The villages where randomly selected using maps and village lists provided by the Zambian Central Statistical Office (CSO) in Lusaka. 13 villages within a radius of 15 kilometers from the two large-scale farms (*_near* villages) and 16 villages (*_further* villages) within a 50 to 70 kilometer radius from the large-scale farms were selected.

Once the *_near* and *_further* villages were identified, village heads were approached to request permission to conduct the lab-in the-field experiments in their village. Unaware of the true motive of the research questions, the village heads were asked to invite all adults in the village to participate in an incentivized study that sought to analyze socio-economic conditions in the villages. A total of 442 adult participants took part in these experiments in *_near* villages and 484 in *_further* villages.

In order to elicit the impact of exogenous market exposure on participants' competitive behavior, the incentivized competition game of Gneezy et al. (2009) was employed.[45] This experiment was selected due to its simple nature that makes it suitable for a setting such as ours where more than half of the study participants could not read or write well in English or in the main regional languages (Nyanja or Bemba). In addition to being simple, the experiment is well suited for such a setting as the task (throwing ten tennis balls using an undertoss) is unfamiliar.

Before tossing the balls, participants were asked to decide between two options: Option A and Option B. Option A meant that the participant earned 5 Zambian

[45] The game was the third and last task, after a sequential prisoner's dilemma to measure social capital and a deception game. Khadjavi et al. (2017) provide further information on the results from the sequential prisoner's dilemma.

Kwacha (approx. $0.50 at the time of the study) for each successful toss into the bucket. Option B paid 15 Zambian Kwacha (approx. $1.50) for each successful toss (the threefold amount of Option A) to the participant, but only if the participant scored more tennis balls into the bucket than an anonymous randomly matched participant from the same village. Hence, the payment in Option A was a piece rate that was independent of other participants' success while the payment in option B was a combination of a piece rate and a competition. If a participant scored fewer balls into the bucket than the other participant, then she/he received no money in the game under Option B. In case of equal scores, Option B yielded 5 Zambian Kwacha for each successful throw (just like Option A).[46] Ten successful tosses could earn the participants 150 Zambian Kwacha. The payoffs from competing can be considered as high since the average rural per capita monthly income was estimated at 185.9 Zambian Kwacha during the period in which the study was conducted (CSO, 2016).

After a participant made her decision on the option and tossed the tennis balls, she was directed to a spatially separate waiting area. This measure ensured that neither the two groups nor participants within each group could communicate the task, their decisions or scores. Great caution was undertaken to ensure that all tosses were made in secluded areas with natural barriers to block other participants from learning about the scores of their companions. Figure 4.A.1 in Appendix 4.6 illustrates such a set-up.

To investigate whether children's competitive behavior is also altered by adults' market exposure, we adjusted the nature of the pay-offs so that they were no longer monetized. The incentive structure for children was the same, except that they earned 1 (Option A) or 3 marbles (Option B, if own_score > other_score) for each scored tennis ball. Marbles themselves are valuable to children as they are

[46] Appendix 4.7 contains the instructions of our study.

commonly used by children in Zambia to play traditional games such as *Nsolo* (a variant of the board game Mancala).[47] After receiving their earnings, the children were informed that they may retain the marbles or exchange them for other toys and school stationary (at exchange rates mirroring market prices). 401 children between the ages of 5 and 15 participated in our competition game. Children were only allowed to participate in the experiment after they had been granted permission by their parents or guardians.

Recognizing that it would be extremely difficult and costly to design such a study within a panel setting that tracks the evolution of competitive behavior before and after the establishment of a large-scale farm, we undertake several measures to ensure that the *_further* villages are a good counterfactual for the *_near* villages. First, we compare the possible determinants of small-scale farmers' competitive behavior prior to the establishment of the large-scale farms. As shown in Table 4.1, a large set of pre-treatment village characteristics, such as population density, rainfall and access to infrastructure, do not differ significantly between *_near* villages and *_further* villages.

Second, we compare small-scale farmer and village level characteristics after the establishment of the large-scale farm and only find significant differences in the mean age of small-scale farmers, in the number of small-scale farmers that have worked on large-scale farms as well as the number of small-scale farmers solely engaged in crop sales. However, these differences are not surprising as it can be expected that there is a larger number of farm workers in the vicinity of large-scale farms and a higher number of small-scale farmers engaged in crop sales further away from the large-scale farms since alternative employment opportunities are unavailable.

[47] Marbles have also been used as a form of payment for children in other experimental studies that sought to elicit children competitiveness, for instance see Madsen (1971).

Table 4.1. Summary statistics by village type

	_near villages		*_further* villages		
Variable	**Mean**	**SD**	**Mean**	**SD**	**p-values**
	Individual and household characteristics				
Household head	0.46	0.09	0.49	0.13	0.32
Number of household members	6.35	0.81	7.11	1.08	0.07
Male	0.55	0.15	0.47	0.12	0.12
Age	35.07	2.46	41.11	5.25	**0.00**
Years in education	6.56	1.08	6.52	0.86	1.00
Large-scale farm worker	0.52	0.26	0.24	0.18	**0.00**
Recently migrated to the village	0.20	0.16	0.17	0.13	0.68
Asset index	0.42	0.03	0.41	0.10	0.46
Land title	0.35	0.29	0.31	0.29	0.66
Crops sold	0.68	0.61	0.82	0.10	**0.03**
Crop index	0.21	0.06	0.20	0.06	0.46
	Village characteristics				
Village size (hectares)	413.00	579.19	1112.56	2069.41	0.90
Ethnic groups in village	8.46	3.31	7.84	3.11	0.55
Village is patrilineal	0.15	0.38	0.38	0.50	0.19
	Pre-treatment village characteristics				
Population density (pixel)	5.50	0.52	5.54	0.52	0.85
Population density (5 km buffer)	5.50	0.52	5.54	0.51	0.74
Mean monthly rainfall (pixel)	81.29	3.32	80.05	5.59	0.47
Mean monthly rainfall (5 km buffer)	81.26	3.05	80.18	5.73	0.51
Elevation (pixel)	1213.85	28.82	1250.63	140.12	0.83
Elevation (5 km buffer)	1221.39	28.56	1252.24	132.78	1.00
Mean monthly maximum temperature (pixel)	30.47	0.49	30.08	1.32	0.98
Mean monthly maximum temperature (5 km buffer)	30.42	0.50	30.08	1.25	0.86
Distance to nearest road	0.49	0.61	1.54	2.14	0.20
Distance to nearest water line	1.97	1.13	1.79	1.83	0.33
Distance to nearest rail	71.90	77.57	63.82	65.45	0.20

Note: The p-values are based on two-sided Mann-Whitney tests on the village-level. The asset index includes information on the households' possessions of livestock holdings, radios, agricultural equipment, transportation, as well indicators of the quality of housing.

Importantly, we do not find any significant differences across gender, ethnicity and whether the village has a patrilineal lineage. These variables have been identified in the literature as key determinants of competitive preferences (Croson and Gneezy, 2009; Siddique and Vlassopoulos, 2017; Gneezy et al. 2009).

Third, we collected soil samples from all the villages visited to test whether differences in soil quality could influence the location of large-scale farms and the competitiveness of small-scale farmers. Fourth, we conducted interviews with the large-scale farm managers and the Investment Promotions Officer at the Zambian Development Agency - which is the agency charged with promoting and facilitating investments - to ensure that villagers' preferences did not play a role in the settlement of the investors. Fifth, to make sure that other forms of market integration were not driving the results we kept access to roads constant across both sets of villages. None of these additional cautionary measures revealed that small-scale farmers in *_near* villages are systematically different from their counterparts in *_further* villages.

4.4 Results

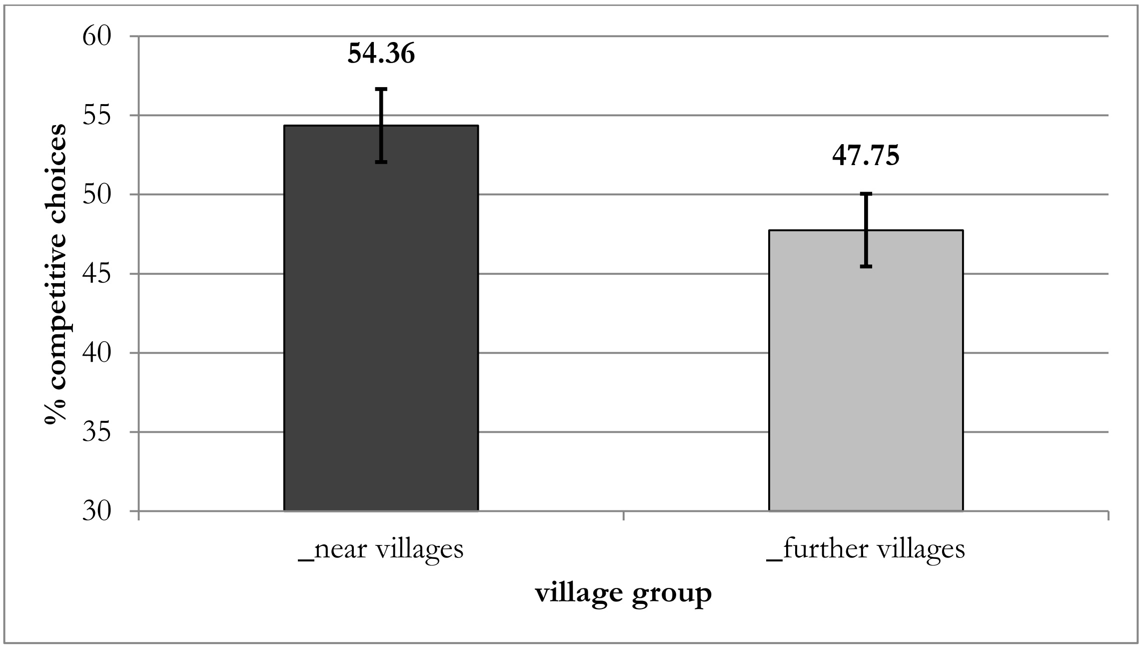
We first report the results of the lab-in-the-field experiment with the adult participants. This is followed by the results of the same experiment with children aged 5 to 15 years old in a subset of villages. Finally, we present a robustness check where our main explanatory variable of interest, distance from the investment farms, is continuous rather than dichotomous as in the base specification.

4.4.1 Adults

In line with our central hypothesis, we indeed find that participants in *_near* villages are more likely to choose the competitive option (54.36 percent) when compared to participants in *_further* villages (47.75 percent).

This difference of about 14 percent is statistically significant based on a (two-sided) chi-squared test ($p < 0.05$). Note also that the share of competitive choices in *_near* villages is greater than chance (binomial test, $p < 0.05$). Figure 4.1 depicts this result.[48]

Figure 4.1. Competitive choices of adults by village group



Given the rich data collected in the survey, we investigate whether the results presented in Figure 4.1 hold after controlling for individual, household and village level socio-economic observables. We also include a variable that indicates whether a participant sells crops as our proxy for market integration and estimate a logit regression of the following form:

$$y_i = \alpha_i + \beta_1\tau_v + \beta_2\mu_i + \beta_3\chi_{ihv} + \beta_4\rho_r + \varepsilon_{ihv}$$

where y_i represents the individual's decision to choose the competitive option, τ_v is a dichotomous variable equal to 1 for *_near* villages, μ_i is a variable that indicates whether an individual engages in crop sales, and χ_{ihv} is a vector of individual, household and village-level socio-economic variables. ρ_r is used to control for any

[48] See Figure 4.A.2 in Appendix 4.6 for histograms of competition game scores in our two village groups. A Kolmogorov-Smirnov test cannot reject the null hypothesis of equal distributions in the two village groups ($p > 0.2$).

region-specific effects while ε_{ihv} is the error term. As a robustness check we replace τ_v with a continuous variable δ_v measuring the distance from the large-scale farm to the villages. Since the outcome variable y_i is dichotomous, we estimate all specifications with logit regressions and report the marginal effects in the tables below.

We find consistent evidence that competitive behavior is stronger in *_near* villages even after estimating different specifications that introduce step-wise controls for individual, household and village-level socioeconomic characteristics (columns I, II and III). Further, we find that small-scale farmers who sell crops on markets are significantly more competitive than small-scale farmers that do not engage in such crop sales.

Interestingly, the two channels of market exposure, (1) the effect of living close to large-scale agricultural investments and (2) selling crops on markets, affect competitiveness jointly. We therefore find clear evidence that both endogenous market integration (the decision to sell crops on markets) and exogenous market exposure (the settlement of agricultural investments next door) increase competitiveness.

In addition, we obtain evidence that village level characteristics that have been identified as determinants of competitive behavior in existing literature also affect the decision to compete of participants in our study. First, we observe that an increase in the number of ethnicities in a village significantly reduces participants' willingness to compete. This is in line with Siddique and Vlassopoulos (2017), who also find a reluctance to participate in competition games when the pool of potential competitors is multiethnic in Bangladesh.

Table 4.2. Regression analysis of adults' competitive behavior

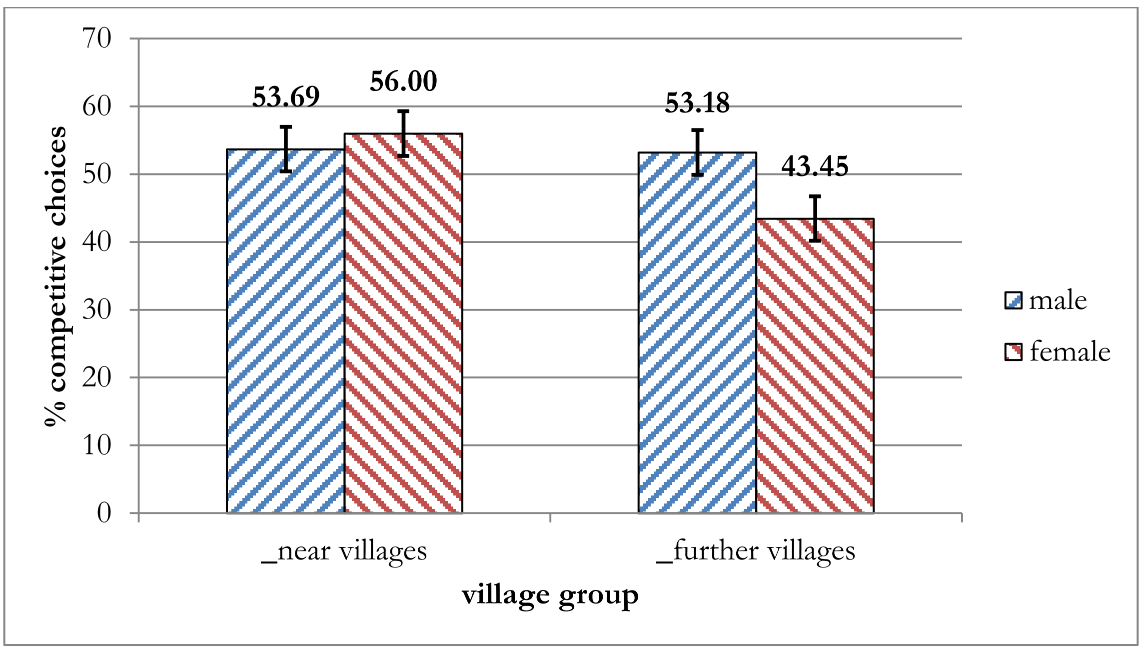
VARIABLES	I Logit	II Logit with individual and household controls	III Logit with household and village controls
_*near* village = 1	0.093**	0.084*	0.145***
	(0.044)	(0.043)	(0.039)
Household sells crops = 1	0.123**	0.111**	0.110**
	(0.052)	(0.053)	(0.054)
Household head = 1		0.010	0.018
		(0.050)	(0.051)
No. of household members (continuous)		-0.003	-0.002
		(0.007)	(0.007)
Age (continuous)		-0.000	-0.001
		(0.001)	(0.001)
Male = 1		0.025	0.024
		(0.053)	(0.056)
Education in years (continuous)		0.001	0.001
		(0.006)	(0.007)
Large-scale farm worker = 1		0.021	0.015
		(0.041)	(0.041)
Migrated after large-scale farm = 1		-0.045	-0.042
		(0.050)	(0.051)
Asset index based on pca		-0.023	-0.002
		(0.083)	(0.084)
Crop index based on pca		0.091	0.099
		(0.077)	(0.075)
Land title = 1		0.060	0.063
		(0.051)	(0.051)
Village area (continuous)			0.000
			(0.000)
No. of ethnic groups i (continuous)			-0.013*
			(0.007)
Village is patrilineal = 1			0.118*
			(0.061)
Region = 1	0.008	0.036	-0.025
	(0.046)	(0.047)	(0.043)
Observations	842	795	795

Note: The table presents marginal effects, except for the constant of the estimation. The observations from the _further control villages are the baseline of the estimations. The standard errors in parentheses are clustered at the village-level (29 villages) in all estimations. Statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

Second, we find that being in a patrilineal village increases participants' willingness to compete. This is in line with Gneezy et al. (2009), who use the same game as we do and show that nurture in matrilineal and patriarchal settings plays a significant role in shaping competitive preferences. Surprisingly, in contrast to previous studies (e.g. Croson and Gneezy, 2009; Booth and Nolan, 2012), we do not find that gender influences competitive behavior.

This null result on gender is particularly surprising in the context of rural Zambia where differences in gender equality and ideologies are prolific (Evans, 2017). We further explore this puzzling outcome by comparing the competitive behavior of female and male participants in the two village groups.

Figure 4.2. Competitive choices by village group and gender



In *_further* villages we indeed find that female participants are more likely to shy away from competition as pointed out in the literature on gender and competitiveness (Croson and Gneezy, 2009; Booth and Nolan, 2012): 43.45 percent of females and 53.18 percent of males opt into competition. A chi-squared test rejects the null hypothesis at $p < 0.05$. Conversely, in *_near* villages 56.00 percent of females and 53.69 percent of males opt into competition. This difference is not significant ($p > 0.6$). Figure 4.2 depicts the results.

To better understand what might be driving these results, we run a logit regression disaggregated by gender and control for the same socioeconomic variables as in Table 4.2.

Table 4.3 reports the results for male participants in the first two columns and for female participants in the last two columns. This time we find that male participants' competitive behavior is determined by endogenous market exposure (crop sales) while female participants' competitive behavior is driven by exogenous market exposure (proximity to the large-scale farms). We no longer find that both forms of market exposure jointly affect competitive behavior.

This result on the heterogeneous effects of market exposure is puzzling as it indicates that different mechanisms drive male and female competitive behavior. Comparing the males and females in our sample in Table 4.A.1 in the appendix, we observe that the percentage of study participants who report that they are engaged in crop sales is balanced. However, despite the fact that there are no significant differences in crop sales across both sexes, endogenous market exposure is only important for males. This is likely to be driven by prevailing norms and customs in rural Zambia that favor male participation in the labor and agricultural markets and assign domestic and agricultural roles to women (Evans, 2017). Thus, even though the males and females in our study are both engaged in crop sales, males may be more proactive in these markets while females may have to balance crop sales along with agricultural work and other domestic chores.[49]

[49] Crop sales are reported as a binary variable thus we cannot estimate the intensity of male and female sales.

Table 4.3. Regression analysis of adults' competitive preferences by gender

VARIABLES	IV Logit (Males)	V Logit (Males)	VI Logit (Females)	VII Logit (Females)
_Near village = 1	0.034	0.062	0.141**	0.203***
	(0.051)	(0.055)	(0.063)	(0.073)
Household sells crops = 1	0.180***	0.140**	0.070	0.087
	(0.056)	(0.060)	(0.066)	(0.067)
Household head = 1		0.085		-0.027
		(0.075)		(0.062)
No. of household members (continuous)		-0.003		-0.001
		(0.009)		(0.009)
Age (continuous)		-0.002		-0.000
		(0.002)		(0.002)
Education in years (continuous)		0.007		-0.005
		(0.009)		(0.009)
Large-scale farm worker = 1		0.032		-0.011
		(0.057)		(0.058)
Migrated after large-scale farm = 1		-0.049		-0.033
		(0.060)		(0.100)
Asset index based on pca		0.022		-0.097
		(0.130)		(0.147)
Crop index based on pca		0.052		0.178
		(0.086)		(0.142)
Land title = 1		0.145**		0.020
		(0.074)		(0.069)
Village area (continuous)		0.000*		0.000
		(0.000)		(0.000)
No. of ethnic groups (continuous)		-0.010		-0.015
		(0.010)		(0.012)
Village is patrilineal = 1		0.111*		0.116
		(0.059)		(0.108)
Region = 1	-0.031	-0.023	0.032	-0.028
	(0.051)	(0.069)	(0.065)	(0.083)
Observations	419	402	423	393

Note: The table presents marginal effects, except for the constant of the estimation. The observations from the _further control villages are the baseline of the estimations. The standard errors in parentheses are clustered at the village-level (29 villages) in all estimations. Statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

Examining the remaining socio-economic characteristics in Table 4.A.1, we observe that males are more educated, own more assets and cultivate a more diverse selection of crops. In addition, males are more likely to head households than females. This suggests that females are more economically disadvantaged than their male counterparts. Considering that males have significantly more productive resources and that there are multiple factors jointly affecting their competitive behavior (see Table 4.3), exogenous market exposure may have a minimal effect on them since they already behave competitively. Thus given the setting, it is reasonable that females are more responsive to exogenous market exposure as there are no other factors that simultaneously affect their competitive behavior.

To further understand the mechanisms in which exogenous market exposure affects females' competitive behavior, we interact the dummy variable that indicates a village is near a large-scale farm with females' socioeconomic characteristics. These results are reported in Table 4.A.2 in the appendix. We do not find that females' competitive behavior is raised because large-scale farms increase female asset holdings or employment opportunities. This indicates that other mechanisms are driving the observed effect.

A study that analyzes willingness to compete in rural and urban Uganda by Bjorvatn et al. (2016), finds a gender gap in competitiveness for rural areas but not for urban settings. The authors argue that these results are driven by the rural context where attitudes towards women are negative. In a similar vein, considering that large-scale farms bring development opportunities to rural areas, it is likely that exogenous market exposure raises females' awareness of opportunities that were previously unavailable and weakens the prevailing norms that are disadvantageous to women. While our data cannot confirm that market exposure increases females competitive behavior through empowerment and exposure to opportunities, evidence for an analogous effect in Zambia is provided by Evans (2017) who uses ethnographic data from a rural and urban setting in the Luapula and Copperbelt provinces and finds that exposure to women that are engaged in socially valued roles erodes masculine gender ideologies.

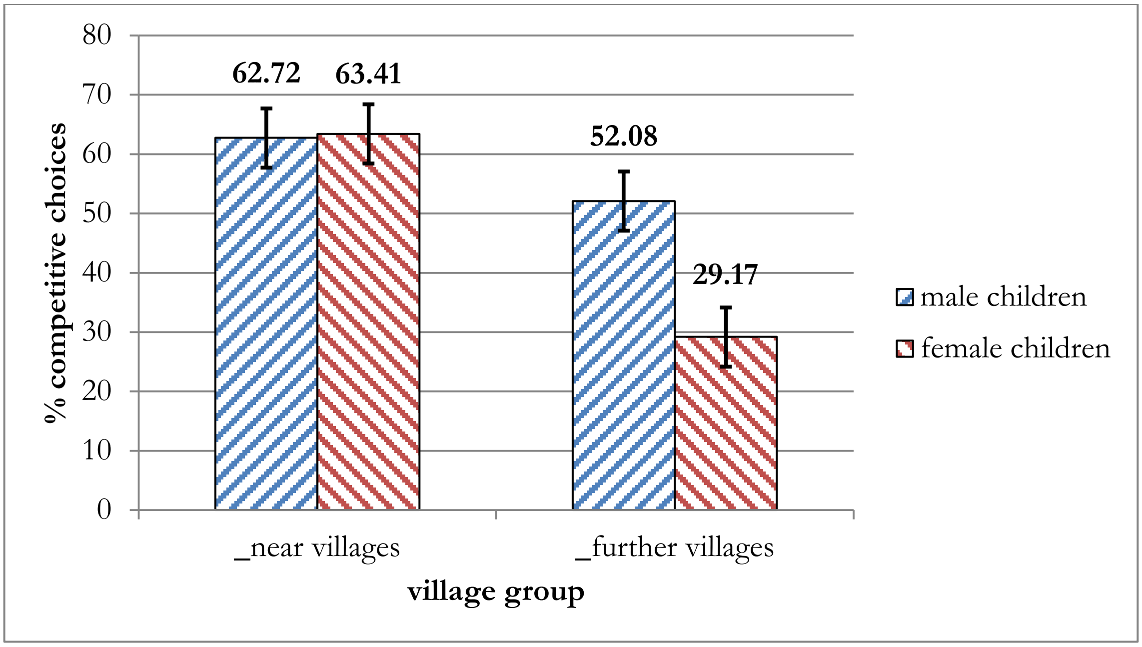
Overall, we can conclude that exogenous market exposure in our rural, developing country setting balances the competitiveness of females and males. The effect is so large that it closes the commonly associated gender gap. This finding may provide an additional element in the quest for measures to overcome gender differences (e.g. Balafoutas and Sutter, 2012; Niederle et al., 2013).

4.4.2 Children

Next we complement our analysis of adults' competitive behavior with children's behavior. Analyzing children's behavior is interesting, as they may be more receptive to short-term changes in their environment. While adults have developed their preferences over decades, children are at the prime of their preference formation.

We find a similar effect of exogenous market exposure: there are a significantly higher number of participants who decide to make competitive choices in *_near* villages compared to *_further* villages (63.09 percent vs. 42.26 percent respectively, two-sided chi-squared test: $p < 0.000$). Examining the results of females and males separately, we find that both genders are more competitive in *_near* villages compared to *_further* villages (see Figure 4.3). Analogous to the results that we obtained for adults in Figure 2, we find a large gender gap in competitiveness for *_further* villages (52.08 percent for males vs. 29.17 percent for females, chi-squared test: $p < 0.01$), but not for *_near* villages (62.72 percent for males vs. 63.41 percent for females, (chi-squared test: $p > 0.9$).

Figure 4.3. Competitive choices of children by gender and village group.



Controlling for all other available variables regarding the children (age, number of scored tennis balls in the competition game and region of data collection) in a logit regression analysis confirms these results (see Table 4.A.3 in Appendix 4.6 for details).[50]

It is likely that children's competitive behavior is influenced by that of adults (Almas et al., 2015; Deckers et al., 2015; Khadjavi and Nicklisch, 2015). In *_near* villages, females may pass on their competitive preferences to their children which cause competitive behavior to rise for both their male and female children. Although these suggested mechanisms are in line with existing literature that point out how children's competitive behavior is shaped by their parents socioeconomic characteristics and preferences, more data that explains how exactly these changes come about would be required to establish strong causal relations.

[50] Other information on children's socioeconomic variables was not collected due to ethical and time considerations.

4.4.3 Robustness of results

In order to investigate whether the two main results obtained on exogenous market exposure reported in Tables 4.2 and 4.3 are robust, we change the specification of our main variable of interest from a dichotomous variable that is equal to 1 if a village is near a large-scale farm to a continuous variable that indicates the distance away from the large-scale farm. All other individual, household and village-level socio-economic controls from the previous specifications are retained. The results are reported in Table 4.A.4. We now see that an increase in the distance away from the large-scale farms significantly reduces the likelihood that a participant will engage in competition. This corroborates our result that proximity to a large-scale farm increases competitive behavior.

Next we investigate whether we observe heterogeneity in the drivers of male and female competitive behavior as reported in Table 4.3. These results are reported in Table 4.A.5. Again we find that exogenous market exposure, which is now measured as the distance from the large-scale farm, is only pertinent for female participants. We do not find evidence indicating that these preferences are driven by other factors for female participants. The main determinants of males' competitive preferences remain unchanged.

4.5 Conclusion

Our investigation concentrates on the encounter of two economic and farming systems which are at the extremes along the dimension of market exposure. There is peasant, small-scale farming on the one hand and capital-intense market-oriented large-scale farming by the global agricultural industry on the other hand (Timmer, 1997). Our result is that living in the proximity of large-scale agricultural investment sites makes small-scale farmers more competitive compared to similar small-scale farmers who live at a distance to the investment sites. We regard this finding as highly important for agricultural policy and for the broader understanding of what kind of societal arrangements may influence individuals' preferences (Bowles, 1998).

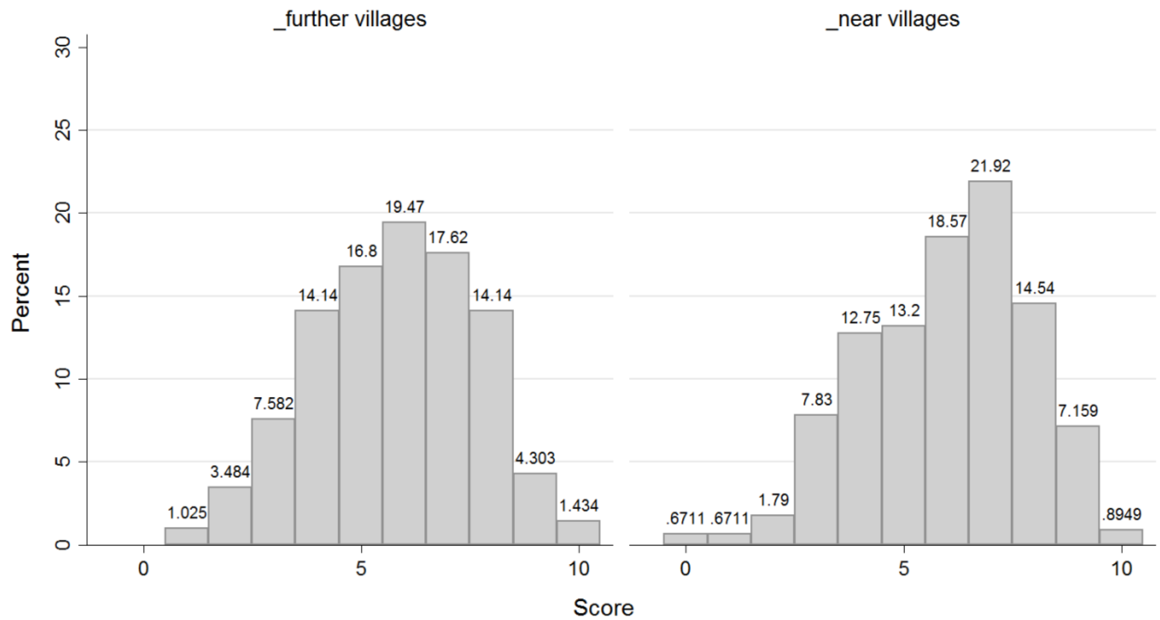
Depending on the desirability of competitiveness in society, this externality by large-scale farms may be regarded as a benefit or a cost. In the specific case of rural Zambia, we believe that moving small-scale farmers' preferences towards greater competitiveness may increase their market participation and thereby enable them to achieve higher productivity. The externality we identify in our research may therefore be deemed beneficial.

In communities further away from investment sites we find the commonly observed gender gap in competitiveness (Gneezy et al., 2003; Croson and Gneezy, 2009), i.e. that males are more competitive than females. Conversely, the gender gap is completely closed in communities near the sites. This finding suggests that in our case market exposure not only increases competitiveness of small-scale farmers in general, but that females' competitiveness 'catches up' with males'. Further research is needed to establish the mechanisms in which females' competitive behavior is raised through exogenous market exposure. A large body of literature argues that competitiveness is key to succeed in market environments and that females' lack of competitiveness explains their lower incomes and participation in leadership positions (Niederle and Vesterlund, 2007; Buser et al., 2014). Accordingly, balancing competitiveness of females and males through market exposure in the rural setting of developing countries may be regarded as a valuable positive externality.

4.6 Appendix: Additional figures and tables

Figure 4.A.1. The competition game environment

Figure 4.A.2. Histograms of competition game scores



Note: A Kolmogorov-Smirnov test cannot reject the null hypothesis of equal distributions in the two village groups ($p > 0.2$).

Table 4.A.1. Summary statistics by gender

Variable	Female (Mean)	Female (SD)	Male (Mean)	Male (SD)	p-value
Household head	0.28	0.45	0.64	0.48	**0.00**
No. of household members	6.74	2.96	6.77	3.37	0.94
Age	37.23	16.30	38.85	16.90	0.16
Years of education	5.57	3.37	7.33	3.19	**0.00**
Large-scale farm worker	0.32	0.47	0.46	0.50	**0.00**
Recently migrated to the village	0.15	0.36	0.18	0.39	0.15
Asset index	0.39	0.17	0.44	0.17	**0.00**
Crop index	0.18	0.15	0.24	0.20	**0.00**
Crops sold	0.75	0.43	0.78	0.42	0.32
Land title	0.36	0.48	0.38	0.49	0.52

Note: Statistically significant p-values in bold. The p-values are based on two-sided Mann-Whitney tests for the continuous variables and chi-squared tests for the binary variables.

Table 4.A.2. Mechanisms driving females' competitive behavior

VARIABLES	(1) Logit (Near)	(2) Logit (Employed)	(3) Logit (Farm work)	(4) Logit (Assets)
_Near village	0.128**	0.118*	0.139**	0.115
	(0.058)	(0.061)	(0.064)	(0.109)
_Near village * employed		0.105		
		(0.148)		
Employed		-0.048		
		(0.104)		
_Near village * farm worker			-0.041	
			(0.101)	
Large-scale farm worker			0.036	
			(0.083)	
_Near village * asset index				0.067
				(0.273)
Asset index based on pca				-0.163
				(0.158)
Region = 1	0.052	0.055	0.045	0.053
	(0.059)	(0.059)	(0.059)	(0.059)
Observations	467	467	463	461

Note: The table presents marginal effects, except for the constant of the estimation. The observations from the _further control villages are the baseline of the estimations. The standard errors in parentheses are clustered at the village-level (29 villages) in all estimations. Statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

Table 4.A.3. Regression analysis of competitive decisions of children

VARIABLES	(1) Logit (all children)	(2) Logit (male children)	(3) Logit (female children)
_*near* village	0.210**	0.112	0.348***
	(0.087)	(0.099)	(0.111)
Age (continuous)	0.018	0.006	0.025*
	(0.011)	(0.014)	(0.013)
Score	-0.021*	-0.017	-0.027
	(0.012)	(0.017)	(0.023)
Region= 1	0.002	-0.029	0.043
	(0.103)	(0.128)	(0.118)
Observations	400	205	195

Note: The table presents marginal effects, except for the constant of the estimation. The observations from the _further control villages are the baseline of the estimations. The standard errors in parentheses are clustered at the village-level (29 villages) in all estimations. Statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

Table 4.A.4. Adults' competitive behavior with distance from large-scale farm

VARIABLES	(1) Logit	(2) Logit with household controls	(3) Logit with household and village controls
Distance from large-scale farm (continuous)	-0.002**	-0.002**	-0.004***
	(0.001)	(0.001)	(0.001)
Household sells crops = 1	0.124**	0.123**	0.115**
	(0.052)	(0.051)	(0.054)
Household head = 1		-0.006	0.017
		(0.049)	(0.051)
No. of household members (continuous)		-0.004	-0.002
		(0.006)	(0.007)
Age (continuous)		0.001	-0.000
		(0.001)	(0.001)
Male = 1		0.055	0.025
		(0.056)	(0.056)
Education in years (continuous)		0.019**	0.001
		(0.010)	(0.007)
Large-scale farm worker = 1		0.012	0.014
		(0.042)	(0.041)
Migrated after large-scale farm = 1		-0.051	-0.043
		(0.051)	(0.051)
Asset index based on pca		-0.009	-0.017
		(0.081)	(0.083)
Crop index based on pca		0.094	0.107
		(0.081)	(0.076)
Land title = 1		0.071	0.064
		(0.050)	(0.050)
Village area (continuous)			0.000**
			(0.000)
No. of ethnic groups in village (continuous)			-0.014**
			(0.007)
Village is patrilineal = 1			0.118*
			(0.063)
Region = 1	-0.004	0.023	-0.047
	(0.044)	(0.045)	(0.044)
Literacy (continuous)		-0.060**	
		(0.026)	
Observations	842	785	795
Regional FE	YES		

Note: The table presents marginal effects, except for the constant of the estimation. The observations from the _further control villages are the baseline of the estimations. The standard errors in parentheses are clustered at the village-level (29 villages) in all estimations. Statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

Table 4.A.5. Adults' competitive behavior by gender

VARIABLES	(1) Logit (Males)	(2) Logit (Males)	(3) Logit (Females)	(4) Logit (Females)
Distance from large-scale farm (continuous)	-0.001	-0.002	-0.003**	-0.005***
	(0.001)	(0.001)	(0.001)	(0.002)
Household sells crops = 1	0.181***	0.144**	0.071	0.090
	(0.056)	(0.060)	(0.066)	(0.067)
Household head = 1		0.084		-0.030
		(0.075)		(0.061)
No. of household members (continuous)		-0.003		-0.001
		(0.009)		(0.009)
Age (continuous)		-0.002		-0.000
		(0.002)		(0.002)
Education in years (continuous)		0.007		-0.006
		(0.009)		(0.009)
Large-scale farm worker = 1		0.030		-0.012
		(0.057)		(0.057)
Migrated after large-scale farm was set-up = 1		-0.049		-0.034
		(0.060)		(0.099)
Asset index based on pca		0.015		-0.121
		(0.129)		(0.145)
Crop index based on pca		0.055		0.188
		(0.084)		(0.147)
Land title = 1		0.143*		0.024
		(0.074)		(0.070)
Village area (continuous)		0.000**		0.000
		(0.000)		(0.000)
No. of ethnic groups in village (continuous)		-0.011		-0.016
		(0.010)		(0.013)
Village is patrilineal = 1		0.115*		0.113
		(0.062)		(0.106)
Region = 1	-0.035	-0.036	0.016	-0.054
	(0.050)	(0.071)	(0.064)	(0.084)
Observations	419	402	423	393

Note: The table presents marginal effects, except for the constant of the estimation. The observations from the _further control villages are the baseline of the estimations. The standard errors in parentheses are clustered at the village-level (29 villages) in all estimations. Statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

4.7 Appendix: Instructions

Introduction

Thank you all for taking the time to come today. Today's activities may take three to four hours. Before we begin I want to make some general comments about what we are doing here today and explain the rules that we must follow.

We will ask each of you to make decisions involving money and to answer a few questions. Whatever money you earn during the activities will be yours to keep and take home. Nobody but the researchers and you will know what you decided and earned, and **money will be given in private. No other participant will learn about your decisions and earned money.** We will be supplying the money. This money was given to us by the London School of Economics, a university in Great Britain, to use for research and it is not our own personal money.

Before we proceed any further, **let me stress something that is very important**. Many of you were invited here without knowing very much about what we are planning to do today. If at any time you find that this is something that you do not wish to participate in for any reason, you are of course free to leave whether we have started the activity or not.

We will be asking you to do **three activities** with other individuals in your village today. **Your earnings from all three activities sums to your total earnings**. You will be informed about the outcomes in the three activities and your total earnings in private **at the end of all activities**.

If you have heard anything about these types of activities, you should try to forget about that because each activity can be completely different. It is important that you listen as carefully as possible.

We will run through some examples of how the activities work. **You cannot ask questions or talk while here in the group. This is very important.** Please be sure that you obey this rule, because it is possible for one person to spoil the activities for everyone. If one person talks about the activities while others can hear it, we would not be able to carry out the activities today. Do not worry if you do not completely understand the rules as we go through them here in the group. Each of you will have a chance to ask questions in private to be sure that you understand how the activities work.

Before we explain the activities we divide you into **two groups, the Green Group and the Black Group**, according to the colored cards that you have drawn from the bag a moment ago. The two groups will separate, so that green-card people and black-card people cannot see or hear each other.

After we have explained the activities, you will all wait in a group. We will call you by the number on your ticket, so please listen carefully for your number. While you are waiting you can talk about anything else you want other than the activities here today.

Activity 3 (instructions for research assistants in parentheses)

Activity 3 is throwing this ball into this bucket from a line. (Show them the ball, bucket and line.) You will have 10 tries.

We now ask you to choose one of two options according to which you will be paid in the experiment.

OPTION 1: If you choose this option, you will get 5 kwacha for each time you get the ball in the bucket in your 10 tries. So if you succeed 1 time, then you will get 5 kwacha. If you succeed 2 times, then you will get 10 kwacha. If you succeed 3 times, you will get 15 kwacha, and so on.

OPTION 2: If you choose this option, you will receive a reward only if you succeed more times than a randomly matched person who is playing in the other group (green or black). If you succeed more than this person, you will be paid 15 kwacha for every time you succeed. So if you succeed 1 time, then you will get 15 kwacha. If you succeed 2 times, then you will get 30 kwacha. If you succeed 3 times, you will get 45 kwacha and so on. But you will only receive a reward if you are better than the person in the other group. If you both succeed the same number of times, you will both get 5 kwacha for each success.

A successful throw is one where the tennis ball remains inside the bucket.

We now ask you to choose how you want to be paid: according to Option 1 or Option 2. Now you may play.

(Record both their ID number and their choice,

Allow the participant to toss the balls, while you record the result of each ball in the following manner: S is success, X is failure.)

5 Agribusinesses, smallholder tenure security and plot-level investments: Evidence from rural Tanzania[ζ][ψ]

5.1 Introduction

The rise in the demand for agricultural land and its consequences on surrounding communities has been widely debated in recent years. In the last 16 years, 1,004 agricultural deals covering an area of 26.7 million hectares have been concluded globally. This area is much larger when one considers the area taken up by intended and failed agricultural investments (Nolte et al., 2016). While a lot of attention has been paid to the impacts of these growing agricultural investments on their surrounding communities, very little is known about how local communities are affected once an investment has ceased or reduced its operations.

It is now acknowledged that not all large-scale agricultural ventures are successful. There are a number of reasons why agricultural investments fail. Most prominently, a number of international firms speculated on the recent global fuel crisis by acquiring vast amounts of land in developing countries for the production of biofuels. However, these firms did not consider the subsequent global recession and fall in the price of fossil fuels that led many of them to abandon their agricultural ventures (Mujenja and Wonani, 2012; Sulle

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[ψ] This study was supported by funding provided by the UNU-WIDER through its PhD internship program.

and Nelson, 2013; Sulle, 2015). In addition, the rapid scale of these investments, coupled with widespread activism on 'land grabs' forced many governments to reconsider their investment friendly policies. As a result prolonged negotiations with national governments, financial constraints as well as changes in the policy environment further contributed to the withdrawal of agricultural investments (Nolte et al., 2016).

Large-scale agricultural investments have been heavily criticized for their adverse impacts on the tenure security of smallholders living in adjacent communities (HLPE, 2011). The impacts of these investments on tenure security are particularly pertinent for smallholders in rural regions of sub-Saharan Africa, where formal title is largely absent and customary tenure is prevalent (Cotula, 2011; HLPE, 2011).

The importance of tenure security has been widely recognized by a vast literature (see for instance: Besley, 1995; Braselle et al., 2002; Besley and Ghatak 2010; Fenske, 2011). In addition to protecting land users from expropriation, tenure security is a key determinant of smallholders' plot investments and technical efficiency (Njikam and Alhadji, 2017). Secure tenure has been found to enhance smallholder investments in the following ways: first, a lower probability of land expropriation provides an incentive for smallholders to undertake long term investments that yield higher returns. Second, if tenure security has been strengthened, through for example, the adoption of title, plots gain collateral value that can be used to obtain credit. Finally, if legally recognized property rights are available and an active land market exists where land can easily be sold or rented out, smallholders will have a higher plot valuation and incentive to invest in improving the quality of their plots. Braselle et al. (2002) refer to these three respective channels as the assurance, collateralization and realizability effects. Of the three channels, it is the first that has received the most attention from development scholars. They have analyzed how several factors such as political connectivity (Goldstein and Udry, 2008; Markussen and Tarp, 2014), inheritance customs (Dillon and Voena, 2016), migration-induced population pressures (Grimm and Klasen, 2015) and land reform programs (Banerjee et al., 2002, Holden and Yohannes, 2002; Deininger and Ali, 2008; Leight, 2016; Zikhali, 2010) influence tenure security and investments.

Despite this vast literature, the relation between tenure security and smallholders' investments remains inconclusive, particularly when one considers the case of sub-Saharan Africa. Positive associations have been found between tenure security, fallow, agricultural productivity and soil conservation (Besley, 1995; Deininger and Ali, 2008; Lovo, 2016) while Migot-Adholla et al. (1991) find little support for the role of tenure security in enhancing productivity. This chapter contributes to the literature by investigating how a reduction in the share of land held by agribusinesses and plantations in smallholder villages affect tenure security and plot-level investments. More specifically, we investigate the spill-over effects from a decrease in the share of land held by agribusinesses or plantations on smallholders *de jure* and *de facto* plot-level tenure security and investments in rural Tanzania.

Tanzania makes a good case for a study on the impacts of decreasing areas held by agribusinesses on adjacent smallholder communities. It was among the top 20 countries targeted for agricultural land investments in the late 2000s, however recent data shows that this is no longer the case (Nolte et al., 2016). The country also experienced a large influx of biofuel investments in the mid-2000s that later ceased their operations (Arndt et al., 2011; Sulle and Nelson, 2013; Sulle, 2015). Drawing on two waves of plot-level data from the Tanzania National Panel Survey (TZNPS) and adopting a plot and year fixed effects approach, we find that a decrease in the share of land held by agribusinesses significantly increases tenure security. Moreover, we find that the share of land cultivated by agribusinesses positively and significantly increases the time spent on plots but has no significant effect on fallow and other cash intensive investments. Analyzing other possible transmission mechanisms, we find that agribusinesses have a positive and significant impact on the number of household members employed in the agricultural sector.

Our findings provide insights for two important strands of literature; first they add a new dimension to the growing literature on the impacts of large-scale agricultural investments on neighboring smallholder communities. This is the first attempt to rigorously analyze the impacts of agribusinesses on smallholder tenure security and the first to investigate how smallholders are affected when agribusinesses cease or decrease their operations. Second, we contribute to the already existing but inconclusive literature on the impacts of tenure security on land related investments.

The remainder of this chapter is organized as follows: Section 5.2 provides an overview of the Tanzanian land tenure system and discusses the relation between agribusinesses and tenure security. Section 5.3 discusses the conceptual framework and hypotheses while section 5.4 introduces the data and summary statistics. The econometric approach is presented in Section 5.5. The results are presented in section 5.6 and section 5.7 concludes.

5.2 Tanzanian land tenure and agribusinesses

5.2.1 Land tenure system

The Tanzanian land tenure system has its roots in the "villagisation" program that was introduced in the 1960's to encourage rural peasants and pastoralists living in chiefdoms and individual settlements to move into centrally planned Ujamaa villages (Collier et al., 1986; Odgaard, 2006; Knight, 2010). The villagisation program was expected to facilitate the use of modern agricultural techniques and ease the provision of goods and services. It was grounded in equity enhancing principles that allocated uniform plot sizes to households (Thiele, 1986; Odgaard, 2006). Similar land reforms were undertaken across other sub-Saharan African countries such as Ethiopia (Kebede, 2002). Despite this socialist backdrop, the program had a distorting effect which was fueled by the mass expropriation of land, forced resettlement as well as uncertainty over the loss of family land (Knight, 2010). In response to these distortions, the government of Tanzania initiated and tasked the Shivji commission with investigating and making recommendations on how these land issues could be addressed. The recommendations influenced the formulation of the 1995 National Land Policy as well as the enactments of the Land Act (responsible for the governance of urban land) and the Village Land Act in 1999. Following these Acts, land tenure in Tanzania is classified into three main categories that comprise village land at 70 percent, reserved lands at 28 percent (set aside for forests, game reserves, public utilities and land designated under the town and country planning ordinance) and general land (unassigned public land held by the Commissioner of Lands) which covers 2 percent of all land (Odgaard, 2006; Knight, 2010; Byamugisha, 2014).

According to the Village Land Act, the main institutions responsible for the governance of village land are: (i) the village assembly that includes all village residents above the age of 18 and elects the village council every five years, (ii) the village council which is an elected committee that administers land on behalf of the village assembly (Odgaard, 2006; Knight, 2010). The village council is responsible for village land categorization into communal land (publicly used and occupied); land that is occupied on an individual or family basis under customary law and vacant land that may be availed for communal or individual occupation in the future (Odgaard, 2006; Wily 2003). Unlike other sub-Saharan African countries with customary law embedded in their historical traditions, the forced relocations into Ujamaa villages, abolishment of chiefdoms and strong socialist policies pursued in the 1970's did away with all forms of custom (Knight, 2010; Wily, 2003). This complex history dissuaded the Village Lands Act from ascribing a fixed definition of customary rights and instead allows each village to determine their own rules and practices as long as they are not discriminatory and do not contradict Tanzanian land law. Thus customary law is often based on the customs or norms that were prevalent in the village prior to the introduction of Ujamaa (Knight, 2010).

All land in Tanzania is vested in the president, and thus only 'customary rights of occupancy' can be granted to village land-owners by the village council. Customary rights of occupancy may be granted either verbally or in writing. They carry as much weight and validity as the granted rights of occupancy that apply to general lands (Knight, 2010). Customary rights of occupancy accord land owners usufruct and transfer rights that include the rights to sell, gift, endow, rent and collateralize their plots. A major contribution of the Village Lands Acts has been to recognize the legality of transferable and inheritable use rights on village land. However, the Act does not clarify whether customary rights of occupancy are a prerequisite for land users to exercise their transfer rights (Odgaard, 2006).

One of the key stipulations of the Village Land Act is that a village first has to be formally registered and has to have obtained a certificate of village land before any of the provisions of the Village Land Act can be brought to force. Certificates of village land can only be awarded after villages have harmonized their boundaries with neighboring villages; demarcated their land into communal, individual and reserve land; and undertaken a cadastral survey. The application is submitted to the district officer, who drafts the certificate for approval by the village council. Once the village council approves the certificate, it is then sent to the Commissioner of Lands for final approval. This step-wise process is purposefully designed to protect villagers' rights and to allow communities to govern themselves (Knight, 2010; Byamugisha, 2014).

The implementation of the Village Land Act had a slow start due to the lack of finances and administrative capacity. In 2004, former Tanzanian President Benjamin Mkapa, set up the 'Property and Business Formalisation Programme' (MKURABITA) with the assistance of Peruvian economist Hernando de Soto to hasten the process (Pedersen, 2011; Ali et al., 2016; Byamugisha, 2014). Several pilot land formalization projects have been carried out under MKURABITA and by 2011, the number of villages that had their land registered increased to 60 percent. Despite the increase in the number of village certifications, the uptake of individual and household titles has been very low with only 0.4 million household and individual titles being registered in 2011 (Byamugisha, 2014). One of the major factors behind this low uptake of title has been the high costs of formalization which are not affordable for poor households (Ali et al., 2016).

5.2.2 Agribusinesses and tenure security

The Tanzanian government actively promotes agribusinesses as one of the main pillars of its Kilimo Kwanza strategy (Agriculture First) that aims to make agriculture the mainstay of the economy. For instance, the government initiated the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) in 2010 (SAGCOT, 2011; Sulle and Nelson, 2013). SAGCOT's objective is to increase the profitability of the agricultural sector by promoting clusters that incorporate all phases of the agricultural value chain, starting from agricultural research stations, large-scale farms and ranches with out-grower schemes to processing, storage and transport facilities (SAGCOT, 2011).

Despite these efforts by the government, the number and size of agribusinesses have reduced in the last years. The current wave of agribusinesses has largely been driven by the global crisis that resulted in an increase in the demand for land to be used for the cultivation of biofuels (Arndt et al., 2011). Sulle and Nelson (2009), estimate that by 2009, over 4 million hectares of land had been requested for the cultivation of jatropha, sugar cane and oil palm. Investments covering 2.5 percent of this land (100,000 hectares) were granted full rights of occupancy. Many of these investments ceased their operations just a few years after being granted these rights of occupancy (Sulle and Nelson, 2013; Sulle, 2015). This decrease in bio-fuel related investments has also occurred in other Sub-Saharan African countries. In neighboring Zambia, for instance, the global recession led many of the agribusinesses that acquired land for biofuel production, particularly jatropha to cease their operations (Mujenja and Wonani, 2012).

The withdrawal of agribusinesses from village land has fueled a discussion on their impacts on smallholder land tenure security (Sulle and Nelson, 2013). Agribusinesses and other private entities are only allowed to lease land that falls under general land (Cotula et al., 2009). If an agribusiness identifies suitable village land or is shown prospective village land by the Tanzania Investment Centre (TIC), the village assembly will decide whether to allocate land to the agribusiness or not. Some of the key criteria considered are whether the agribusiness will contribute to the economy and wellbeing of locals as well as whether the area of land being requested is so extensive that it "will impede the present and future occupation and use of village land by persons ordinarily resident in the village" (Village Lands Act, 1999: 108). When a decision has been made, the village council is entitled to grant a maximum of 5 hectares of land without external approval, 5 to 30 hectares with the approval of the village assembly, more than 30 hectares with the approval of both the village assembly and the commissioner of lands (Knight, 2010). The agribusiness will only be able to access the land after undergoing a series of negotiations with the village council, the district council land committee and village assembly which result in the conversion to general land.

While the Village Land Act has several checks and balances that protect villagers' tenure security from outsiders, there are legal loopholes that can be used to circumvent the Act. First, the President of Tanzania retains the right to transfer land from village land to general or reserved land (compulsory acquisition) as long as it is in the interest of the public. Since agribusinesses may be deemed to be of national interest, villages face the risk of having their land expropriated for such investments. Village assemblies have the right to approve or reject the partitioning of village land but only if the area identified by the Tanzanian government is less than 250 hectares (Knight, 2010).

Moreover, there is a discrepancy in the definitions of general land between the two land acts, which may result in the conversion of village land to general land without villagers' consent. According to the Village Land Act, general land is defined as "all public land which is not reserve land or village land". However, in the definition provided by the Land Act, general land also includes unoccupied or unused village land (Knight, 2010). Since village land may often be left unused or under long durations of fallow to allow for soil replenishment or rejuvenation of pasture, considering unused village land as general land may reduce the amount of land available to smallholders. Once converted, general land is out of bounds to smallholders and cannot be accessed even after the agribusiness has ceased its operations and left the village (Sulle and Nelson, 2013).

5.3 Conceptual framework and hypotheses

5.3.1 Plot-level tenure security and decreasing agribusiness sizes

The first part of the empirical analysis is concerned with how a decrease in the share of land cultivated by agribusinesses in a village may affect smallholder plot-level tenure security. As noted in the previous section, the Tanzanian land tenure system protects smallholders land rights and any uncertainty over land tenure security mostly arises after the agribusiness has failed and smallholders are not able to reclaim their land. The heightened uncertainty that comes with the failure of agribusinesses may increase smallholders need to secure their plots by acquiring individual title. Based on this, we formulate the following hypotheses:

Hypothesis 1a: A decrease in the share of land held by an agribusiness at the village level increases smallholder's incentives to gain *de jure* tenure security.

Our definition of *de jure* tenure security is not restricted to customary rights of occupancy but also includes other forms of recognized title such as letters from the village assembly, letters of inheritance and agreements certified by the local court which are less costly.

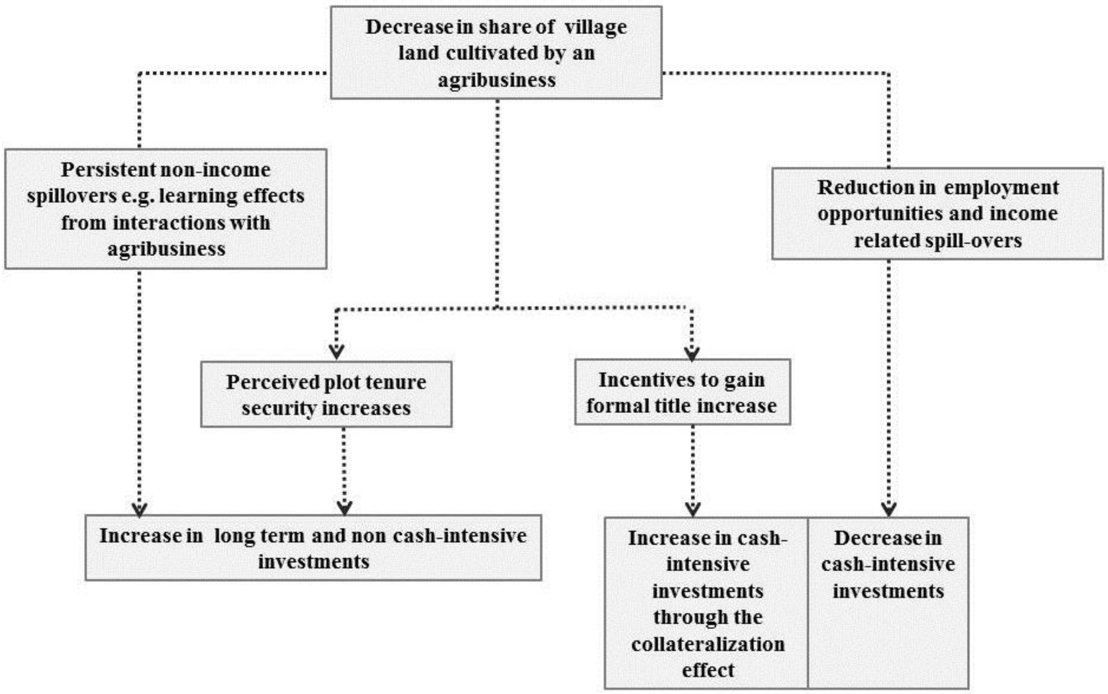
Hypothesis 1b: A decrease in the share of land cultivated by an agribusiness at the village level increases smallholders' plot-level *de facto* tenure security.

Smallholders' perceptions of plot security are taken as the *de facto* measure of tenure security. It is expected that once the agribusinesses decrease the share held or leave a village smallholders perceive that their plots are more secure.

5.3.2 Decreasing agribusiness sizes and plot-level investments

The impacts of a decrease in the area held by agribusinesses on plot-level investments are more ambiguous. Theoretical works show that a decrease in tenure security reduces agricultural investments (Besley, 1995; Besley and Ghatak, 2010). Based on this, it is likely that if a decrease in the area cultivated by agribusinesses increases smallholders *de jure* tenure security, smallholders will have collateral that can be used to obtain credit and increase cash-intensive investments. This is the collateralization effect (Braselle et al., 2002; Maiangwa et al. 2004). Moreover, if a decrease in the area cultivated by agribusinesses increases smallholders' perceived tenure security; it may raise their incentives to invest in long term cash-intensive investments through the assurance effect.

Figure 5.1. Conceptual framework



Source: Author's own.

Another strand of literature on large-scale agricultural investments provides evidence for positive spill-overs from agricultural investments to nearby smallholder communities (for example, Deininger and Xia, 2016; Sipangule and Lay, 2015). If agribusinesses increase smallholders' employment opportunities and raise income levels, smallholders are more likely to engage in cash-intensive investments. When agribusinesses cease their operations, these cash generating opportunities dissipate (Sulle and Nelson, 2013). However, if the presence of an agribusiness results in smallholder learning effects, a decrease in the area held by agribusinesses will not reduce smallholders' non cash-intensive plot-level investments.

Thus, as shown in Figure 5.1, it is likely that agribusinesses can affect plot-level investments both negatively and positively and that the net effect will depend on the cash intensiveness of the smallholder plot-level investments.

Based on this we posit the following:

Hypothesis 2a: Due to a learning effect, a decrease in the share of land cultivated by an agribusiness does not reduce smallholders' non cash-intensive investments.

Hypothesis 2b: Due to a rise in smallholders' tenure security, a decrease in the share of land cultivated by an agribusiness increases smallholders' cash-intensive investments.

Hypothesis 2c: Due to a reduction in smallholders' employment and income generating activities, a decrease in the share of land cultivated by an agribusiness reduces smallholders' cash-intensive investments.

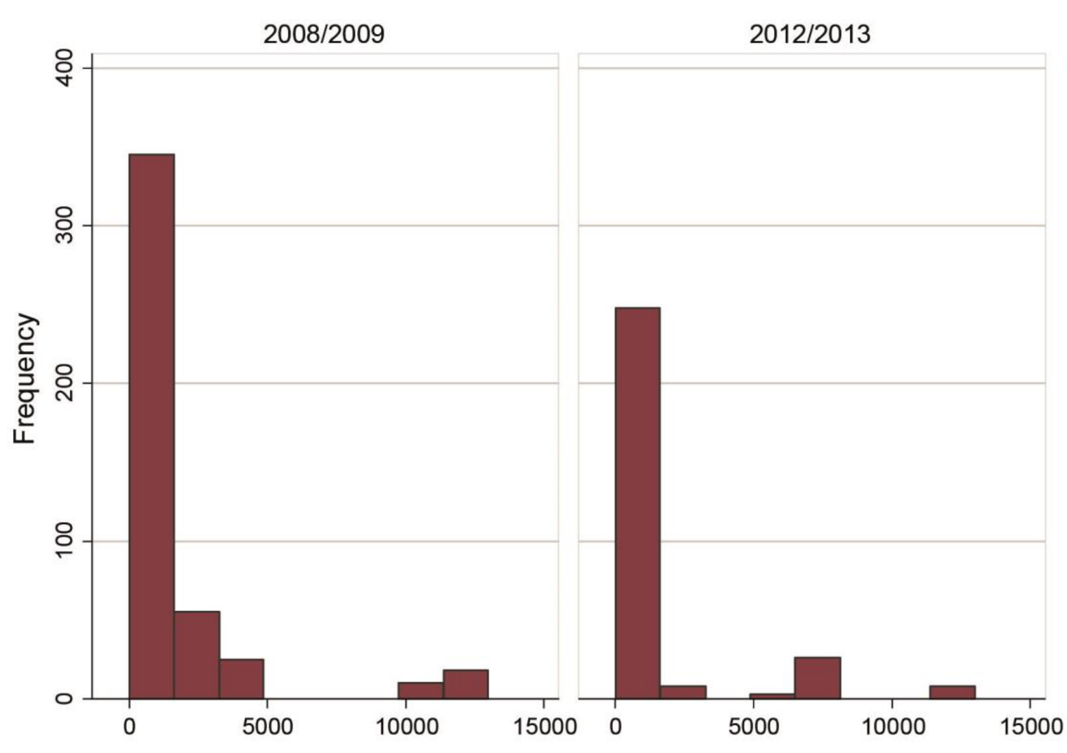
5.4 Data and summary statistics

The data used in this chapter are sourced from the first and third rounds of the Tanzania National Panel Survey (TZNPS). The TZNPS is collected by the Tanzania National Bureau of Statistics as part of the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA). The first round of the TZNPS was collected between October 2008 to September 2009 and the third from October 2012 to November 2013. The first round visited 3265 households across 409 Enumeration Areas across rural and urban areas in Tanzania and Zanzibar. The third wave interviewed 5015 households. The surveys have a low attrition rate of 4.84 percent. The TZNPS are ideal for our analysis as they contain detailed information at the household, plot and village levels. We restrict the sample to plots that have been cultivated in rural areas during *Masika* -the long rainy season. The 2008/2009 dataset originally contains 5128 plots which reduce to 2,554 plots after we impose these restrictions. We use the data from the same plots in 2012/2013 and end up with a panel of 5,101 plots.

The information on the land held by agribusinesses in each wave is taken from the community questionnaire. The community questionnaires were administered at the enumeration area level to village chairpersons, executive officers and several sub-village chair people. In rural areas, enumeration areas roughly follow village boundaries and can thus be considered as providing village level information. 746 plots are in villages that report having experienced an increase in the area cultivated by agribusinesses over the study period, 1409 report a decrease whilst 2946 report no change in the area cultivated by agribusinesses at the village level.

Figure 5.2 shows the distribution of the acres cultivated by agribusinesses in villages in 2008/2009 and 2012/2013. It is clear that both the frequency and sizes of the land cultivated by agribusinesses has reduced over the last four years.

Figure 5.2. Acres held by agribusinesses in 2008/2009 and in 2012/2013



Source: Author's own based on TZNPS data.

This is in line with other literature that points out that many of the agribusinesses that were allocated agricultural land cultivation did not come into fruition or ceased their operations (Sulle and Nelson, 2013; Sulle, 2015)

Figure 5.3a. Agribusiness locations in 2008/2009

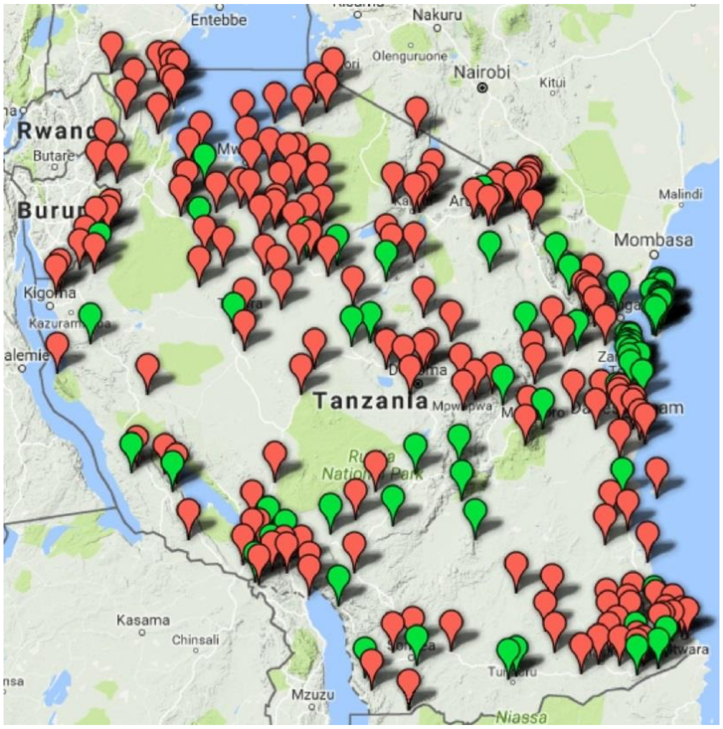
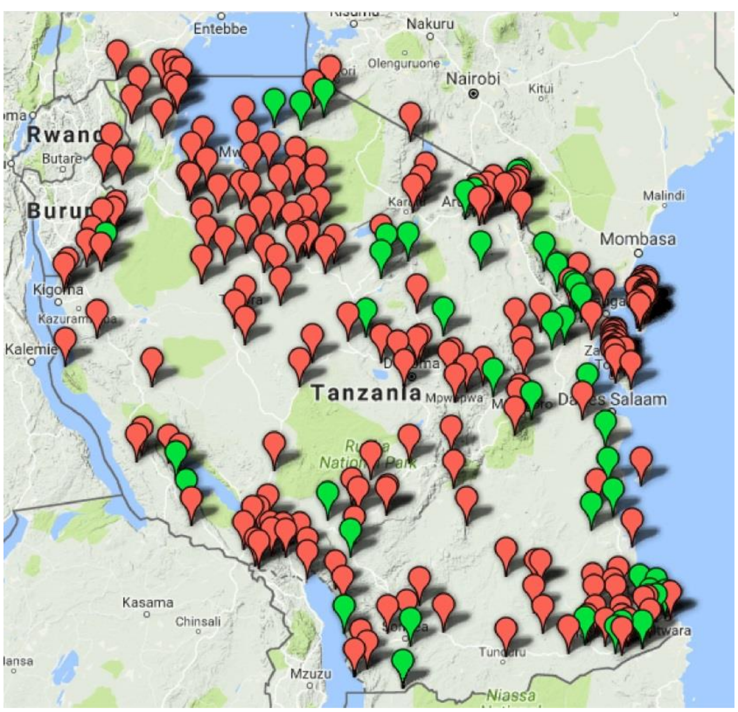


Figure 5.3b. Agribusiness locations in 2012/2013



Note: The green pins indicate the villages with agribusinesses while the red ones are villages without agribusinesses.

Source: Authors own using TZNPS data.

The locations of the villages that report that they have agribusinesses are shown in Figures 5.3.a and 5.3.b. In 2008/2009, 29 percent of the villages (represented by the green pins) reported that they had an agribusiness or plantation cultivating land in their village. By 2012/2013 the number of villages reporting that part of their land was being cultivated by an agribusiness reduced to 18 percent. From Figure 5.3a, it is clear that agribusinesses tend to be clustered in some parts of Tanzania while other regions do not have any villages that report that they have an agribusiness cultivating land.

A key question that emerges is how the locations of agribusinesses are determined. Since agribusinesses are profit orientated, it is likely that their locations are not determined at random. Literature on the determinants of large-scale agricultural investments has found that weak land governance and institutions are amongst the most important determinants of the location of large-scale agricultural investments (Nolte, 2014; Arezki et al. 2015). If village level tenure security influences the likelihood that an agribusiness is set up in that village, our analysis may be prone to endogeneity bias.

In the preceding sections, we outlined the various rounds of negotiation that need to be completed before an agribusiness is granted village land. This tedious process acts as a deterrent to agribusinesses and protects smallholders' interests. The exception is when the state uses its powers to obtain untitled village land under the Compulsory Acquisition Act. However, since all land is vested in the President, village tenure security levels should not play a major role in determining which villages have their land expropriated by the compulsory acquisition act. It is more likely that the state considers market accessibility, the availability of agricultural land and agro-climatic conditions when enacting the compulsory acquisition act. The TZNPS does not contain information on the mode of land acquisition followed by agribusinesses. Thus we draw on data from the 2007/2008 Agricultural Sample Census on Large scale Farms. The 2007/2008 Agricultural Sample Census covers a total of 1,006 large-scale farms (968 for the Mainland and 38 for

Zanzibar). It provides a good estimate of the land acquisition process of agribusinesses in our sample as the data collection phase coincides with the first wave of the TZNPS. The information presented in Table 5.1 confirms that most land acquired by private agribusinesses is obtained via leasehold on general land. This proves that agribusinesses prefer already titled land and are less likely to be located in villages with low tenure security. We revert to this discussion after we have introduced the empirical specification in the next section.

Table 5.1. Modes of land acquisition by large-scale farms (hectares)

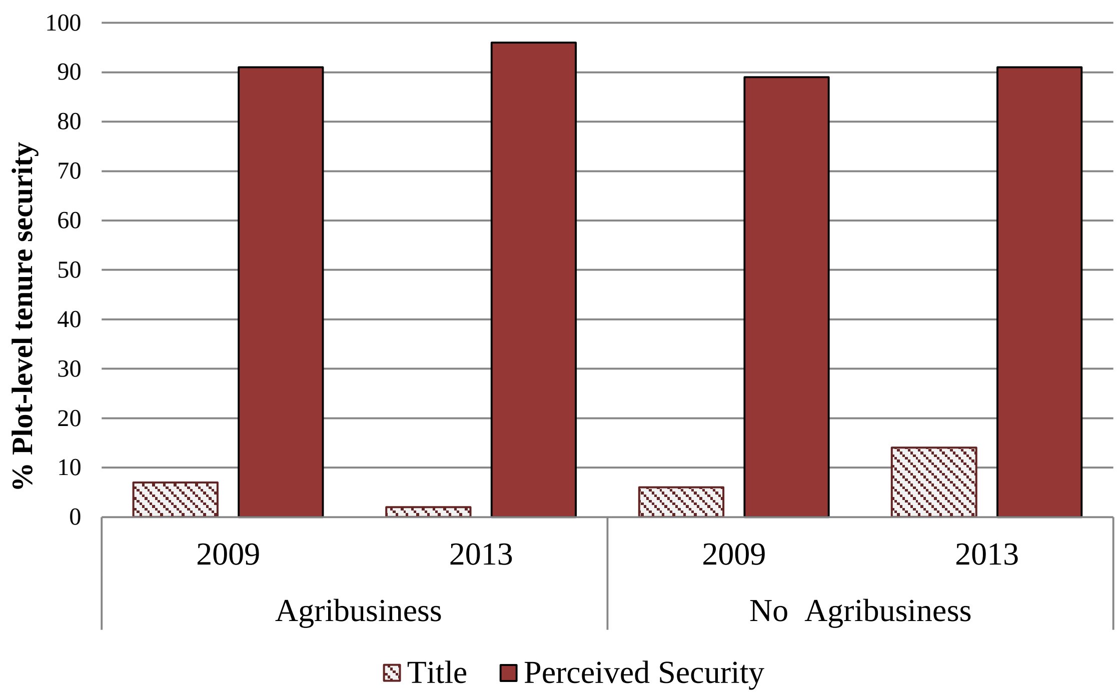
	Lease	Customary	Purchase	Rent	Borrow	Compulsory	Total
State	422,987	15	117	5	217	26,953	450,294
Private	600,868	3,866	13,360	2,135	779	2,109	49,202
Other	18,454	11,541	4,708	735	1,717	3,324	40,479
Total	1042309	15422	18185	2875	2713	32386	1653865

Source: Authors own using data from the 2007/2008 Agricultural Sample Census on Large Scale Farms.

To analyze plot-level tenure security, we rely on two measures from the TZNPS. The first provides information on all plots that have title (*de jure tenure*) whilst the second is based on a question that asks whether plot cultivators are comfortable with leaving their plot fallow for several months without worrying that it will be lost, which indicates whether a plot is perceived as secure (*de facto tenure*). Figure 5.4 graphs the distribution of these. From this graph we observe that in 2008/2009, villages with agribusinesses had slightly more title than villages without agribusinesses. In both villages perceived security is already quite high at approximately 90 percent in 2008/2009; still villages with agribusinesses experience a slight increase in 2012/2013.

Table 5.2 compares the socio-economic and plot-level characteristics of smallholders in villages with and without agribusinesses over the two study periods. From the table we can see that the number of plots in villages with agribusinesses reduce considerably over the study period. In 2008/2009 households in villages with agribusinesses tend to have significantly more assets and a lower number of heads with primary education. In addition, plots in villages with agribusinesses tend to be smaller and to have lower ownership rates as compared to villages without agribusinesses. These plots are also less likely to have suffered from erosion and have a higher value per acre in 2008/2009. However in 2012/2013, many of these differences no longer exist. The only significant differences that persist are that household heads in villages with agribusinesses tend to be younger and tend to apply more kilograms of fertilizer per acre on their plots.

Figure 5.4. Distribution of plot-level tenure security across villages and time



Source: Authors own using data from TZNPS.

5.5 Econometric approach

This section presents the econometric specifications that test the hypotheses stated in the preceding section. We estimate the determinants of plot-level tenure security as follows:

$$T_{pht} = \beta_1 A_{vt} + \beta_2 X_{phvt} + \omega_{ph} + \theta_t + \varepsilon_{1phvt} \qquad (1)$$

where T_{pht} is a dichotomous variable that takes the value of one if the plot p of household h in time t has title (*de jure* tenure security) or the cultivator can leave the plot fallow for several months without fear of expropriation (*de facto* tenure security). A_{vt} represents the share of land cultivated by the agribusiness in each village.

Table 5.2. Socio-economic and plot-level characteristics of smallholders in villages with and without agribusinesses

	2008/2009				2012/2013			
	Agribusiness		**No Agribusiness**		**Agribusiness**		**No Agribusiness**	
Household Characteristics	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age of hh. head	**47.76**	**14.16**	**46.63**	**14.89**	**47.94**	**15.14**	**50.52**	**14.74**
Fem head	0.18	0.38	0.19	0.39	0.13	0.34	0.21	0.41
No. hh members	5.62	2.52	5.82	3.04	5.79	1.84	6.14	3.22
Head with prim. Educ.	**0.49**	**0.50**	**0.70**	**0.46**	0.74	0.45	0.63	0.48
Hh expenditure per member *	380,829	228,825	402,705	278,706	561,314	231,985	592,017	396,887
Asset_index	**0.08**	**0.06**	**0.07**	**0.07**	0.21	0.10	0.21	0.12
Plot Characteristics								
Acres	**1.67**	**3.57**	**2.58**	**5.78**	2.12	2.63	2.40	4.43
Years plot cult.	18.46	13.95	17.57	13.51	19.45	13.83	20.35	14.21
Plot owned by hh.	**0.75**	**0.43**	**0.90**	**0.30**	0.92	0.27	0.86	0.35
Fem head owns plot	**0.12**	**0.32**	**0.16**	**0.36**	0.11	0.32	0.18	0.39
Fem head decides	0.12	0.33	0.15	0.36	0.13	0.34	0.20	0.40
Plot Wetness index	13.17	3.18	13.57	4.66	13.43	1.68	13.87	4.09
Soil eroded	**0.10**	**0.30**	**0.16**	**0.36**	0.11	0.32	0.11	0.32
Plot value per acre	**1,096,132**	**5,358,897**	**982,225**	**5318945**	629,728	722201	1,315,742	489,1109
Plot-level investments								
Intercropping	**0.28**	**0.45**	**0.43**	**0.49**	0.42	0.50	0.41	0.49
Fallow duration	0.18	0.73	0.23	1.50	0.04	0.19	0.04	0.29
Days spent on plot	**123.12**	**108.23**	**107.58**	**109.30**	80.92	75.89	76.42	76.51
Fertilizer kg per acre	58.05	366.31	88.65	594.02	**215.15**	**656.54**	**81.27**	**490.42**
Observations	703		1475		53		2122	

* Expenditures in Tanzanian Shillings, Statistically significant p-values in bold. The p-values are based on two-sided Mann-Whitney tests the continuous variables and chi-squared tests for the binary variables.

In results reported in the appendix, A_{vt} takes on the form of a dichotomous variable that is equal to one if a village has an agribusiness. X_{phvt} is a vector of time varying plot, household and village level controls that include, amongst others, soil quality, years that the plot has been owned, the number of household members and the age of the household head. ω_{ph} are plot fixed effects; θ_t are year fixed effects and ε_{phvt} is an error term.

To examine whether the share of land held by an agribusiness affects smallholder investment decisions at the plot-level, we estimate regressions of the following form:

$$I_{pht} = \delta_1 A_{vt} + \delta_2 \tau_{pht} + \delta_3 A_{vt} * \tau_{pht} + \delta_4 X_{phvt} + \omega_{ph} + \theta_t + \varepsilon_{2phvt} \qquad (2)$$

In this case, I_{pht} represents the land investment choice; τ_{pht} is a tenure index for the plot created by taking the first component from a principal component analysis. $A_{vt} * \tau_{pht}$ is an interaction between the share of land held by an agribusiness and the index of tenure security. ε_{2phvt} is the error term. The dichotomous dependent variables in equations 1 and 2 are estimated using linear probability models while the continuous variables in equation 2 are estimated using Honoré (1992)'s trimmed least absolute deviations (LAD) panel tobit estimator that controls for censoring of the dependent variable that arises from not all cultivators reporting that they have undertaken plot-level investments. This is executed using the pantob command in the Stata statistical software package. Linear probability models are favored as fixed effects are not compatible with panel probit models.

All regressions are estimated using plot and year fixed effects to allow for comparability and to control for time invariant unobservables that may bias the results. As the unobserved differences across plots may not be random or uncorrelated with the predictor and independent variables, fixed effects are better suited to control for this. A Hausman test also rejects the null hypothesis that the errors are correlated with the regressors confirming that plot-level fixed effects are a better fit.

As discussed in the previous section, the results obtained after estimating equation 1 would be biased if the location of an agribusiness was determined by the village level tenure security. To check for this bias, we employ a probit model to analyze the determinants of agribusiness locations in 2008/2009. Based on studies that have analyzed the determinants of agribusiness locations at more aggregated levels (see Arezki et al., 2015), we adopt the following specification:

$$A_v = \alpha_1 T_v + \alpha_2 C_v + \alpha_3 D_v + a_4 X_v + \varepsilon_{3v} \qquad (3)$$

Where C_v is a vector of village agro-climatic variables; D_v is a vector of distance variables and X_v is a vector of other village specific characteristics.

5.6 Results

This section presents the study results. We start by presenting marginal effects of the probit model on the determinants of agribusiness locations. From Table 5.3, we can see that the main determinants of agribusiness locations in 2008/2009 are the distance to the market and district headquarters as well as rainfall patterns. None of the measures of village level tenure security (percentage of plots with *de jure* and *de facto,* the possession of a village certificate) are significant. This confirms the evidence presented in section 5.4 and makes us confident that endogeneity is not a major problem for our analysis.

We now proceed to analyze how a decrease in the area cultivated by an agribusiness affects plot-level security. The results are presented in Table 5.4. Columns 1 and 4 present parsimonious specifications, while Columns 2 and 4 report the full models with household, plot and village time variant observables.

Table 5.3. Determinants of agribusiness locations in 2008/2009

VARIABLES	(1) Probit
Distance to market (ln)	0.128***
	(0.045)
Distance to district headquarters (ln)	-0.100**
	(0.045)
Annual village rainfall (ln)	0.308**
	(0.135)
Annual Village temperature	0.354
	(0.327)
Village has certificate (1=Yes)	-0.105
	(0.092)
Plots with title (%)	-0.003
	(0.003)
Plots perceived as secure (%)	-0.002
	(0.003)
Village Infrastructure	0.306
	(0.210)
Village head is educated	0.045
	(0.053)
Total village size (ln)	-0.002
	(0.026)
Observations	217
Regional FE	YES

Marginal effects from Probit model reported in table, Standard errors in parentheses. Statistical Significance *** p<0.01, ** p<0.05, * p<0.1.

From Table 5.4 we can see that if the share of land held by agribusinesses increases by one unit, the probability that plots have both *de jure* and *de facto* tenure security reduces. This reduction is significant for all specifications except the restricted model on perceived tenure security in Column 3. Inversely interpreted, a one unit decrease in the share of land held by an agribusiness results in a 33 to 39 percent increase in the probability that a plot has *de jure* tenure security and a 13 percent increase in the probability that a plot has *de facto* tenure security.

Table 5.4. Regression analyses of plot-level tenure security and the share of land cultivated by agribusinesses

VARIABLES	(1) Land title	(2) Land title	(3) Perceived Tenure	(4) Perceived Tenure
Agribusiness share	-0.330***	-0.388***	-0.042	-0.133*
	(0.080)	(0.090)	(0.076)	(0.070)
Age of household head		0.004*		0.000
		(0.002)		(0.002)
Number of household members		0.000		-0.000
		(0.005)		(0.004)
Head has primary education = 1		0.025		0.037
		(0.030)		(0.025)
Female household head		-0.027		-0.088*
		(0.038)		(0.052)
Log of expenditure		0.042**		-0.014
		(0.018)		(0.014)
Log off farm income		-0.000		0.001
		(0.002)		(0.002)
Log Plot size		-0.014		-0.010
		(0.022)		(0.017)
Age of plot		-0.000		0.000
		(0.001)		(0.001)
Soil quality		0.005		0.005
		(0.013)		(0.010)
Log of plot value		0.016*		0.004
		(0.008)		(0.006)
Plot owned by household		-0.219*		0.061
		(0.112)		(0.067)
Village certificate = 1		0.001		-0.006
		(0.016)		(0.014)
Log of total village area		0.004		0.002
		(0.002)		(0.002)
Constant	0.143***	-0.713**	0.910***	1.035***
	(0.007)	(0.333)	(0.005)	(0.247)
Observations	4,345	4,067	4,995	4,074
R-squared	0.039	0.057	0.001	0.015
Number of plot_ident	2,395	2,352	2,554	2,354
Crop Controls	YES	YES	YES	YES
Year	YES	YES	YES	YES

Robust Standard Errors in Parentheses, Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

This increase is significant both in economic and statistical terms and is indicative of the smallholders' response to the high uncertainty that arises from the departure of an agribusiness. Based on this we find evidence in favor of Hypotheses 1a and 1b.

Table 5.5. Regression analyses of plot-level tenure security and changes in the share of land cultivated by agribusinesses

VARIABLES	(1) Land title	(2) Perceived Tenure
Increase in agribusiness share	0.001	0.003
	(0.014)	(0.013)
Decrease in agribusiness share	0.037***	0.006
	(0.012)	(0.010)
Constant	0.124***	0.906***
	(0.008)	(0.007)
Observations	4,345	4,995
Number of plot_ident	2,395	2,554
Crop Controls	YES	YES
Year	YES	YES

Robust Standard Errors in parentheses, Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

To better understand this result, we take advantage of our dataset that allows us to distinguish between plots that are located in villages that have experienced an increase and decrease in the area cultivated by agribusinesses over the study period. In Table 5.5, we can see that the results reported in Column 1 and 2 of Table 5.4 are mostly driven by a decrease in the share of land cultivated by agribusinesses. We observe that plots that are in villages that have experienced a reduction in the share of land cultivated by agribusinesses have significantly more title. Comparing these results with Figure 5.4, we can see that perceived security is already quite high across plots (above 90 percent) so that a slight increase does not make a significant difference. Having established that a decrease in the share of land held by agribusinesses positively affects the probability that a plot has tenure security, we now proceed to analyze how plot-level investments are affected. Table 5.6 reports these results.

Table 5.6. Regression analyses of non cash-intensive investments

VARIABLES	(1) Days on plot	(2) Fallow
Agribusiness share	96.504***	7.086
	(33.276)	(13.329)
Tenure_index	14.544	-0.607
	(15.284)	(6.373)
Tenure and Agri_share	-46.734	3.233
	(39.995)	(9.065)
Age of household head	-0.029	-0.000
	(0.659)	(0.273)
Number of household members	7.890***	-1.647
	(2.476)	(1.772)
Head has primary education	-0.938	0.818
	(11.040)	(12.087)
Female household head	9.893	-5.094
	(13.893)	(0.000)
Log of expenditure	-1.413	-2.065
	(7.209)	(3.423)
Log off farm income	2.868***	0.689
	(0.893)	(0.550)
Log Plot size	27.397***	2.796
	(10.593)	(8.555)
Age of plot	-0.214	-0.036
	(0.346)	(0.044)
Soil quality	10.556**	-0.321
	(4.473)	(1.133)
Log of plot value	4.815	0.916
	(3.859)	(1.385)
Plot owned by household	1.545	2.379
	(31.098)	(0.000)
Village certificate	3.415	-8.862***
	(6.224)	(3.336)
Observations	4,067	4,067
Crop Controls	YES	YES
Year	YES	YES

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

We find a significant and positive relation between the share of land held by an agribusiness and the total days that household members spend on the plot but do not find any significant effect for fallow. Recalling Figure 5.3, over 90 percent of the plot cultivators reported that they are not afraid of leaving their plots fallow, thus it is not surprising that the effect on fallow duration is not significant.

Table 5.7. Regression analyses of transmission channels and the share of land cultivated by agribusinesses

	(1)	(2)	(3)
VARIABLES	**Contract_farm**	**Employment**	**Expenditure**
Agribusiness share	0.010	0.907***	-0.157
	(0.014)	(0.223)	(0.125)
Age of household head	-0.003	-0.004	0.036***
	(0.002)	(0.016)	(0.010)
Age of head squared	0.000	0.000	-0.000***
	(0.000)	(0.000)	(0.000)
Number of household members	0.001	0.038***	0.095***
	(0.002)	(0.014)	(0.009)
Head has primary education = 1	0.006	-0.056	0.073*
	(0.005)	(0.077)	(0.044)
Female household head	0.013	0.146	-0.121*
	(0.014)	(0.140)	(0.064)
Constant	0.069	0.011	12.903***
	(0.045)	(0.415)	(0.263)
Observations	2,815	2,815	2,810
R-squared	0.007	0.064	0.405
Number of households	1,410	1,410	1,410
Year	YES	YES	YES

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Subsequently, we analyze whether the share of land held by agribusinesses affects cash-intensive investments. We analyze the impact on the use of improved seeds; irrigation, fertilizer and the total days spent by hired laborers. The TZNPS does not include information on plot demarcation or fencing that are also typically analyzed in the literature. We do not find any evidence that suggests that the share of land held by an agribusiness or tenure security significantly affect cash-intensive investments. The results are reported in Table 5.A2 in the appendix.

In the conceptual framework (Figure 5.1), we showed that agribusinesses may also affect smallholders' plot-level investments through spill-overs that persist even after the agribusinesses have ceased their operations. Table 5.4 shows that agribusinesses raise the number of days spent on the plot through channels other than tenure. To investigate these transmission channels, we employ a household and year fixed effects specification to analyze how the share cultivated by an agribusiness affects households' engagement in contract farming, the number of household members employed in the agricultural sector and household expenditure. The results are reported in Table 5.7.

From Table 5.7, we can see that an increase in the share of land held by an agribusiness in a village increases the number of household members employed in the agricultural sector. Similarly a decrease in the share of land held by an agribusiness reduces the number of workers employed in the agricultural sector. Columns 1 and 3 show that contract farming and household expenditure are not significantly affected by a change in the share of land held by agribusinesses. This confirms that the significant effect observed on the time spent on the plot in Table 5.4 is driven through a spill-over effect that arises when smallholders are employed by agribusinesses and not tenure security. This finding is in line with Hypothesis 2a.

5.7 Conclusion

This chapter investigates how a decrease in the share of land held by an agribusiness in a village affects smallholder plot-level tenure security and investments in rural Tanzania. Taking the literature on tenure security and plot-level investments as a starting point, we find that a decrease in the amount of land held by an agribusiness at the village level, increases smallholders' *de jure* and *de facto* tenure security. The uncertainty that arises after agribusinesses cease their operations and smallholders lose their access to village land, leads smallholders to obtain title for their plots. Since customary rights of occupancy are costly smallholders also obtain other forms of recognized title such as letters from the village assembly, letters of inheritance and agreements certified by the local court.

Analyzing how agribusinesses affect smallholder plot-investments, we find that the share of land held by agribusinesses raises the time spent by household members on their plots. This result is not driven by changes in tenure security but is likely to be driven by a learning effect that comes from employment on the agribusiness. Since employment in the agricultural sector often takes a seasonal nature, smallholders can increase the time invested on the plot while holding short term jobs provided by the agribusinesses. Taken together, our study reveals the importance of taking a comprehensive impact assessment of agribusinesses on local populations. Agribusinesses can have productivity enhancing effects on smallholders by increasing the time invested on plots but can also have adverse impacts such as raising uncertainty once they cease their operations. In order to mitigate these adverse impacts, the existing land framework should be revised to ensure that smallholders are able to reclaim their land if agribusinesses do not come into fruition or cease their operations. In addition, more information should be provided to smallholders the village assemblies and councils on the implications (both positive and negative) that arise from the coming of agribusinesses.

A limitation faced by this study is that we were not able to distinguish between the crops grown and the nature of the agribusiness. It is quite likely that the impacts on smallholder tenure security differ if one considers the different agricultural models and land acquisition procedures followed by the agribusinesses. Further research is needed to analyze these effects in more detail.

5.8 Appendix

Table 5.A.1. Regression analyses of plot-level tenure security and the presence of an agribusinesses

VARIABLES	(1) Land title	(2) Land title	(3) Perceived Tenure	(4) Perceived Tenure
Village has agribusinesses	-0.072***	-0.087***	0.025*	-0.014
	(0.016)	(0.020)	(0.013)	(0.013)
Age of household head		0.004*		0.000
		(0.002)		(0.002)
Number of household members		-0.001		-0.000
		(0.005)		(0.004)
Head has primary education = 1		0.028		0.038
		(0.030)		(0.024)
Female household head		-0.026		-0.089*
		(0.037)		(0.052)
Log of expenditure		0.044**		-0.014
		(0.018)		(0.014)
Log off farm income		0.000		0.001
		(0.002)		(0.002)
Log Plot size		-0.011		-0.009
		(0.022)		(0.017)
Age of plot		-0.000		0.000
		(0.001)		(0.001)
Soil quality		0.005		0.005
		(0.013)		(0.010)
Log of plot value		0.014*		0.003
		(0.008)		(0.006)
Plot owned by household		-0.215*		0.062
		(0.112)		(0.067)
Village certificate = 1		-0.002		-0.005
		(0.016)		(0.014)
Log of total village area		0.006**		0.002
		(0.003)		(0.002)
Constant	0.146***	-0.711**	0.905***	1.030***
	(0.007)	(0.331)	(0.006)	(0.246)
Observations	4,345	4,067	4,995	4,074
R-squared	0.040	0.058	0.002	0.013
Number of plot_ident	2,395	2,352	2,554	2,354
Crop Controls	YES	YES	YES	YES
Year	YES	YES	YES	YES

Robust Standard Errors in Parentheses, Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

Table 5.A.2. Regression analyses of non cash-intensive investments and the share of land cultivated by agribusinesses

VARIABLES	(1) Improved seeds	(2) Irrigation	(3) Fertilizer	(4) Hired labor
Agribusiness share	0.115	0.014	0.109	40.547
	(0.153)	(0.079)	(0.151)	(42.363)
Tenure_index	-0.000	0.013	0.031	-11.222
	(0.049)	(0.015)	(0.032)	(14.889)
Tenure and Agri_share	-0.030	-0.141	-0.202	15.710
	(0.112)	(0.092)	(0.137)	(35.980)
Age of household head	0.000	-0.000	0.000	0.663
	(0.002)	(0.000)	(0.001)	(0.579)
Number of household members	0.002	-0.001	-0.004	-1.131
	(0.007)	(0.001)	(0.004)	(1.614)
Head has primary education	0.091***	0.014	0.007	-1.343
	(0.033)	(0.013)	(0.024)	(17.907)
Female household head	-0.005	0.026	-0.004	10.506
	(0.050)	(0.016)	(0.025)	(17.568)
Log of expenditure	0.025	0.001	0.046***	7.264
	(0.020)	(0.008)	(0.014)	(5.717)
Log off farm income	-0.001	0.000	0.001	0.103
	(0.003)	(0.001)	(0.002)	(0.625)
Log Plot size	0.006	-0.004	0.031*	25.462**
	(0.026)	(0.007)	(0.018)	(10.276)
Age of plot	-0.002**	-0.000	-0.002***	0.046
	(0.001)	(0.000)	(0.001)	(0.251)
Soil quality	0.003	-0.002	-0.018*	-2.994
	(0.013)	(0.005)	(0.010)	(4.246)
Log of plot value	0.008	0.000	-0.002	-2.074
	(0.009)	(0.003)	(0.006)	(2.565)
Plot owned by household	-0.000	-0.004	-0.045	-28.058
	(0.069)	(0.005)	(0.067)	(27.240)
Constant	-0.435	0.012	-0.466**	
	(0.319)	(0.121)	(0.209)	
Observations	3,482	3,482	3,482	3,482
R-squared	0.055	0.016	0.031	
Number of plot_ident	2,006	2,006	2,006	
Crop Controls	YES	YES	YES	YES
Year	YES	YES	YES	YES

Columns 1 to 3 report robust standard errors. Columns 4 reports bootstrapped standard errors obtained from Honore's panel tobit model with plot-year fixed effects. Statistical Significance*** p<0.01, ** p<0.05, * p<0.1.

6 Drivers of households' land-use decisions: A critical review of micro-level studies in tropical regions[Ψ]

6.1 Introduction

Global change is the aggregate result of billions of individual decisions and understanding the determinants of these decisions is crucial for its analysis. This is particularly true in the case of land-use change which is a fundamental component of global change. Land-use change affects biodiversity, food security as well as the levels of greenhouse gas (GHG) emissions. Governments, policies as well as global and domestic markets set the conditions, under which micro-agents, i.e. households, firms, and farms, eventually take and implement decisions on land use. This process is accelerated by interlinked and interacting economic systems as well as by the digital proximity of social systems in a globalizing world (Liu et al., 2014; Liu et al., 2013; Eakin et al., 2014).

Studying the causes and consequences of land-use change requires the integration of natural sciences with social and geographical information (Rindfuss et al., 2004). Geographers and natural scientists utilize spatially explicit models at highly disaggregate scales while social scientists mostly rely on models that include human behavioral components to understand the determinants of land-use change (Irwin et

[Ψ] This chapter is co-authored with Elisabeth Hettig and Jann Lay. It is a slightly modified version of the paper: Hettig, E., Lay, J. and K., Sipangule (2016). Drivers of Households' Land-Use Decisions: A Critical Review of Micro-Level Studies in Tropical Regions published in *Land,* 5(4): 32.

al., 2001). Based on these approaches, land system science (LSS) has evolved from a science that solely addressed the patterns and causes of deforestation to a science that is now capable of analyzing more subtle land-cover changes through the use of intricate models that conceptualize the causal and feedback relationships within coupled human and environmental dynamics (Turner et al., 2007; Lambin et al., 2003). The data fed into these models has become more sophisticated in recent years and now includes high-resolution satellite imagery, geographic information systems as well as detailed socio-economic and geophysical data that model the human-environment interactions driving land-use change (Vance and Geoghean, 2004). Given the theory of coupled human and environmental systems, land system science extends its scope to the linkages and feedback mechanism between integrated coupled systems over geographically and socially large distances (Liu et al., 2013; Eakin et al., 2014). These so-called telecoupled interactions include socioeconomic and environmental effects, which might be non-linear and multidirectional and lead to intended or unintended, direct and indirect changes of different orders in the affected system (Eakin et al., 2014).

Since the emergence of land-change science, a number of literature reviews and meta-analyses that analyze the causes of land-use change have been published, in particular Angelsen and Kaimowitz (1999) and Geist and Lambin (2001). These reviews are based on the first wave of land-use change studies that analyzed the causes of deforestation in tropical regions in the early 1990's. These literature reviews called for more micro-level case studies that enable a better understanding of the causes and the mechanisms of land-use change (Geist and Lambin,2001; Angelsen and Kaimowitz, 1999). Since then, a large empirical literature of micro studies has emerged and meta-analyses of these studies are included in Keys and McConell (2005) and in Rudel (2007).

This chapter aims to analyze and review the drivers of land-use change that influence households' land-use change decisions. More specifically, we systematically review 91 micro-level studies and conduct a meta-analysis to understand the importance of specific determinants of households' land-use decisions. Similar to Keys and McConell (2005), we focus on tropical regions as they have experienced the most dramatic land-use change in the last decades. Hence, the studies we include consist of both empirical and theoretical multidisciplinary works that are conducted in tropical regions, at the village or household level, and published between the years 2000 and 2015.

Two important contributions emerge from our review: first, we depart from the conventional practice in earlier reviews to focus on the conversion of forest lands by including a discussion on the conversion of agricultural and ranching lands, protected forests and wetlands. Second, by placing an emphasis on micro-level studies, we can provide a more detailed assessment of household-level drivers than earlier reviews (with Keys and McConell (2005) being the exception) that stressed the role of more aggregate drivers such as population growth and market developments. This allows us to demonstrate not only the importance of household factors for land-use change, but also the heterogeneity in the relationship between land-use change and growth-associated micro-level drivers, which is caused by the complex interactions among these drivers, in particular income and technology, and the role of context-conditions, in particular institutions, policies, and market conditions. These results imply that land-use policies will have to take into account this heterogeneity and avoid one-size-fits-all approaches. In fact, this may explain why global fairly uniform approaches targeted at influencing land use change, for example Reducing Emissions from Deforestation and Degradation (REDD, and REDD+) have not been overly successful (Angelsen, 2012). The remainder of this chapter is structured as follows: We first introduce a conceptual framework adapted from Angelsen and Kaimowitz' (1999) model. This is followed by a systematic meta-analysis of the micro-level studies reviewed. We then provide a detailed and comprehensive literature review and close with a summary, conclusions, and some reflections on future research.

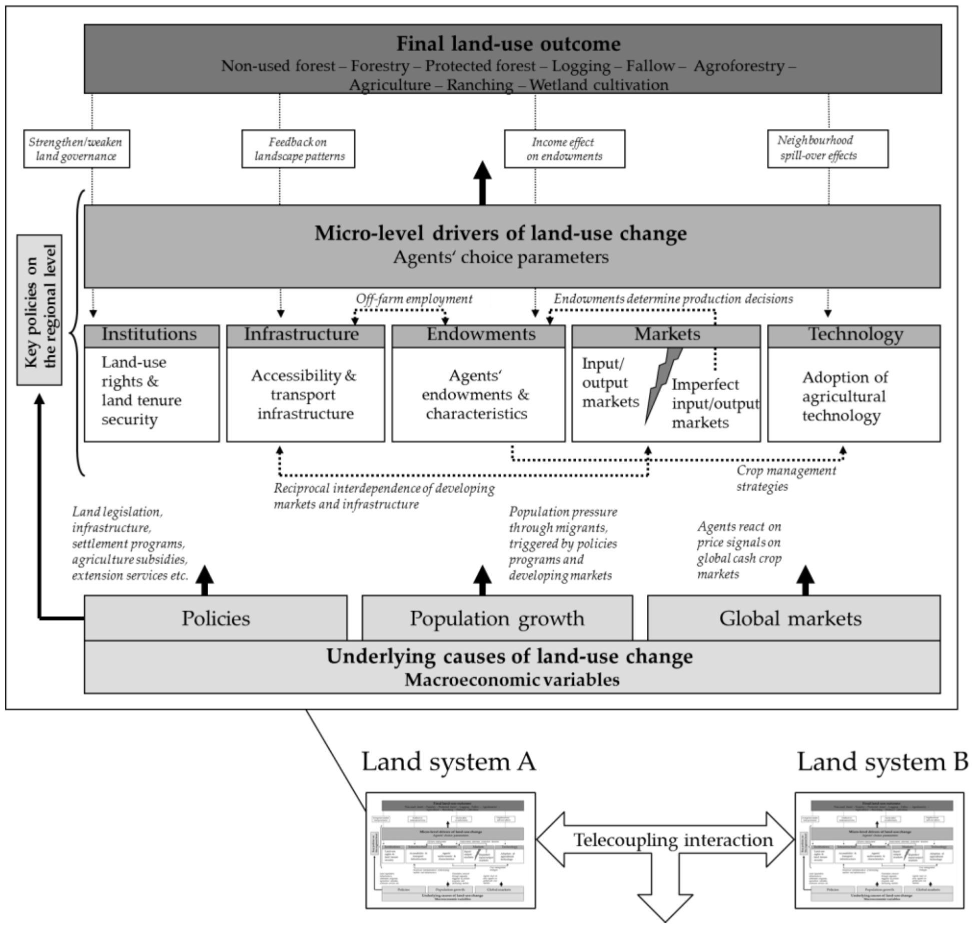
6.2 Conceptual framework of land-use change

To conceptualize the multiform and complex dynamics of human-environmental systems and land-use change, we build on a concept of the causes of deforestation proposed by Angelsen and Kaimowitz (1999). This simple framework that provides a stepwise distinction of the causes of deforestation has been widely cited in both the deforestation and land use literature (see for instance, Geist and Lambin, 2001). It includes a three-stage-process of underlying causes (macroeconomic variables), immediate causes (decision parameters) and sources of deforestation (agents' actions). While we find that this model is a good starting point for a more detailed analysis of the drivers of land-use change, we identify two major limitations of the framework. First, it neglects the role of household endowments and characteristics in driving land-use change. Second, it does not explicitly consider interlinkages and feedback mechanisms within coupled human and environmental systems and between different systems. Within a system, there could be feedback mechanisms between the different stages, for example between agents' choices and underlying causes of deforestation. For instance, agents may influence policies, which again affect land-use decisions. Further, interlinkages between the decision parameters need consideration. For example, technology and infrastructure are likely to be linked. Further, there could be multidirectional interactions of one system towards other socially and geographically remote human-environmental systems, so-called telecoupling interactions (Liu et al., 2013; Eakin et al., 2014).

We draw on the framework by Angelsen and Kaimowitz (1999) but modify it to suit our purposes in the following ways. First, rather than analyzing all actors of land-use change we only focus on the land-use decision parameters of farm-households and small-scale farms. Second, deforestation is obviously only one form of land-use change and we include other categories, such as reforestation or the conversion of wetlands to agriculture. Third, we expand the range of micro-level drivers (institutions, infrastructure, markets and technology) to include household characteristics and endowments (for instance, physical capital and family workforce) and key policies (for example, forest conservation policies, institutional reforms of land rights, or agricultural policies). Fourth, we present more precise elaborations of the feedback mechanisms between and within the hierarchical components of land-use change within a specific human-environmental system. Fifth, we link the dynamics of one system to others capturing the potential interacting and feedback processes between two or more systems (see Figure 6.1). Our concept thus integrates the determinants and outcomes of land-use change in a human-environment system both vertically, i.e. between underlying causes, micro-level drivers and outcomes, as well as horizontally, i.e. between specific micro-level drivers. Embedded in a telecoupled world, it is further linked to at least one other distant land system by telecoupling interactions and feedbacks.

Figure 6.1 shows our framework. It illustrates the decision-making process of micro-level agents and how the underlying causes of land-use change (macro-economic variables) are linked to the micro-level drivers and to the final land-use change outcomes, which we define as non-used forest, forestry, protected forest, logging, fallow, agroforestry, agriculture, ranching, or wetland cultivation. Underlying causes include policies, population growth, and global markets. It further sets the dynamics of land-use change in one system in the context of telecoupling processes with other human-environmental systems. To keep it simple, we do not illustrate the potential cross-scale links between specific elements of the system A to elements of the system B (and possibly further systems, which are described by the third white arrow).

Figure 6.1. Concept of the micro-level drivers of land-use change.



Authors' concept based on Angelsen and Kaimowitz (1999), Eakin et al. (2014) and Liu et al. (2013).

Focusing on the land-use change dynamics of micro-level agents, we refer to the central causalities between macro-economic variables and micro-level drivers of land-use change. The impact of underlying policies on land-use decision making is dependent on two relevant aspects: first, on the institutional framework of land-use rights and the (non-)existence of land tenure security and second, on key policies for land use. Individual land-use decisions highly depend on the respective land governance and on the ways in which land-use rights can be transmitted and guaranteed. Likewise, land-specific key policies such as settlement programs, public schemes for highway expansion, or land extension services, influence and alter all other land-use decision parameters of agents. To illustrate how population growth affects agents' land-use decisions, our concept focalizes primarily on local population pressure via immigration. Immigration is either triggered by key policies and by price signals of developing markets. Finally, we include the impact of global markets and focus on global cash crop markets, which create incentives for agents to switch their land use towards cash crop cultivation and thus might raise households' incomes. Income growth in turn may alter crop consumption patterns and hence crop demand on the regional and global scale.

Introducing institutions, we show that local land-use rights, such as formal property rights or informal (customary) rights drive land-use change. Taking these contrary systems as an example, agents may react differently regarding their decision on land extension or cash crop cultivation. The degree of tenure security, implemented through legal titling or local agreements, determines the reliability of these land rights. As a second decision parameter, the accessibility to public services, market centers and transport infrastructure, influence agents' land-use decisions by enabling rural households to improve their access to agricultural inputs and sell their output.

Third, the agents' characteristics and endowments that include the culture/ethnicity of a household and its physical capital, labor or social capital are key parameters for agent's land-use decision making. For instance, a higher level of wealth enables a household to invest in more capital intensive land uses such as pasture. These individual effects are reinforced if access to capital (or other factor) markets are limited.

Hence, introducing the fourth choice parameter, the quality of input and output markets plays a fundamental role for agents' land-use change. Households' land use differs if markets for labor and agricultural inputs are limited or even non-existent. For example, cash crop adoption and agricultural expansion - and thus the systematic forest conversion - is more restricted for households in areas with fragmented markets. Finally, land-use decisions are determined by the respective agricultural technology available for and adopted by households.

Furthermore, our framework on land-use change identifies four relationships between the micro-level drivers within one human-environmental system that are depicted by the dotted lines in Figure 6.1. First, there is a reciprocal link between the accessibility to infrastructure and developing markets. On the one hand, public improvements in transportation networks reduce costs and facilitate economic activity, which in turn promotes the emergence of input and output markets in remote areas. On the other hand, evolving markets trigger infrastructure development. Both dynamics are interdependent and mutually reinforcing. Second, household characteristics and endowments affect the adoption of technologies and agents' crop management strategies. For example, the adoption of a more labor-intensive technology depends on either household's capital available for hiring labor or on family workforce. Third, access to infrastructure and public services influences agents' options of off-farm employment and vice versa. Lastly, market conditions determine the production decisions of households. If input or output markets are limited or non-existent, households have to fall back on family workforce and capital endowments. Thus, the decision on land-use change depends on the households' own shadow price for family labor, leisure and assets and is not determined by external factor market prices.

Feedback loops also operate from the final land-use outcomes to the micro-level drivers through the mechanisms depicted by the small boxes above the micro-level drivers of land-use change. Certain land-use changes could strengthen or weaken land rights. This is especially the case if land is weakly governed and there are additional informal rules of land rights. Since the conversion of non-used forests in tropical regions goes along with the introduction of property rights, longer fallow periods could attract other agents to encroach and convert forestland for their own purposes. In addition, different land uses and the corresponding landscape changes may influence infrastructure requiring a different set-up such as those necessary for plantation cultivation. At the household-level, land-use choices go along with specific income effects, for example, cash constraints could be relieved allowing the household to accumulate physical capital for new investments. This in turn determines production decisions, especially so under imperfect factor markets. Finally, land-use outcomes induce neighborhood spill-over effects, for example via copying or knowledge transfer in informal networks.

Across systems, telecoupling interactions include socioeconomic-environmental effects, which might be governed and intended, for example global policy programs including the global program for sustainable forest management called Reducing Emissions from Deforestation and Degradation (REDD and REDD+). An example for unintended, ungoverned impacts across systems is the recent phenomenon of large-scale land acquisitions in developing countries – sometimes referred to as "land grabbing". These acquisitions, often by foreign investors are driven by the increased global demand for agricultural products and have repercussions, sometimes land right conflicts, in very remote places (Anseeuw et al., 2012). That conflicts in such places reach the attention of a worldwide audience and influence global discourses through the campaigns of NGOs shows that – in a globalized world – agents might not only cross distance but also scale and hierarchical contexts (Eakin et al., 2014), thereby linking not only the elements of within but also between different systems.

6.3 Overview of reviewed studies and meta-analysis

Following the concepts of Cooper (1982) our review adopts the elements of an integrative research review. As is common with integrative research reviews our study collects and compares the results of primary studies on micro-level land-use change to represent the current state-of-the-art and to point at research gaps within the relevant literature. As part of this, we apply a meta-analysis to synthesize the results of the reviewed studies systematically. Specifically, we code the qualitative information across studies according to a questionnaire (see Appendix 6.6, Table 6.A.1). We further extend the existing theory on the micro-level drivers of land-use change and carefully examine the potential threats to validity of the reviewed studies.

The studies reviewed in this chapter were collected during the period from March 2011 to September 2015. They were sourced from academic databases and search engines such as Google Scholar, Scirus, Repec, Mendeley, AgEcon Search as well as from cross references of cited papers. Keywords and search items included "land-use change" and "household" or "village", restricted to studies published between 2000 and 2015. Our initial search resulted in a total number of approximately 180 studies. These studies were carefully read by two of three authors and only included in the sample of studies if they met the following key criteria. First, the data analyzed in the studies must include information collected at the household or village level. In addition, the studies must analyze land-use change at the village- or household level and the drivers of change have to include household characteristics. Second, the papers had to be published in peer-reviewed journals between 2000 and 2015. We took 2000 as the base year because the last comprehensive meta-analyses and empirical reviews were published in the early 2000s. Third, we restricted our sample to studies that were conducted in tropical regions as these regions experienced the highest rate of land-use change during our study period. Once papers that fulfilled all three criteria were selected, they were further screened for the methodological rigor. If the authors concluded that – despite having undergone a peer review process - a paper still failed to properly identify the drivers of land-use change at the household level it was excluded from the literature review. In the event that the same author published a set of accompanying papers using the same dataset and identifying the same drivers of land-use change, only one paper was included in the review. These restrictions resulted in a subset of 91 studies that were included in the review.

After the 91 papers were selected, the authors underwent a rigorous reading and coding processes based on a questionnaire (see Appendix 6.6, Table 6.A.1). The questionnaire was designed to collect information such as the academic backgrounds and present affiliations of the authors of the reviewed studies, the year of publication, and applied methods. The main results of the papers, i.e. the type of land-use change and land-cover change, the land-use change drivers suggested in the paper as well as the region and country of study were also systematically recorded. Each paper was read and coded by two of the three authors to allow for a stringent cross-verification of all entries.

Our classification of the drivers of land-use change is based on the conceptual framework introduced in the preceding section. In addition to the five main drivers identified by Angelsen and Kaimowitz (1999) we include two new drivers of land-use change, i.e., household characteristics/endowments and key policies (see Appendix 6.6, Table 6.A.2). Overall, 330 proxy variables for specific drivers are reported as having a significant impact on land-use change in the 91 studies.

6.3.1 Land-use and –cover change

The literature on micro-level land-use change often defines land-use change rather implicitly or vaguely and does not use a uniform definition of land-use change. Additionally, some studies do not make a clear distinction between land use and land cover. However, to synthesize the results of the 91 studies, a precise distinction between land use and land cover is required, as suggested by Lambin and Geist (2006) and Fisher and Unwin (2005).

A widely used definition describes land cover as the observable (bio-) physical qualities of the Earth's land surface (Di Gregorio and Jansen, 2000). In contrast, classifying land use always demands a socio-economic perspective on land (Fisher and Unwin, 2005). Consistent with this approach, Lambin and Geist (2006: 4) refer to land use as the "purposes for which humans exploit land cover. It involves both the manner in which biophysical attributes of the land are manipulated and the intent underlying that manipulation". Hence, land use is always determined by the "arrangements, activities and inputs people undertake on a certain land-cover type to produce, change or maintain it" (Di Gregorio and Jansen, 2000). Following these definitions, a change in land use does not necessarily lead to a change in land cover, for example in the case of intensification. Moreover, the terms land cover and land use follow a many-to-many relation (Fisher and Unwin, 2005). For example, land covered by forest could be land used for forestry or conservation. In addition, agriculture can occur on land cover classified as grassland, woodland or wetland. Inconsistencies in the use of these terms render the systematic comparison of study results difficult, especially if evidence is based on remote sensing data, which need the interpretation of aerial information (Fisher and Unwin, 2005).

In our systematic analysis of land-use change we are able to capture more subtle land-use change scenarios, which have not yet been classified in earlier literature reviews. Moreover, we illustrate that it is indeed useful and instructive to distinguish between land-cover (change) and land-use (change) clearly. We identify the initial land uses (LU) and land covers (LC) and the final LU and LC for each study in our sample using a one-to-many relationship between LC and LU categories (see Table 6.1). Considering the variety of research objectives and applied methodologies, we only include land uses and land covers, which are central for each study. For those cases that do not provide direct information about the initial and final land covers/ land uses, we derive the categories from study site description and central statements or conclusions provided by the respective study. Since most studies analyze several land-use change scenarios, we allow for more than one land-use change scenario per study. We finally identify 184 land-use change scenarios that fall into 33 different categories of land-use change.

Due to the variety in land-cover information across studies and disciplines (and sometimes the lack of precise information), our cover categorization follows a broader definition than other, more detailed categorizations, for example, the Land Cover Classification System (LCCS) by Di Gregorio and Jansen (2000). Thus, we classify land cover into forest, cultivated land, grassland, shrubland, desert and wetland (Table 6.1). Under forest we include land cover such as natural forest, primary forest, old-growth forest, mature forest, secondary forest, residual forest or woodland. We define cultivated land as areas used for agricultural purposes (including orchards and plantations). The land-cover categories grassland, shrublands and deserts denote land cover described as pasture land, arable land, savanna, bushland, or non-forest vegetation. Since one of the studies reviewed analyses land-use change at desert fringes, we also include desert as land cover, referring to dune landscape. The last land cover, wetland, indicates land covered, for example, by swamps.

Under these LC categories we further classify 12 different land uses (Table 6.1). We assign the following forest uses: Non-used forest that captures natural forests; forestry, which refers to resource extraction, for example, firewood collection and hunting; protected forest that includes forest reservation; logging, which denotes logged forests for commercial reasons; and fallow, which is land left for regeneration, mostly within a cultivation cycle of shifting cultivation. Cultivated land could be used for agriculture or agroforestry whereby agriculture as a broader term encompasses mono and mixed-cultivation (including plantations) and is mostly used for cash crop cultivation. Agroforestry describes woody perennials and agricultural crops planted in agroforestry systems as well as shifting cultivation (Nair, 1993;

Raintree and Warner, 1986). Grasslands, shrublands and deserts (i.e. dune landscape) are mainly used for ranching; this includes livestock farming, cattle ranching or agro-pastoralism. To capture the use of natural grasslands, shrublands and deserts, we include the terms non-used grassland/non-used shrublands/non-used deserts. Similarly under wetland, we subsume non-used wetland, that captures natural wetlands, and wetland cultivation, that includes landscapes, for example, with rice fields.

Overall, 77 percent of all scenarios analyzed in the reviewed studies concern land covered initially by forests (see Table 6.1). Within this subsample, the conversion of non-used forest and forestry receives most attention. Looking at final land uses, land is predominantly changed towards agricultural usage (52 percent) followed by ranching (22 percent) and some minor categories, like fallow (9 percent) and forestry (5 percent). Hence, as expected, the most analyzed scenario is the conversion of non-used forests or forestry for agricultural purposes, together these make up 62 cases (34 percent of all land-use changes in the reviewed studies). The second largest share (35 cases or 19 percent) is accounted for by studies that analyze the conversion of non-used forests or forestry towards ranching. Hence, deforestation - represented by the land-cover change of forests into cultivated land or grassland/shrubland - is still the main focus of studies analyzing land-use change on the micro-level.

Table 6.1 also reveals other important land-use change scenarios, for example the change of land use for agriculture/ranching towards fallow holding, which is covered by 14 cases in the scenario sample. In contrast, we identify only 8 cases of converted fallow holdings for agricultural purposes and 1 for ranching. There are also an important number of cases (14) that analyze the transformation of protected forest. Very few studies (5) in our sample delve into the reverse process, i.e. land-use change scenarios towards protected forest (or other protected zones).

Table 6.1. Land-use (and cover) change of reviewed micro-level case studies.

Initial LC and LU \ Final LC and LU		*Forest*					*Cultivated Land*		*Grassland, shrubland, desert*		*Wetland*		**Total**
		Non-used forest	*Forestry*	*Protected forest*	*Logging*	*Fallow*	*Agroforestry*	*Agriculture*	*Ranching*	*Non-used grassland /shrubland/ desert*	*Wetland Cultivation*	*Non-used wetland*	
Forest	*Non-used forest*		6		2	1	2	36	18				65
	Forestry	1			1			26	17				45
	Protected forest		3					7	4				14
	Logging			1				3	2				6
	Fallow	3					1	8					12
Cultivated land	*Agroforestry*					1		4	1				46
	Agriculture			1		12		1	1	1			21
Grassland/ Shrubland/Desert **Wetland**	*Ranching*			1		2		6	2				4
	Non-used grassland/shrubland, desert												48
Wetland	*Wetland cultivation*												
	Non-used wetland										3		3
Total		4	9	5	3	16	3	95	45	1	3		N=184

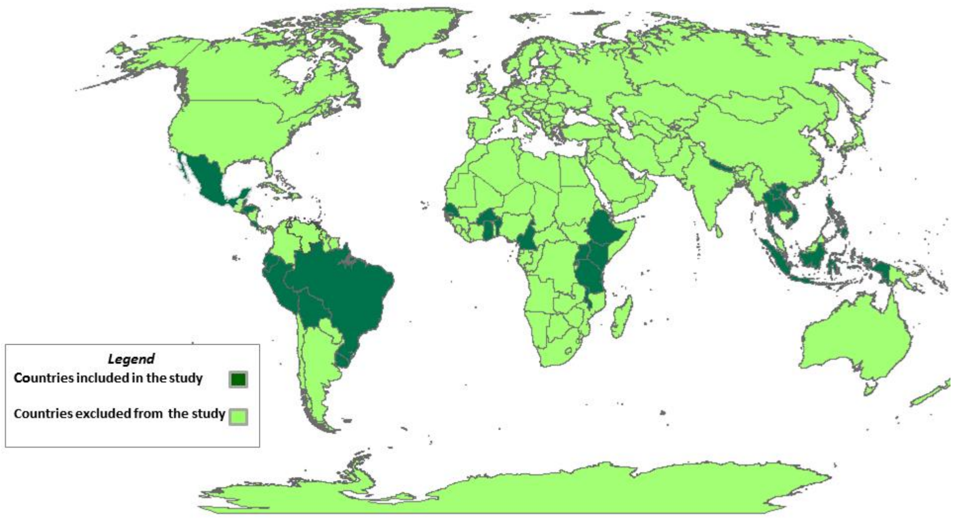
While these transformations may indeed be less frequent, this relatively low number of studies at the micro-level – at least when our inclusion criteria are applied – is surprising. Furthermore, the small number of cases focusing on the conversion of wetlands for agricultural purposes reveals the lack of research on, amongst others, the transformation of mangrove forests, which have been declining at a faster rate than adjacent inland tropical forests (Duke et al., 2007). Additionally, only three cases consider land-use transitions from non-used forests/forestry to logging. The low number of studies examining logged forests maybe explained by the fact that logging is predominantly carried out on large-scale concessions (Sodhi et al., 2007). Further, we could not find any studies that analyze the contribution of agents - who conform to our definition of micro actors - to systematic logging. This could be because logging activities carried out by households, might be illegal and thus less likely to be reported in household surveys (Sodhi et al., 2010)

6.3.2 Geographical coverage

The studies in our sample were carried out in 29 (sub) tropical countries (see Figure 6.2). South America accounts for the largest share of studies in our sample (41 percent) and together with Central America, it contributes to 63 percent of all the studies reviewed (see Table 6.2). This result is in line with the earlier review by Geist and Lambin (2001) who find that the majority of case studies come from Latin America.

This large share can be attributed to the high deforestation rates in Central and South America, which hold the major share of earth's primary forest cover and stocks in forest biomass (FAO, 2015; Laurance et al., 2001). The high number of studies in this region could also be a result of regional preferences by research groups and the related availability of land-use data. Land-use change studies on African countries account for 20 percent of all reviewed case studies; however, the bulk of these studies (N=13) are conducted after the year 2010 – pointing at the rising importance of land-use change in African countries (Chidumayo and Kwibisa, 2003).

Figure 6.2. Geographical coverage of micro-level case studies



Source: Authors' own compilation

Only 15 percent of all case studies analyze land-use change in Asian countries. The limited number of Asian case studies is surprising, since research hints at high deforestation rates in South-East Asia due to logging activities and plantation agriculture (Elz et al., 2011; Miettinen et al., 2011; Sodhi et al., 2004).

Table 6.2. Regional coverage of reviewed micro-level case studies

Region	Central America	South America	Africa	Asia	Total
No. of studies	20	37	20	14	91
Percent	22	41	22	15	100

As noted above with regard to the lack of studies on logging, firms that operate such logging or large-scale agricultural activities appear to remain beyond the scope of micro-level studies of land-use change determinants.

6.3.3 Interdisciplinarity

Ideally, land-change science integrates natural, social and geographical sciences to understand patterns of land-use change (Rindfuss et al., 2004). We examine which disciplines are most actively involved in land-use change research and to which extent these disciplines collaborate. This is done by scrutinizing the authors' educational qualifications and their current research interests. Table 6.3 provides a summary of the disciplines that are involved in land-use change research according to the studies reviewed. Within all case studies, most research is done by economists and geographers, followed by ecologists. Moreover, about half of the studies are multidisciplinary (N=47) and this share remains relatively constant over the period from 2001-2015.

Table 6.3. Scientific disciplines in micro-level studies reviewed.

Discipline	**Sub-discipline**	**Coverage (%)**
Economics	Agricultural Economics, Forest Economics, Environmental Economics, and Resource Economics	41
Geography	Spatial Analysis and Spatial Planners	29
Ecology	Environmental Sciences, Ecology, Biology, Botanic, Forestry, Biogeochemistry, Agricultural Science, Oceanography, Biostatistics, Entomology, and Soil Science	15
Anthropology	Anthropology	10
Social Science	Sociology, Political Science, Development studies, Public policy	2
Demographic Science	Demography, Population Science	3
Multidisciplinary studies - with at least one differing discipline		52

6.3.4 Methods and data

We aggregate all methods used into five categories that comprise regression analysis (including choice models), multivariate analysis, descriptive statistical analysis, theoretical models, and (data-based) simulation techniques. Some studies use multiple methods, which results in 106 methods applied in 91 studies. Table 6.4 shows that regression analyses account for 70 percent of the methods used. In addition, a few studies (9 percent) rely on multivariate analysis (for example ANOVA, Hazard models) or on simple descriptive techniques, such as correlation analysis. 10 percent of all applied methods are simulation techniques and out of these, half of the studies use agent-based modelling systems. We do not find that the disciplinary background of the authors determines the choice of methods used.

Table 6.4. Methodological approaches taken in micro-level land-use change studies.

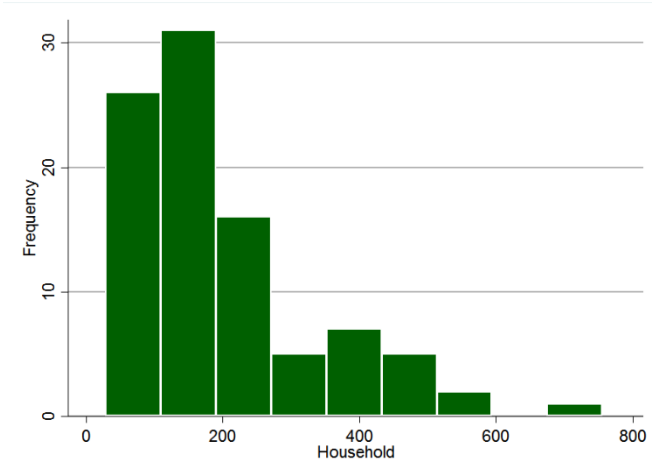
Method	%	N
Regression analysis	59	62
Multivariate analysis	9	10
Theoretical model	6	6
Descriptive analysis	16	17
Simulation techniques	10	11
	100	106

Most studies analyze land-use change using household and village data, relying often on relatively small samples of 100-200 observations (see Figure 6.3).

Moreover, 48 percent of all studies integrate socio-economic data and information from satellite images (N=45). Only a few studies (explicitly) include qualitative data, such as results from focus group discussion or expert interviews (N=4). Though most studies explore between-household variation, i.e. household-level data, 8 percent

(N=7) of all studies are based on village-level data. Some studies use also more than one database, which leads to a total number of databases of 93.

Figure 6.3. Sample size of household data in reviewed case studies



Note: For the graph one study with a sample size of 3554 households has been excluded.

In terms of temporal dimension, most studies are based on cross-sectional data, and only 16 studies use panel data with typically two rounds of observation (see Table 6.5). Beyond that, some studies rely on retrospective data (N=6) although this approach is prone to measurement errors, for example through recall biases, which especially increase for longer periods (Bernard et al., 1984).

Table 6.5. Temporal dimensions in micro-level land-use change studies

Spatial level	Cross-section analysis	Panel Analysis(t=2)	Panel Analysis(t>2)
Household or farm	51	15	8
Village	5	0	2
Region	5	1	2
N	61	16	12

6.3.5 Internal and external validity

Before providing some meta-analytical insights on the results of the studies, we briefly discuss some of the methodological challenges one is likely to encounter in the analysis of the micro-level drivers of land-use change and then explain how the studies reviewed have dealt with them. One of the key empirical challenges is revealing a truly causal relationship between a specific driver and the dependent variable. While some studies do their best to address the challenges of causal inference, other studies face problems of internal validity because of endogeneity (simultaneity and reverse causality) and omitted variable bias. If these possible sources of bias are not accounted for, a correlation between land-use change and changes in a specific driver (or rather a proxy of it) is mistaken as a causal effect of the latter on the former.

In a number of studies, these empirical (econometric) problems are not adequately addressed. When estimating the causal effects of household-level variables (agents' endowments, off-farm employment) on land use, the results may often be biased because of reverse causality and simultaneity, i.e. not only is the driver influencing land-use change, but also vice versa. For instance, if household wealth (or income) and a particular land use, such as cash cropping or ranching, are found to be correlated, this does not necessarily imply that wealthy households are more likely to be engaged in these land uses. Such a correlation is also likely to reflect that engaging in these commercial activities may have turned households wealthy in the first place. A similar argument can be made for off-farm employment - a variable that is often used as an explanatory variable in land-use change regressions. Here, reverse causality stems from the fact that the proceeds from cash crop farming enable otherwise liquidity-constrained households to invest in off-farm activities. More generally, both theory and evidence suggest that rural households that are constrained on important factor markets – most notably labor and credit markets – decide simultaneously on agricultural and non-agricultural production as well as consumption. This simultaneity is formalized in agricultural household models.

At the household level, another potential source of bias – often ignored in empirical land-use change studies – is the so-called "unobserved heterogeneity". In particular, regression analyses of technology adoption or market participation, i.e. cash crop adoption and land-use change, suffer from omitted-variable bias. Households may have unobserved characteristics, such as their intrinsic motivation or entrepreneurship skills, engagement in rent-seeking behavior, or risk-attitudes that directly explain their patterns of land-use change. Such unobserved characteristics tend to be correlated with some of the typical household or farmer characteristics included in regression analyses, for example education, income, and wealth. If unobserved characteristics are omitted from the estimation equation, the effects of these variables are likely to be biased.

Omitted variable bias is not only a problem at the household-level. A particular challenge of empirical studies at the micro-level regards disentangling the effects of policies that tend to affect all studied households and individual (household-level) effects. Large-scale land-use change is often the result of deliberate planning policies, in particular agricultural and settlement policies. These policies establish infrastructure and create markets. Households react to these policies and incentives by moving to the agricultural frontier, and engaging in cash crop farming (sometimes through contract farming). This implies that empirical studies in such contexts need to account for the fact that there is a policy that simultaneously causes roads to be built, migrants to move into a certain area and to engage in a specific land use. It is obvious, that the correlation between roads and deforestation that will be observed in such a context cannot be interpreted as a causal effect.

Finally, another very severe problem of reverse causality often arises, when the effect of institutions on land-use change is analyzed. Property rights at the agricultural frontier are often obtained directly by deforestation. This implies that a correlation between insecure property rights (acquired by deforestation) and land-use change cannot be taken as a sign of a causal relationship from weak institutions to deforestation. All these challenges pose serious threats to the internal validity of micro-level land-use change studies, i.e. to correctly attributing causality to specific drivers of land-use change. These challenges are addressed in only 17 of the 57 regression analyses by using Instrumental Variable (IV) techniques or fixed effects estimations. This includes the studies by Shively and Pagiola (2004), Maertens et al. (2006) and Chibwana (2011). The application of these techniques is taken as a proxy that the study has made an explicit effort to reflect upon issues of endogeneity. We acknowledge that this is not to say that these issues have been addressed convincingly by the respective study. In principle, these empirical problems do not apply to simulation and theoretical models (with the exception of regression-based simulations). Here, assumptions, functional forms, rules, and parameters have to be put under scrutiny. Very few studies, however, rely on very stylized optimization models (N=2).

Studies dealing with land-use change on the micro-level may also face difficulties of external validity. Since micro-level studies have per definition a small geographical coverage, they have to be clear in their contextualization also referring to the representativeness of their results. However, some studies fail to differentiate between the mechanisms specific to the study area and possibly generalizable results. For example, the insights on the impact of a particular set of communal rights on land may only be relevant in the respective context. This holds in particular for drivers related to institutional and policy change.

6.3.6 Overview of covered drivers

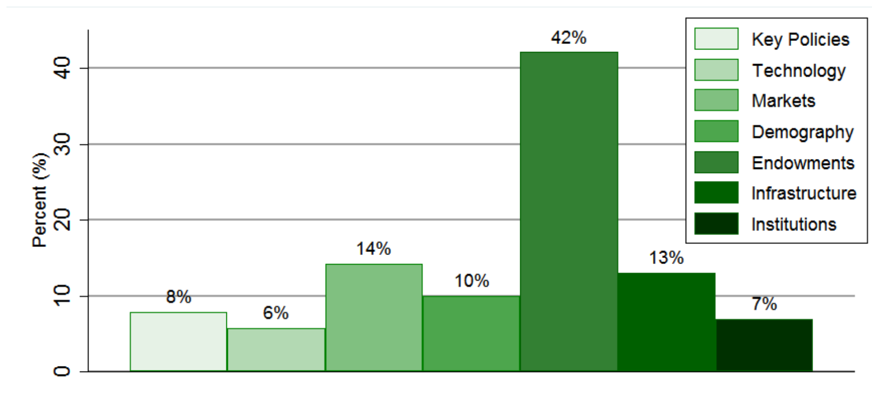
In this section, we present some first generalizations on the drivers of households' land-use decisions analyzed by the reviewed case studies over space and time. This indicative analysis is based on the frequency of a reported driver that is found to have a significant effect on land-use change. Since many studies are not using regression models, our interpretation of significance does not only refer to statistical significance, but also classifies as significant those drivers that are stressed most by authors within the result or conclusion section. We classify the 330 variables that were reported as significant land-use change determinants in the case studies into seven main categories of drivers (institutions, infrastructure, endowments and characteristics, markets, technology, key policies, and demography referring to population and migration) (see Appendix 6.6 Table 6.A.2).

Our findings reveal that household endowments and characteristics account for 42 percent of all identified drivers (see Figure 6.4). This is followed by markets and infrastructure, representing 14 percent and 13 percent of the drivers reported in the studies; demography, technology, key polices, and institutions play a minor role in driving land-use change in the studies reviewed. Since household endowments and characteristics emerge as the most prominent driver, we further disaggregate this driver into physical-, human- and social capital and labor (see Appendix 6.6, Table 6.A.3). Among the household endowments, physical capital is often found to be significantly associated with land-use change. In addition, labor and human capital also receive considerable attention (see Table 6.6).

These meta-analytical findings need to be interpreted with caution. They cannot be directly taken as evidence that household characteristics and endowments are the most important driver of land-use change.

For their interpretation, it is important to understand that the findings reflect the level of variation between households. In micro-level studies, households tend to be exposed to the same socio-economic and ecological environment; be it with regard to prices, other market conditions or institutions. Detecting land-use change in response to changes in the households' environment typically requires variation and data over time; and as seen above, less than half of the studies have such data. That scale matters for the results, becomes apparent when we disaggregate the studies into different scales distinguishing between data collected on the household, village or regional level.

Figure 6.4. Micro-level drivers of land-use change (N=330)



Then it turns out that demography is the most important driver of land-use change on the village level. This finding points at the importance of migration for land-use change since demographic variation between villages is mainly driven by migration, not by natural demographic forces.

Table 6.6. Decomposition of the micro-level driver: Household endowments and characteristics

Household endowment and characteristics	Physical capital	Labor	Human capital	Social capital
%	50	33	14	3

Once the caveats to the above aggregation exercise of drivers are understood, the meta-analytical findings first tell us that there is indeed substantial household heterogeneity, not only in terms of household-level characteristics, but also of observed land-use choices. Second, the household heterogeneity, in particular in terms of income and endowments, is significantly associated with land-use change.

It is important to note that this is not necessarily the case, as one may expect household-level land-use change to be driven mainly by external forces with all households reacting more or less the same. In contrast, the detailed review of selected studies below will illustrate how household-level factors condition households' reaction to these external forces. Third, in addition to this general insight regarding the heterogeneity in household characteristics and reactions, the results of Table 6.5 and 6.6 can be taken as a first indication that economic growth is an important aggregate force that drives land-use change. This is because the micro-level determinants of economic growth, in particular physical capital, often turn out to be associated with households' land-use decisions.

However, the relationship between land-use change and these growth- associated micro-level drivers is not simple. As the subsequent literature review will show, there are complex interactions between these micro-level determinants, for example in the use of capital and labor, the application of technologies, and context-conditions, in particular institutions, policies and the conditions on factor markets.

6.4 Drivers, studies and cases of households' land-use decisions

We organized the review below according to the grouping of seven drivers suggested above. In addition to the factors that have been considered in earlier reviews, we carefully review household endowments/characteristics as well as key policies addressing land-use change. The many examples and case studies illustrate the complex interrelationships between land-use change and its supposed drivers. Different transmission channels with varying importance in different contexts are at work, often simultaneously. Empirical ambiguities do not only arise from different context conditions, but also because of the existence of non-linearity's in the relationship between a specific driver and land-use change.

6.4.1 Property rights and institutions

In a setting where households draw their sustenance from agricultural activities, the rules and institutions that govern the ownership and utilization of land play a key role in determining households' behavior and decisions. A significant number of the households analyzed in the studies reviewed are faced with weakly defined and insecure property rights (Etongo et al., 2015; Adams et al., 2013; Newby et al., 2012; Muriuki et al., 2011; Dolisca et al., 2007; Mena et al., 2006a; Pan et al., 2004; Murphy, 2001; Otsuka et al., 2001).

In the absence of well-defined property rights and tenure security households often gain *de facto* land rights through deforestation and land clearing (Etongo et al., 2015; Damnyag et al., 2012; Dolisca et al., 2007; Otsuka et al., 2001; Cattaneo, 2001). Cattaneo's (2001) simulation model-based analysis of deforestation in the Brazilian Amazon assumes that deforestation enables the acquisition of property rights to "unclaimed" land. He further argues that this adds a speculative value of informal tenure rights to the potential returns from agriculture. These relationships imply an ambiguous effect of tenure security on deforestation or other forms of land-use change. In general, households or farmers in environments with relatively insecure rights may tend to use land conversion or possession of "unclaimed" land as a way of establishing informal land-use rights. In line with this argument, Dolisca et al. (2007) find that illegal occupants are more likely to convert forest into cultivable land than farmers with titled land in Haiti. Such behavior is reinforced by regulations that foresee titling through adverse possession; that is, farmers acquire titles after physically living on a piece of land for a 20-year period. Yet, Dolisca et al. (2007) also point at evidence for the same country that shows that titling programs have equally caused more deforestation, as more land is then cleared because of an increased value of the property rights established by clearing – this is very much in line with Cattaneo's (2001) argument above. Generally, households will deforest or clear land up to the point where the marginal benefits of clearing (including both the value of potential agricultural production and of tenure rights) exceed or match the marginal costs of doing so (including the direct costs of clearing, for example labor costs, and of violating laws).

Beyond these "direct" effects of establishing property rights through land conversion, the presence of insecure tenure has important effects on agricultural management practices, profits to be earned from agricultural activities, and, hence, investment decisions. It is well established that insecure property rights have an inverse relation with household's planning horizons (Besley and Ghatak, 2010; Goldstein and Udry, 2008).With shorter planning horizons, farmers are more likely to apply less sustainable agricultural management practices; in particular, they may invest less in soil conservation measures and leave too little land fallow. In line with this argument, Damnyag et al. (2012), show that farm households in Ghana are more likely to invest in shade grown cocoa and other perennial crops when they have a secure land title. One should note that these decisions might still be optimal for the individual household under the constraints faced. Less sustainable agricultural practices may eventually lead to land degradation and to possibly higher rates of conversion of non-cultivated to cultivate land again.

In household surveys, the common practice in collecting information on land tenure and property rights is to include questions that either specify the characteristics of land tenure arrangement (customary or freehold, titled, rented or leasehold, share cropped) or that ask about the land acquisition process (inheritance, leasehold, purchase or illegal use) Damnyag et al., 2012; Dolisca et al., 2007). In cases where land titles are absent (or no information is available), property rights may be proxied through the duration of residence (Dolisca et al., 2007). These measures and proxies are typically used as explanatory variables in equations that explain land-use change. This procedure is not without problems, as it neglects the possibility that causality may be reverse: for instance, it assumes that land-use decisions are determined by property rights and not vice versa. However, the act of forest clearing may be observed because this decision gives rise to some kind of property right.

The feedback between land rights and land-use change is illustrated in a study by Otsuka et al. (2001) who use data from Sumatra, Indonesia. They show that customary land rights respond to changing context conditions, in particular higher population pressure, by giving higher tenure security to households that invest more, specifically through planting trees, into land acquired by clearing communal forests.

6.4.2 Market accessibility and infrastructure

Households' land-use choices highly depend on access to infrastructure and markets. Infrastructure networks and market integration determine households' production decisions. This is because they influence economic structures beyond agriculture, i.e. income-generation opportunities in non-agricultural sectors with possible repercussions on land-use change. Hence, on a gradient of market integration, the production costs of agricultural commodities, the marketing networks, and the opportunity costs of engaging in agriculture differ and so will households' land uses. The interrelation between developing markets and infrastructure extension is twofold: First, infrastructure can be triggered by developing markets, cash crop adoption and economic growth – possibly reinforced by spontaneous in-migration. Secondly, infrastructure extension can be a component of rural development and settlement policies and exogenously drive market integration. In reality, this process will often be iterative and both channels will reinforce each other.

Similar to earlier reviews (Geist and Lambin, 2001; Angelsen and Kaimowitz, 1999), recent empirical findings confirm a strong impact of changing market integration on households' land-use decisions (Kaminski and Thomas, 2011; Vadez et al., 2008; Caviglia-Harris, 2004). Better access to markets is found to be positively correlated with the extension of agricultural areas, especially for cash crop cultivation (Adams et al., 2013; Ellis et al., 2010; Klepeis and Vance, 2003; Vance and Geoghegan, 2002). Accordingly, a number of studies find a negative relation between distance to market centers and deforestation (Caviglia-Harris and Harris, 2011; de Souza Soler and Verburg, 2010; Wyman and Stein, 2010; Pan et al., 2007; Geoghegan et al., 2004; Sunderlin and Pokam, 2002).

Most studies capture the effect of accessibility to markets on land-use change by controlling for infrastructure variables, such as distance to markets (Müller and Zeller, 2002) or distance to all-year roads (Maertens et al., 2006). As outlined above, interpreting the correlations between these variables and land-use change decisions as causal may be problematic. This is because neither the establishment of infrastructure nor the development of markets (the latter even much less) can always be considered to be exogenous to the household's decision. Instead, both land-use change decisions as well as the establishment of rural infrastructure may be driven by the same – unobserved or omitted – factors, for example a rural development policy aimed at cash crop expansion. Furthermore, capturing market accessibility via distance variables is prone to ignore underlying variables, for example failing output and input markets.

Some studies provide very instructive insights on the relationship between infrastructure/markets and land-use change. Cattaneo (2001), for example, uses a dynamic computable general equilibrium model to analyze the impact of infrastructure extension on deforestation in the Amazon. He explicitly considers the response of commodity markets and finds that a 20 percent reduction in transportation costs for all agricultural products leads to an increase in deforested land between 21-39 percent.

Other studies, however, suggest a more complex relationship between market access and land-use change. Using cross-sectional village-level data combined with GIS-data from Central Sulawesi, Indonesia, Maertens et al. (2006) analyze how improved technologies in the lowlands affect agricultural expansion and deforestation in the uplands. In doing this, the authors also control for market access of households. Their findings suggest an inverse U-shaped relation between market access and agricultural expansion and argue that improved market access and declining transaction costs lead households to expand their land for agricultural production. However, at a later stage, households start to invest in off-farm activities, which in turn reduce the pressure on the forest. Müller and Zeller (2002) combine satellite imagery and survey data from Vietnam to analyze the land-use dynamics in the central highlands of Vietnam econometrically. They find that a period of land-intensive agricultural expansion (at the expense of forest) was followed by a second period of labor and capital intensive agricultural growth. This pattern of agricultural growth without further land expansion was mainly driven by increased market integration that eased constraints on agricultural input and output markets.

6.4.3 Household characteristics, income and wealth

Household characteristics and endowments are crucial determinants of households' behavior and are often included as control variables in regressions even when they are not the main motivation behind the study. Education levels, income, wealth/assets, gender and age of the household head are commonly controlled for in regression analyses of land-use change. Furthermore, households' endowments with land, physical capital, and (family) labor are important determinants of land-use change decisions, but these will be discussed in the subsequent section.

The conceptual framework above clearly shows the rationale for including education and income as explanatory variables into land-use change regressions. Yet, most studies could be more explicit about the reduced-form character of this type of exercise. In addition, endogeneity issues remain largely unaddressed in most studies. Education, gender and age, for example, affect the productivity and opportunity costs of most economic activities (in off-farm activities often more than in farming). At the same time, they affect values and attitudes of all kinds, for example the valuation of work as a farmer or consumption aspirations. Hence, the effects observed in a regression of land-use change on education (or age) will always reflect a combined (reduced-form) effect of these different transmission channels. Instead of acknowledging this, most studies tend to present an eclectic interpretation of the relationship between a specific household characteristic and land-use change. For example, Codjoe and Bilsborrow (2011) and Dolisca et al. (2007), point at a possible effect of education through increased consumption aspirations. Busch and Geoghegan (2010) stress the importance of education for the profitability of off-farm and non-agricultural opportunities at higher levels of education. While the hypothesized effects are likely to be at work in the respective cases, there may be other relevant transmission channels of education to land-use change. In addition, most studies fail to note that formal education is typically correlated with unobserved abilities (of different kinds, for example logical reasoning), which again tends to bias the measured effects.

In particular in the absence of functioning labor markets, the availability of household labor, i.e. the composition of households in terms of age and gender, will affect agricultural production decisions and thus land use change (Perz et al.,2006). Perz et al. (2006), for example, finds that the number of both old and young household members is correlated with the cultivation of annuals and perennials, no such correlation can be detected for pasture. The relationship between income and land-use change is the most important and interesting, but empirically most challenging one. It is common for empirical micro-level land-use change studies to find a positive correlation between income and bringing land under cultivation (Godoy et al., 2009; Schmook and Vance, 2009).We have already pointed at the obvious problem of reverse causality in this relationship above, i.e. income determines the household's current land use and, at the same time, this land use also influences income levels. Yet, very few studies make an attempt to address this problem. One exception is Caviglia-Harris and Harris (2008) who use lagged variables of income – instead of current income – in their analysis of cattle ranching expansion in the Brazilian Amazon. They find a positive correlation between income and pasture but not for cropland

Off-farm income is often explicitly considered in analyses of land-use change as an important component of income of many rural households. It can reduce households' dependency on agriculture and, as an important alternative income generation strategy, determines the opportunity costs of engaging in agriculture (Broadbent et al., 2012; Kaminski and Thomas, 2011). At the same time, off-farm activities may provide the liquidity required to invest in certain agricultural activities that need some initial investment, for example livestock or certain cash crops. Most studies do not make an attempt to disentangle these effects, but they confirm a net reduction in deforestation due to increased off-farm income. As the income portfolio and hence income, are simultaneously determined (by the same factors), the empirical caveats in terms of a causal relationship between off-farm income and land-use change mentioned above, also apply to on-farm income.

Setting these concerns aside, the Mexican case study from the southern Yucatán, by Geoghegan et al. (2001), finds that households' income generated through off-farm employment is found to be negatively correlated with forest clearance. In one of the few panel data studies, Rodríguez-Meza et al. (2004) empirically analyze the determinants of households' land use in El Salvador. Controlling for household fixed effects, they also find that households' engagement in income diversification through non-farm activities reduces land clearance. Pender et al. (2004) examine the determinants of land management in Uganda using village-level data. The results suggest six different development pathways where one is related to increasing non-farm activities. The study points at another interesting effect of higher opportunity costs for labor. The pathway of increased off-farm opportunities seems to enhance soil degradation since less household labor is available for more sustainable practices. Similarly, the pressure on (local) labor markets by better-paying off-farm opportunities may encourage switching to less labor-intensive crops. For example, Newby et al. (2012), mainly attribute the increase of smallholder teak plantations in Northern Laos to such an effect.

Access to and the availability of capital may also considerably raise households' income levels. Access to capital may not only be required to finance investment costs, for example to set-up a rubber or oil palm plantation, but also to finance fertilizer and other inputs. These are two important related, but yet separate transmission channels that would probably result in ambiguous dynamic effects of access to capital – facilitating agricultural expansions initially and saving land later. To date, however, the literature has little to say on these possible dynamic ambiguities, which are also difficult to assess empirically. This is, for example, because capital incorporated in established farming activity is often not easy to measure. This may explain why the reviewed studies typically hypothesize a positive correlation of the availability of physical capital with agricultural land use. This conceptual weakness is reinforced by the fact that the problems of endogeneity and attribution of causality, which are similar to those with regard to income, are often not addressed. While some studies directly use capital endowments to explain land-use change, others recur to access to capital. It should be noted that the estimates of the effects of the latter variable are also prone to suffer from endogeneity biases, as access to capital is typically determined by the same unobserved factors that determine land-use change, for example entrepreneurial or farming ability. Despite these shortcomings, the fact that capital (or access to it) is often found to be correlated with land-use change has some empirical content and points at the important role of capital. A number of studies suggest that capital is an important driver of deforestation for ranching and agriculture purposes (Busch and Geoghegan, 2010; Wyman and Stein, 2010; Schmook and Vance, 2009; Perz et al., 2006; Vance and Iovanna, 2006; Vance and Geoghegan; 2004; Klepeis and Vance, 2003; Vance and Geoghegan; 2002). The "effect" of capital on land-use change can be very large. For example, using data on 132 households from Uruará county in eastern Brazil, Caldas et al. (2007) find that households with some capital (measured as durable goods available to the household upon arrival on the property) deforest between 20-30 hectares more of forest than poorer households without any capital (the mean farm size in the study is 23 hectares). In addition, access to capital is also found to be associated with the adoption of longer term and higher yielding activities such as the cultivation of perennial cash crops and adoption of pasture in a number of studies (Van Wey et al., 2012; Vanwambeke et al., 2007; Perz et al, 2006). Kaminski and Thomas (2011) investigate the impact of institutional reforms within the cotton sector on households' land uses in Burkina Faso, Africa. The authors combine a structural framework with cross-sectional regression analyses to show that the increase in cotton cultivation can be linked to both the enhanced access to credits and improved credit conditions after institutional reforms.

While education, income, capital accessibility and wealth are certainly among the fundamental drivers of land-use change towards agricultural use, they are often reinforced (or mitigated) by social networks and other forms of social capital that are likely to play an important role particularly in the diffusion of certain crops or agricultural technologies. They facilitate learning by observation and provide farmers with local knowledge of soil quality, suitable agricultural technologies and crop marketing when extension services and other forms of formal institutions are absent. Busch and Vance (2011), for example, develop a theoretical model that focuses on the role of information spill-overs in spurring the diffusion of pasture in the southern Yucatan for groups of households originating from the same villages.

They find that increases in village networks raise cattle adoption at a decreasing rate. Similarly, Vanwambeke et al. (2007) find that belonging to a social network is positively correlated with a household's increased use of inputs (intensification) in irrigated areas in Northern Thailand. They also use village membership as a proxy for membership in a social network. Their analysis is limited to short-term effects and they do not find evidence for the decreasing positive impact of social capital reported in Busch and Vance (2011).

6.4.4 Input and output markets

In developing countries, rural smallholders typically face considerable constraints on input and output markets. While constraints on output markets generally hamper agricultural expansion, imperfections on capital, labor and other input markets may have ambiguous effects. On the one hand, they may also simply constrain expansion; on the other hand, input factor and input market imperfections may lead to substitution of these factors for land and thus promote land-intensive agricultural strategies.

This mechanism is shown by Busch and Geoghegan (2010) who analyze land-use choices of rural households in the southern Yucatán region in Mexico. Using a cross-sectional survey, the authors show that labor scarcity drives households' expansion in cattle ranching, which is more intensive in land and capital than in labor. However, intensification of one sector can alter returns to factors and thus reduce pressure on land. In his case study on Philippine farm households at rainforest margins, Shively (2001) illustrates the effect of agricultural intensification in a context of a dichotomous lowland-upland economy. He estimates a theoretical model of lowland agricultural production with a model of labor allocation on a representative upland farm and finds that upland forest clearing and hillside farming are reduced by agricultural intensification in the lowlands (in this case, the introduction of irrigation). Higher labor productivity in the lowlands increases demand for labor from the uplands and creates a small but significant reduction in the rate of forest clearing.

A typical finding of micro-level studies with regard to labor is the correlation between deforestation and agricultural extension and the use of hired labor (for example, Caviglia-Harris and Harris, 2008; Mena et al., 2006b; Walker et al., 2002; Walker et al., 2000), particularly for commercial agriculture Walker et al., (2002).Unfortunately, these studies do not take into account that hired labor is endogenous to land-use change: Labor use, be it family or hired labor or a combination, is always determined by the production technology and labor market conditions, i.e. wages and the availability of labor for hire – rather than vice versa.

In the same study, Kaminski and Thomas (2011) also theoretically analyze the role of price fluctuations and the role of marketing risk for household's crop choices; hence looking at product markets. To account for the importance of price fluctuations, Kaminski and Thomas (2011) include the relative variability of crop prices as a proxy. They find that optimal land use is also determined by the relative risk-profitability of households' crop portfolios, which are a function of households' technologies and input and output prices. This study illustrates the important role of output markets as a central driver of households' production decision and land-use change, as does another study by Caviglia-Harris and Harris (2011) on the impact of settlement design in the Brazilian Amazon. Based on panel data of Brazilian households, who are predominantly small-scale farmers, the authors find a short- and a long-term impact of fluctuating milk prices on deforestation: First, increasing milk prices translate directly in higher income and encourage agents to intensify agricultural production. Then, labor is drawn away from forest clearing. In the longer term, increasing milk prices however raise incentives to extend the production, which leads to further forest clearance to support larger cattle herds.

The effect of new markets has received surprisingly little attention in the literature. One exception is Hought et al. (2012) who examine land-use change in Banteay Meanchay Province, Cambodia. The study that combines remote sensing data with field interviews suggests that a sharp increase in (regional) demand for biofuel feedstock has been associated with a rapid expansion of cassava production at the expense of forests. While energy demand drives land-use change in this case, an important secondary effect of cattle ranching is pointed at by Luisana et al. (2012). Using a spatially explicit ecological-economic model, they consider the twofold land-use change of cattle ranching, on the one hand, and the associated cultivation of feed resources and fodder, on the other.

Finally, recent analyses of land markets stress the role of speculation. For example, Takasaki (2011) uses a theoretical model to show that, if labor and land markets exist, increasing land prices may promote forest clearing for speculative land holding. The case study of Carrero and Fearnside (2011) provides the corresponding empirical evidence for the role of speculation in land holding in their analysis of land-use strategies of households in one of Brazil's deforestation hotspots along the Trans-amazon Highway. Their case study results suggest that at least 30 percent of surveyed farmers acquire land for speculative reasons.

6.4.5 Adoption of agricultural technology

The availability of and the capacity (and willingness) to adopt agricultural technologies is a key driver of land-use change. Once a technology is chosen, it will determine smallholders' factor use and the respective output level. Hence, the technology applied by households determines land uses and may induce land-use change depending on the specific characteristics of the technology. These technological characteristics that include the level of substitutability between input factors, interact with household endowments, such as the availability of family labor, and prevailing factor market conditions, for example the availability and price for hired labor. Once new agricultural technologies are adopted, they may lead to technological spill-over effects within villages and communities.

Recent studies on the impact of technology on agriculture examine technology as a land- saving or land-consuming driver of land-use change. Empirically, these studies focus on the use chemical inputs (Caviglia-Harris and Sills, 2005; Rodríguez-Meza et al., 2004), irrigation systems (Shively and Pagiola, 2004), or mechanical tools (Codjoe and Bilsborow, 2011). The results are ambiguous: Some studies observe a negative link between the adoption of a new technology and deforestation or agricultural expansion (Vanwambeke et al., 2007; Pender et al., 2004; Mertens et al., 2000). However, other studies find evidence for land extensification that is driven by technological improvements (Rodríguez-Meza et al., 2004; Sankhayan and Hofstad, 2001). In this context, the effects of farm input subsidy programs to encourage the use of fertilizer may also be instructive. Chibwana et al. (2011) analyze the effect of the nationwide Farm Input Subsidy Program (FISP) in Malawi. The authors draw on a household survey of 380 households and apply a two-step regression strategy to control for endogenous selection into the program. They find an increased use of inputs for households participating in the FISP and an increase in the area of land planted with maize and tobacco. Furthermore, results suggest that subsidies reduce crop diversity and promote specialization in maize production.

Although these studies show a correlation between land conversion and technology adoption, some of them fail to take the respective market conditions into account, particularly on input markets, as an underlying driving force. Especially in rural regions, area extension due to technical improvements may be induced through relaxed access to formerly constrained input markets. We have already referred to Kaminski and Thomas' (2011) study on institutional reforms as the main driver of cotton expansion in Burkina Faso above. These reforms improved access to input markets and to technical advice. Underlying driving factors would need to be factored in not only conceptually, but also in the empirical analysis. The correlation between the use of a technology, for example chemical inputs or mechanical tools, and land conversion may often be traced back to underlying driving forces, such as access to capital or degraded soils.

Moreover, the ambiguity of the findings on the impacts of technological change can be due to differences in elasticities of demand for agricultural products. As has been argued by Villoria et al. (2013) and Hertel (2012), a productivity improvement can be land-consuming when this demand elasticity is high, as it would be, when innovation happens at regional scale and the product substitutable. However, on the global level, demand for agricultural products is likely to be rather inelastic – close to the demand elasticity for food – and the response to technological change then land-saving (2012). Only a few studies discuss the net effects of new technologies on land use once the technology's impacts on factor use (substitution), factor prices and possibly resulting spill-over effects between regions and sectors are taken into account. In South-East Asia, rural areas are often characterized by an upland-lowland dichotomy. Shively's (2001) study of such a context in the Philippines suggests that the adoption of a more labor-intensive technology (irrigation) in the lowlands promotes employment and reduces pressure on forests in both regions: With higher productivity, the factor returns in the lowland increase and lowland wages rise. As a consequence, upland households, who are now employed in the lowlands, pursue an intensification strategy on their own land, which in turn leads to a decrease in forest clearing and hillside farming. Within the same country context, Shively and Pagiola (2001) confirm these results using panel data with a focus on the impact of intensification on deforestation. With irrigation development in the lowlands, wages and employment rise and the authors show a positive correlation between the shadow value of lowland labor and the days of hired labor in the uplands. This indicates that upland households employed in the lowlands replace family labor with hired labor on their own farms. The wage-induced increase in labor productivity in the uplands reduces forest clearing and leads to intensification.

Müller and Zeller (2002) use cross-sectional regression analysis to investigate the possible land-saving effects of intensification in the Central Highlands of Vietnam. They show that intensification indeed triggers land-saving effects; however, this result is only observed if technological change is accompanied by enhanced market integration and simultaneously enforced forest protection policies. These results are in contrast to those obtained by Maertens et al. (2006) who use cross-sectional village-level data combined with GIS-data to analyze the land-use implications of the introduction of hand-tractors in the rice sector in Central Sulawesi, Indonesia. They show that the improved technology for rice cultivation induces a shift of labor into the forested uplands and thus increases agricultural extension and deforestation. The contradicting effects found in these two studies illustrate the importance of context specific conditions, here in particular the labor market conditions, in shaping the effects of technological change.

With regard to the processes of technology adoption, a couple of recent studies have investigated the role of household interaction with the diffusion of technologies. Mena et al. (2011) use an agent-based model fed with empirical data, in this study, the authors assume that households transfer information and knowledge through imitation of neighbors' cultivation strategies. Vanwambeke et al. (2007) analyze the emergence of cash crop markets and the industrialization of rural households in northern Thailand. Based on cross-sectional household data and remote sensing data, the authors apply a choice model to examine the impact of social-networks on new land-use strategies. The authors show that social networks defined by the number of other adopters in the village lead to intensified land use through information via sharing or observing.

6.4.6 Population and migration

There is a consensus in the literature that population pressure is an important driver of land-use change (Mekasha et al., 2014; Garedew et al., 2012; Ellis et al., 2010; Mena et al., 2006b) and that it also triggers technological change in agriculture technologies (Vance and Geogheghan,2002). Since population pressure can only be partially reflected at the household level, micro-level studies on land-use change often incorporate census data into their analysis (see for instance, Garedew et al., 2012; Ellis et al., 2010; Walsh et al., 2008; Maertens et al., 2006; Takasaki, 2007; Maertens et al., 2006; Mena et al., 2006a; Geoghegan et al., 2004 and Cattaneo, 2001). More precisely, population growth – often accelerated by migration – can either result in extensive (if uncultivated lands are available) or intensive land use (if uncultivated lands are not available).

As many of the areas within the studies reviewed were previously forestland before they were converted to settlements or agricultural lands, the opening of these lands has been accompanied by migration into the previous forestlands. In fact, migration has received considerable attention in the land-use change literature and migration status has in many micro-level studies been hypothesized to affect households' land-use decisions. First, migrants are expected to follow extensive and unsustainable agricultural practices that lead to the encroachment of the forest frontier because they have shorter planning horizons, which cause them to be more destructive than host populations (Sunderlin and Pokam, 2002). Second, migrants are assumed to use unsustainable agricultural practices due to their limited knowledge of the local agro-ecological conditions of their new region. Codjoe and Bilsborrow (2011) find weak empirical support for these hypotheses for migrant farmers in central Ghana, as they tend to have less fallow years than non-migrants.

In a study on colonist farm incomes in the Ecuadorian Amazon, Murphy (2001) finds that new migrants earn less because they have less experience about the regional conditions. While this supports the claims made above that new migrants are not familiar with the agro-ecological conditions of their new residence it does not provide any evidence on their land-use patterns. Other studies that show that duration of residence matters for land-use change include Dolisca et al. (2007) who find that the longer households have lived in the Forêt des Pins Reserve in Haiti the less likely they are to clear forests.

Using data from Southern Yucatán in Mexico, Schmook and Radel (2008) find that households with US based migrants have more pasture than non-migrant households. This is because the establishment of pasture is initially labor intensive but requires very low levels of labor inputs once established which makes it ideal for households with members that have migrated to the US. In addition, they find that migrant households cultivate more summer maize and chili and are less likely to cultivate traditional milpa when compared to non-migrants.

6.4.7 Key policies

To analyze the impacts of policies, inter-temporal data that captures the conditions before and after the policy or data from a counterfactual group that consists of households with the same characteristics that have not been exposed to the policy change is necessary (Schmook and Vance, 2005). However since policies are often experienced uniformly within a region, such data is not usually available for most of the studies reviewed in this chapter and the analyses are sometimes made with retrospective data that questions households on their experiences before the policy change.

Market-oriented reforms adopted by many developing countries in the 1980s and 1990s played an important role in altering land use in many of the countries covered by the reviewed studies. One of the most extensively studied policies with respect to its land-use change implications is the Programa de Apoyo Directo al Campo

(PROCAMPO), a cash transfer program introduced in 1994 in Mexico to mitigate the possible adverse effects of the North American Free Trade Agreement (NAFTA) on rural populations (Schmook and Vance, 2009; Kleipeis and Vance, 2003). Kleipeis and Vance (2003) were the first to clearly establish a link between the receipt of PROCAMPO cash transfers and the subsequent land-use decisions made by farm households. Using a panel data set with individual farm-level data that spans an eleven year period from the southern Yucatán peninsula in Mexico, the authors show that PROCAMPO payments are responsible for nearly 38 percent of deforestation that occurred in the study region between 1994 and 1997. They relate this finding to the eligibility conditions of PROCAMPO that are at odds with fallow regeneration and cause households to clear more forests in order to maintain the cultivation of crops in rich soils. A later study, by Schmook and Vance (2009) uses a seemingly unrelated regression to compare the effects of PROCAMPO and another agricultural support program - Alianza Para el Campo - on the households in the same region. PROCAMPO puts no restrictions on how the transfer should be spent, but attaches conditions on how land should be used. Instead, transfers from Alianza are tied to specific agricultural activities that have to be implemented by households (Schmook and Vance, 2009). In line with Kleipeis and Vance (2003), they find that PROCRAMPO is significantly correlated with a reduction in forest area and with increases in area under pasture and cultivation. In a similar vein, Alianza is found to significantly influence land use, in particular in favor of pasture.

Using recall plot data from 1970-2009 in combination with aerial photographs, Ribeiro Palacios et al. (2013) examine the broader impact of economic reforms on land-use change in Mexico. Looking at the region of Southern Huasteca, the authors stress that market-oriented policies such as the promotion of agribusinesses are a key driver of a reinforced land conversion for cash crops, especially for citrus orchards. This typically occurs at the expense of food crop agriculture and secondary forests. The finding that market-oriented reforms increased deforestation and expanded areas devoted to agriculture is not unique to south-eastern Mexico. Another example is the abovementioned case of the reform of the Burkinabé cotton sector analyzed by Kaminski and Thomas (2011) that included the privatization of the parastatal firm SOFITEX (National Cotton Fibre Company). Going back to Mexico, Barsimantov and Antezana (2012) discuss how the adoption of the 1992 Forestry Law and the 1992 Reform of the Mexican Constitution that were part of a set of free market and reregulation policies increased deforestation and later led to an increase in the production of avocados. The authors show that forest cover was reduced considerably because of these policy changes, particularly in the non-forestry communities that had relatively less forest cover to begin with.

Other policies that have played a key role in driving the land-use decisions made by households in the reviewed studies include policies targeted at infrastructure development (Pender et al., 2004; Müller and Zeller, 2002) and settlement policies (Caviglia-Harris and Harris, 2011). Caviglia-Harris and Harris (2011) show that even when policy makers take extra precautions in designing alternative new settlement policies to ensure that they meet both environmental and social objectives, in the long term the design does not influence land cover choices and that land clearing is extensive in all agricultural lots. After a ten-year period, they find that very little forest remains in the radial lots that are introduced by the new alternative settlement policy.

Prominent examples of land-related policies include the Payment for Environmental Services (PES) and Reducing Emissions from Deforestation and Degradation (REDD and REDD+). These policies directly address households' decisions to deforest by altering the payoffs to different land uses. Therefore, their effects on land-use change depend on the farmers' livelihood and crop options and the related opportunity costs of altering land uses (Chavez and Perz, 2012). This is confirmed by Newton et al.'s (2012) evaluation of the impact of Bolsa Floresta, a PES scheme with an undifferentiated reward structure in the Brazilian Amazon. They emphasize the heterogeneity among farmers' livelihood strategies that results in a strongly heterogeneous impact of the program on the decision of deforesting. In addition, the schemes' impact also depend on possible differences in farmers valuations of ecosystem services (Vihervaara et al., 2012). Mello and Hildebrand (2012) who analyze the potential effects of carbon trade on land-use decisions and farm income of small-scale farmers in the eastern Brazilian Amazon illustrate the importance of sufficient compensation. The authors stress that carbon prices have to be high enough to cover transition costs to adopt land-saving technologies.

6.5 Conclusion

For this chapter, we have reviewed 91 recent empirical and theoretical studies that analyze land-use change at the farm-household level. The review builds on a conceptual framework of a human-environmental system focusing on micro-level agents and resulting land-use change drivers. This concept extends previous work by Angelsen and Kaimowitz (1999). The framework considers feedback mechanisms between the different stages of the land-use change process, for example between the actions of agents and macroeconomic variables, and between specific causes within a stage, for example between different decision parameters such as the interlink between technology options and accessibility of infrastructure. Considering telecoupling interactions, the concept allows for multidirectional interactions of the whole system towards other socially and geographically remote human-environmental systems. Furthermore, our framework explicitly considers the role of household endowments and characteristics as drivers of land-use change.

We first conduct a meta-analysis of the 91 studies. We find that the most frequently analyzed scenario is the conversion of non-used forests or forestry into land used for agricultural purposes – about a third of all scenarios. The second largest share is accounted for by studies that look into the conversion of non-used forests or forested areas into ranching. Most studies analyze land-use change using household and village data and, in doing so, often rely on relatively small samples of 100-200 observations. There is a clear regional concentration of studies on Central and South America and some studies on African countries, while only 11 percent analyze land-use change in Asian countries. The limited number of Asian case studies is surprising, since evidence hints at high deforestation rates in South-East Asia due to logging activities and plantation agriculture. In our view, this may be explained by the literature's focus on household farms. Yet, the omission of firms that operate logging and large-scale farming activities implies that a key (micro-level) actor's behavior remains unexplored. We find that a number of studies face problems of internal validity because of endogeneity (simultaneity and reverse causality) and omitted variable bias that are not adequately addressed.

When we aggregate the variables identified as drivers in the micro-level studies into stylized categories, we find that household-level heterogeneity and the resulting differences in land-use decisions can be considered a key driver of land-use change. This is less trivial than it may appear, as it is also conceivable that forces external to households, in particular, policies and market signals, are strong enough to dwarf the effects of household-level differences. Among the household-level characteristics, the literature points at micro-level determinants of economic growth, in particular in physical capital, as a catalyst of human induced land-use change.

However, as our detailed literature review shows, the relationship between land-use change and these growth-associated micro-level drivers is complex, in particular because of the interactions between these drivers, for example the use of capital and labor and the applied technologies, and also context-conditions, in particular institutions, policies and the conditions on factor markets. These complexities and interactions cause the abovementioned important challenges in the empirical study of land-use change.

Land governance systems make a good case for the complexities and interactions discussed above. It is well established that the absence of well- defined property rights and tenure security often leads households to gain *de facto* land rights through deforestation and land clearing. In addition, insecure tenure shortens farmers' planning horizons, which, in turn, makes them more likely to apply less sustainable agricultural management practices. When the impacts of tenure security on land use and management practices are empirically analyzed reverse causality issues, i.e. the fact that tenure security is influenced by land-use and management, receive too little attention in the literature.

Reverse causality is also an often-unresolved issue in a fundamental relationship in micro- level land-use change studies, the relationship between income and land use: Income determines the household's current land use and, at the same time, this land use also influences income levels. Similarly, empirical problems often remain unaddressed in the analysis of the effects of infrastructure development and increasing market integration that some studies also deem to be an important driver of land-use change. More and better infrastructure can be the result of increasing demand caused by cash crop adoption and economic growth, but it can also exogenously drive market integration. The literature too often assumes a one-directional causal relationship and ignores that infrastructure development may well be driven by the same rural development policy, for example one aimed at cash crop expansion.

Complex causal relationships hence complicate the empirical analyses and so do non-linear relationships as well as interactions between different drivers that are also frequently observed. One example for an important non-linearity is the inverse U-shaped relationship between market access and agricultural expansion that has been shown in a number of studies: Improved market access first leads to agricultural expansion, but, in a second stage, households start to invest in off-farm activities and reduce the pressure on forests. Important interactions are at work between factor (land, labor and capital) markets and household characteristics. Factor markets in developing countries tend to be imperfect, which implies that households' initial factor endowments, for example initial wealth or household labor, may play an important role in explaining land-use and management choices. Factor market imperfection and limited household endowments may then simply constrain expansion. However, as the same market imperfections may lead to substitution effects, they may also promote land-intensive agricultural strategies. In the case of capital, these ambiguities are reinforced by the fact that capital does not only finance initial investment costs but also current costs for fertilizer and other inputs. This implies that access to capital may facilitate agricultural expansions initially and saving land later. These mechanisms are similar for technology adoption. New technologies, for example the introduction of a new crop, are often found to lead to agricultural expansion. Yet, they may also lead to land savings, conditional on the substitutability between input factors and possible interaction with household endowments and factor market conditions. In terms of household-level determinants of technology adoption, the literature has often stressed that migrant status tend to be associated with the application of intensive and unsustainable agricultural practices.

In sum, the rich empirical literature that has been reviewed in this study, illustrates the complexity of micro-level land-use change processes, in particular the interrelationships between household-level characteristics, factor market conditions, and land-use change. These are conditioned by institutions and policies. The review suggests that market-oriented reforms adopted by many developing countries in the 1980s and 1990s have had an important role in altering land use. The empirical designs of many reviewed studies do not account for the complexity of the land-use change processes properly. While the studies have explored some key facets of household-level drivers of land-use change, future research would greatly benefit from methodological rigor and some more care should be taken when results are interpreted as causal relationships. Yet, does it matter if an empirical analysis does not pay attention to the fact that income is also determined by land-use change and not only vice versa? Yes, it does since the conclusion to be drawn from either finding differs dramatically. If income growth causes deforestation, there are good reasons to worry since most rural households at forest frontiers are still way below income levels that they would consider desirable – and are probably likely to achieve income growth at some point in the future. If incomes, however, have in the past grown for reasons related to land-use change, for example because of growing a cash crop on converted forest, they might in the future grow for different reasons, for example because growing economies tend to become more diversified and people engage more in non-agricultural activities.

We want to close by reflecting briefly on some further implications of this review for the way forward. To generate evidence from local to global levels, the telecoupling framework is a simple but general and common approach to describe the interactions different between human-environmental-systems in a globalized world. It helps to capture synergies and trade-offs across different scales and systems and facilitate global policies to meet relevant socio-economic and environmental challenges. The telecoupling framework demands research on integrated systems, and more empirical studies building on this concept are desirable. Approaches may include both statistical and model-based analyses that combine data from a variety of sources, of course still including survey-based information. This should also enable researchers to extend the sample sizes and increase the external validity of the findings. External validity could also be improved by paying due attention to case selection and some more reflection on whether results should be regarded as context-specific or generalizable.

These approaches may include both statistical and model-based analyses that combine data from a variety of sources, of course still including survey-based information. This should also enable researchers to extend the sample sizes and increase the external validity of the findings. External validity could also be improved by paying due attention to case selection and some more reflection on whether results should be regarded as context-specific or generalizable.

Recently, the wider literature on land-use change has shifted from exploring the determinants of direct human-induced land-use change towards assessing how households (and other agents) can cope with the consequences of global environmental change; thus land-use change indirectly caused by human activity. There are of course important lessons to be drawn from our review for this emerging literature, as the reviewed land-use change determinants are closely related to a household's or farmer's capacity to cope with climate change. Moreover, recent studies often extend their analysis to examine also the implications of land-use change on livelihoods. The latter trend shows that it is increasingly acknowledged that land-use change and household welfare are simultaneously determined.

Most of the studies focusing on land-specific policies combine satellite images with descriptive statistics of field data, which allow first snapshots on economic-ecological consequences of land-use change on broader scales. However, whether these policies are effective over time in actually influencing land-use change decisions is still under-researched. A dynamic analysis using panel data on the plot or household level would be necessary to assess these policies more rigorously. Also impacts of more recent policies, like PES or REDD+, have to be further explored.

Finally, while our review focused on household-level studies, we were surprised to find virtually no study that would have analyzed – at the micro-level – the decisions by firms that operate logging and large-scale farming activities. This implies that a key (micro-level) actor's behavior remains unexplored and this omission partly explains the lack of studies in Asian contexts, where these players are probably more important.

6.6 Appendix

A questionnaire was constructed to systematically record information from the 91 studies selected to be included in the review (Table 6.A1). The entries were recorded and cross verified by two of the three authors and a research assistant working with the authors.

Table 6.A.1. Review questionnaire

Question	Comments
Who authored the paper?	*List authors according to the order in the publication*
What are the academic backgrounds of the authors?	*Here look at the authors academic qualifications and profiles*
In which (peer-reviewed) journal was the paper published?	
When was the paper published?	
In which region (tropical or subtropical) was the data collected?	
What country was the data collected in?	
What type of analysis is conducted in the study?	
What type of methodology is used by the authors in the study?	
What type of spatial analysis is used in the study?	
What type of data is collected in the study?	
When was the household data used in the study collected?	
What variable did the authors use to identify land use change?	
Which explanatory variables are found to have a significant impact on the land change variable identified in the question above?	*Here only record the variables that significantly affect LUC*
What are the main socio-economic drivers of land-use change identified by the authors?	*Here only include the main drivers that are cited by the authors and not all significant explanatory variables listed in question 13.*
How can the drivers identified in questions 14 be classified to match our coding scheme?	*Here classify the drivers in question 14 into the 7 main categories*

Table 6.A.2. Categorization of the drivers of land-use change

Driver reported in studies	Category assigned in meta-analysis
Population density	Demography
Population pressure/growth	Demography
Migration	Demography
Agriculture output prices/Cash cropping	Markets
Agriculture input prices	Markets
Off-farm income/ Off-farm labor/ Off-farm wages	Markets
Hired labor	Markets
Credit (access)	Markets
Farm size	Endowments
Household size	Endowments
Household composition children	Endowments
Household composition gender	Endowments
Household composition labor	Endowments
Household education	Endowments
Social networks	Endowments
Technological progress	Technology
Land property rights	Institutions
Land tenure security	Institutions
(Key) Policies	Key Policies
Market access	Infrastructure
Infrastructure	Infrastructure

Table 6.A.3. Categorization of household endowments.

Reported endowments and characteristics in reviewed studies	Category assigned in meta-analysis
Farm size	Physical capital
Wealth and capital endowment	Physical capital
Income	Physical capital
Household size	Labor
Household children	Labor
Household labor	Labor
Household education	Human capital
Social networks	Social capital

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