AGRODEP Working Paper 0040

January 2018

Credit Constraints and Agricultural Productivity in Developing Countries:
The Case of East Africa

Bethuel Kinyanjui Kinuthia

About the Author

Bethuel Kinyanjui Kinuthia is a Lecturer at University of Nairobi, School of Economics and Director of the Institute of Research on Economic Development (IRED), Nairobi, Kenya.

Acknowledgements

I would like to thank IFPRI for funding this project. In addition, I thank Dr. Betina Dimaranan and Fousseini Traore and other referees for the very useful comments throughout the project. This paper has gone through AGRODEP's peer-review procedure. The opinions expressed here belong to me, and do not necessarily reflect those of IFPRI and AGRODEP.

Table of Contents

Abstract

Sustained agricultural growth is crucial for reducing hunger and poverty in East Africa, where majority of the population rely on agriculture for their livelihood. However, smallholder farmers in the region face long-standing challenges, including low labor productivity, low levels of profits, and credit constraints factors that have adverse effects on smallholders' farm output and investment. This paper seeks to re-examine the impact of credit on agricultural productivity and the efficiency losses associated with credit constraints in East Africa. The data is based on the Living Standards Measurement Study-Integrated Surveys on Agriculture for Tanzania and Uganda. The results show that credit affects agricultural productivity in East Africa in various ways. For example, households' decision to borrow affects agricultural productivity in Uganda but not Tanzania. Additionally, the decision to borrow from formal and semi-formal sources affects agricultural productivity, and thus efficiency, significantly and positively in Uganda compared to Tanzania.

Résumé

Une croissance agricole soutenue est cruciale pour réduire la faim et la pauvreté en Afrique de l'Est, où la majorité de la population dépend de l'agriculture pour sa subsistance. Cependant, les petits agriculteurs de la région font face à des défis de longue date, notamment une faible productivité du travail, de faibles niveaux de profits et des contraintes de crédit qui ont des effets négatifs sur la production agricole et l'investissement des petits exploitants. Cet article cherche à réexaminer l'impact du crédit sur la productivité agricole et les pertes d'efficacité associées aux contraintes de crédit en Afrique de l'Est. Les données sont basées sur l'Enquête sur la mesure des niveaux de vie - Enquêtes intégrées sur l'agriculture pour la Tanzanie et l'Ouganda. Les résultats montrent que le crédit affecte de diverses manières la productivité agricole en Afrique de l'Est. Par exemple, la décision d'emprunter des ménages affecte la productivité agricole en Ouganda mais pas en Tanzanie. De plus, la décision d'emprunter à des sources formelles et semi-formelles affecte la productivité agricole -et donc l'efficacité- de façon significative et positive en Ouganda par rapport à la Tanzanie.

1. Introduction

Sustained agricultural growth is crucial for reducing hunger and poverty in East Africa Agricultural growth has powerful leverage effects on the rest of the economy, especially in the early stages of development and economic transformation, when agriculture accounts for large shares of national income, employment, and foreign trade. In addition, smallholder farmers occupy the majority of the region's land and produce most of its crop and livestock products. Yet most of the population engaged in smallholder agriculture continues to be poor (Salami *et al*., 2010). According to Udry (2015), the root of this poverty is low agricultural productivity. Agricultural productivity is still lagging in many African countries, and most of the continent's lands remain uncultivated.[1]Africa's value added per worker also still lags behind compared to other regions, and therefore there is need to raise agricultural productivity to achieve distributed economic gains.

After decades of policy inattention, disproportionate taxation, and a lack of investment, the importance of the agricultural sector is starting to be recognized by most African countries. The Maputo Declaration (AU, 2003) pledged the investment of 10 percent of countries' national budgets into agriculture and a 6 percent annual growth rate of the agricultural sector. The Malabo Declaration (AU, 2014) builds on this previous declaration to include a doubling of productivity gains (Dryden, 2015). If agriculture is to catalyze Africa's development, however, smallholder farmers will need to be the drivers of sustainable agricultural growth. To achieve this goal, the Bill and Melinda Gates Foundations, among other donors, have aimed address factors that can result in doubled productivity and sustainability for African smallholders through partnerships that leverage an annual investment in agriculture of US$400 million. While policies aimed at increasing yields per hectare through the use of modern seeds and sufficient fertilizer are important, other policy interventions need to be implemented, such as expanding credit in rural areas (Zedillo, 2015). According to Udry (2015), for such interventions to be successful, they need to take into account farmers' heterogeneity and local conditions.

Credit constraints affect farm productivity through their adverse effects on smallholders' farm output and investment (Guirkinger and Boucher, 2008; Karlan *et al*., 2014; Barrett *et al.*, 2010). As most smallholder farmers tend to be poor, self-financing of necessary agricultural inputs is not easy; thus, there remains a lag between inputs and the expected agricultural output. Credit can help farmers purchase the inputs required to ensure increased agricultural output. In addition, it helps to smoothen consumption and can affect poverty levels. Therefore, credit constraints may have strong implications for households' chances of falling into

[1] About 60% of Africa's arable lands (Zedillo, 2015).

or climbing out of poverty traps, as well as for the level and distribution of income in the overall economy (Boucher *et al.*, 2009).

Credit can take on both formal and informal forms, especially in rural markets. Informal finance often hampers development because it tends to be expensive, normally gets used for consumption, and is not enough to spur investment and growth. Such informal finance has been traditionally viewed as unfair by policymakers and development practitioners, who argue that lenders take advantage of their position to exploit poorer borrowers (Gine, 2011). As a result, formal finance is considered important in rural areas (Khandker & Faruqee, 2003). However, Adjognon et al. (2017) shows that the use of traditional credit remains extremely low among farmers in Africa. Increasing formal credit in rural areas lies at the heart of several government and NGO policies and interventions (Gine, 2011).

Since smallholder farmers account for the major proportion of rural poor people in East Africa, their access to adequate credit has the potential to play an important role in reducing rural poverty and enhancing food security. Effective formal credit accelerates the adoption of new technology, enhances market efficiency and diminishes the role of informal money lenders. Hence, the opportunity for smallholders to increase their production and eventually to improve their income largely depends on their access to the credit market (Hussein & Thapa, 2012). Despite the importance of credit to smallholders, however, empirical studies show that access to credit continues to pose a severe problem, especially in developing countries (Reyes & Lensink, 2011). These high credit constraints have been attributed to a lack of collateral, as is characteristic of poor households, and to the high transaction costs associated with screening applicants (Barry & Robinson, 2001). In addition, Fidrmuc *et al.* (2013) suggest that high default rates among borrowers lead to losses within lending institutions and a subsequent reduction in the issuance of new loans.

Assessing the benefits of credit is also often problematic because funds can be used for various activities; it is thus not clear if the measured credit effect reflects a borrowing constraint or the unobservable characteristics of a borrower. The presence of bias caused by self-selection of borrowers into credit programs may bias assessment of benefits of these programs by as much as 100 percent. Nonetheless, there are a number of studies that have successfully examined credit programs in developing countries. For example, in Asian countries such as Thailand, banks tend to be limited ability in enforcing contracts (Gine, 2011). Borrowers face sizeable transaction costs in obtaining external credit. In China, credit constraints lead to low agricultural productivity and rural household incomes (Dong *et al.*, 2010). In addition, credit constraints adversely affect production and livelihood choices in China and India (Kumar *et al.*, 2014). In Latin American countries such as Peru, productivity is linked to endowment for constrained households and credit constraints; these credit constraints lower agricultural output (Guirkinger & Boucher, 2008). In some African countries such as Mali, there is heterogeneity in returns on investments and strong evidence that farmers with higher marginal returns on investment self-select into lending programs (Lori *et al.*, 2014).

In Ghana, formal and informal credit has positive and significant effects on agricultural productivity (Akudugu, 2016).

In East Africa, a majority of smallholder farmers depend on savings from their low income to provide for investments, which limits their expansion (Salami *et al*., 2010). In Rwanda, for example, credit-constrained households are unable to participate in off-farm self-employment activities. Reducing credit constraints in the semi-formal sector increases output (Ali *et al*., 2014). Hence, expanding smallholders' access to formal credit markets remains a high priority for policymakers in the region. This study focuses on the impact of credit on agricultural productivity, as well as the magnitude of this impact. The study estimates the returns to productive endowments for farmers who borrowed and for those who did not borrow from the formal credit market in East Africa.

The findings of the study will contribute to a better understanding of how the credit constraints faced by farming households affect productivity in East Africa. In particular, the findings will inform policymakers regarding whether the informal credit market can fully meet the liquidity needs of the households that are constrained in the formal market. The study is also based on a new and rich panel dataset; most comparable studies rely on cross-section data. A key advantage of this study, thus, is that it uses efficient and unbiased panel estimators.

The paper is structured as follows. Section 2 presents the literature review. This is followed by a conceptual framework and the empirical strategy in Section 3. Section 4 describes the data and provides descriptive statistics. Section 5 discusses the results of the empirical analysis, while Section 6 contains the conclusion and recommendations.

2. Literature Review

The literature acknowledges that in the absence of markets, households would be expected to allocate their labor such that additional labor input is just equal to the marginal utility of the additional output attainable with that labor input (Chayanov, 1965). In addition, the household sets the marginal value product of labor equal to the marginal rate of substitution between consumption and leisure, which is the shadow price of labor, a function of the demographic structure of the household and its preferences and endowments. Within such an environment, the absence of markets implies that households' production and consumption choices are not separable. However, Singh (1986) clarifies that non-separability was a consequence of missing markets, such that prices are not parametrically given to the households [2], rather than a reflection that the

[2] Prices are endogenously determined by the choices of the household, as opposed to exogenously within the-prices of factors of production and output, as would be the case under conditions that make it optimal for a utility maximizing farmer to apply a production model that is independent of consumption considerations.

household is an integrated production and consumption unit. As shown in Vance and Geoghegan (2004), the non-separable models show that the utility- and the profit-maximising behavior no longer holds.

The notion that working capital with which to purchase inputs is scarce and expensive in developing countries resulted in new literature which suggests that capital constraints can restrain the rates of growth and development. Feder *et al* (1990) show that in the presence of market failure in land and labor, improvements in capital access with land endowments result in a positive relationship between farm productivity and size. Hence, a household that is quantity-rationed in the market will under-invest relative to an unconstrained household.

The existing literature has attempted to identify the sources of quantity rationing. According to Stiglitz and Weiss (1981), this problem results from lenders' unwillingness to raise the interest rates to clear excess demand because doing so would result in adverse selection of the applicant pool or morally hazardous behavior by borrowers. Quantity rationing may also result from a household's inability to post the quantity or quality of collateral that the lender requires to overcome the information problems intrinsic to credit transactions. In an extreme case, quantity-rationed individuals will be involuntarily be restricted in their access to credit, resulting in foregoing an expected income-enhancing opportunity. In addition, actions taken by lenders may also induce some households to voluntarily withdraw from the credit market even though they have investments that are profitable when considered against the interest rate, or price, of available loans.

Apart from quantity rationing, information asymmetry may also result in transaction cost rationing and risk rationing. First, banks may pass the transaction costs associated with screening applicants, monitoring borrowers, and enforcing contracts on to borrowers. Farmers with investments that are profitable when evaluated at the contractual interest rate may decide not to borrow once these transaction costs are factored in. Second, lenders may require borrowers to bear significant contractual risk in order to mitigate moral hazards. If insurance markets are imperfect and if this risk is too great, a farmer will prefer not to borrow even though the loan would, on average, raise his productivity and income. Just like a quantity-rationed household, the resource allocation and productivity of a household facing transaction cost rationing or risk rationing will be altered relative to a first-best world (Guirkinger & Boucher, 2008).

Empirical literature shows that money lenders and other informal lenders co-exist with formal lending institutions such as government or commercial banks and, more recently, micro-lending institutions. Potential borrowers presumably face sizable transaction costs in obtaining external credit. Based on data from Thailand (Gine, 2011), banks have limited ability to enforce contracts, which is crucial in understanding the observed diversity of lenders. This limited capacity plays a bigger role in constraining lenders than do the transaction costs incurred prior to advancing loans to borrowers (Gine, 2011). Guirkinger and Boucher (2008) show that in Peru, productivity is independent of endowments for

unconstrained households but is tightly linked to endowments for constrained households. They estimate that credit constraints lower the value of agricultural output in the study region by 26 percent. Reyes and Lensink (2011) show that in Chile, most farmers consider themselves credit-unconstrained, irrespective of the type of credit constraints they actually face. Although a long-term relationship between farms and banks has no impact on the probability of being a quantity-constrained farmer, it does affect risk and/or transaction cost rationing because the borrower likely has more experience filling out credit application forms and because the bank requires less paperwork from these known clients.

In China, credit constraints reduce the effect of production inputs, farmers' capabilities, and education. By removing credit constraints, agricultural productivity and rural household income can be improved by about 23.3 percent (Dong *et al.*, 2012). Credit constraints in China and India in 2008-2009 negatively affected food consumption, farm input application, and health and educational attainments (Kumar *et al.*, 2013). Empirical literature on the impact of credit constraints on agricultural productivity remains limited. Using mixed methods in Ghana, Akudugu (2016) finds that formal and informal credit has positive and significant effects on agricultural productivity. However, formal credit has lower effects on agricultural productivity compared to informal credit. In Rwanda, the elimination of all credit constraints in rural areas could increase output by about 17 percent (Ali *et al.*, 2014). A study by Davis *et al*. (2012) focusing on East African countries finds that young farmers who belong to entities like savings and credit groups tend to participate in farmer field schools[3]. These groups tend to have an impact on crop productivity, increasing incomes by 61 percent when pooling the three study countries (Kenya, Tanzania, and Uganda). Participation in these groups led to increased production, productivity, and income in nearly all cases. The most significant changes were seen in Kenya for crops (80 percent increase) and in Tanzania for agricultural income (more than 100 percent increase).

3. Conceptual Framework

In developing countries, multiple markets failures can cause households to adopt different resource allocation (combinations). This results in quantity rationing in the credit market, with credit-constrained households under-investing relative to credit-unconstrained households. As shown by Guirkinger and Boucher (2008), the adverse consequences of quantity rationing tend to involuntarily restrict households' access to credit, preventing them from engaging an expected income-enhancing opportunity[4]. Therefore credit-constrained households' or individuals' participation in the credit market is limited due to

[3] "Farmer field schools (FFSs) are a popular education and extension approach worldwide. Such schools use experiential learning and a group approach to facilitate farmers in making decisions, solving problems, and learning new techniques" (Davis *et al*., 2012).

[4] See more quality rationing in Guirkinger and Boucher (2008).

asymmetric information. Quantity-rationed individuals' participation in credit markets is involuntarily limited, and they have excess demand for credit that is not met by lenders.

At the same time, while quantity-rationed households are denied access to loans, non-rationed households instead often voluntarily withdraw from the credit market because of the non-price terms of available contracts. It is particularly important to account for credit constraints deriving from these latter two forms of non-price rationing because the types of policies that can alleviate them may be quite different from those designed to alleviate quantity rationing (Boucher *et al.*, 2009; Reyes & Lensink, 2011).

In many developing regions such as East Africa, farmers face imperfect credit markets. These markets failures can result in low agricultural productivity, an underdeveloped non-farm sector, asymmetric information, and high transaction costs in credit markets. As a result, households make both consumption and production decisions simultaneously. Therefore, the non-separable household model provides a suitable framework for analysing the micro-economic behaviors of farmers under market imperfections. Moreover, households in East Africa are endowed with different resources such as human capital, social capital, and physical capital; they can also be affected by credit constraints that affect agricultural productivity. As shown by Guirkinger and Boucher (2008) a farmer who does not have liquidity and requires a loan to finance production requires collateral to lower information asymmetry.

This requirement by lenders for borrowers to put up collateral is important, as collateral encourages borrowers to take action to avoid failure and address moral hazard. It can also help in selecting borrowers and therefore addressing adverse selection. Farmers who cannot post the minimum required collateral are involuntarily excluded from the credit market. Quantity rationing occurs when a farmer has a profitable project, and thus positive notional demand for credit, but faces zero supply. Quantity constraints are thus a supply-side manifestation of asymmetric information (Boucher *et al*., 2009; Guirkinger & Boucher, 2008).

The cost of a loan affects a variety of factors, including farmers' perceptions, expectations, and preferences regarding various sources of loans and the kind of inputs used in production. These in turn will condition farmers' decisions in term of investment, crop choice, and resource allocation to various inputs. Expectedly, this would affect farmers' consumption, marketing of harvested quantities of different crop varieties, savings, and income-generation activities. Therefore, household decisions and choices constitute behavior outcomes which affect agricultural productivity.

Using Asfaw et al. (2012), it is possible to use a random utility framework, in which smallholder farmers make both production and consumption decisions and the choice of credit and inputs used are optimized by heterogeneous agents based on their utility. Farmers optimize in the presence of constraints on their budget, information, and credit access, among other inputs. Thus, farmers are assumed to maximize their utility functions subject to these constraints. Therefore, households will use credit if the choice is expected to be

profitable or advantageous. Using a random utility framework, the difference between the utility from credit/borrowing (U_c) and non-credit/non-borrowing (U_n) may be denoted as U^*. Therefore, utility-maximizing farmer will choose credit if the utility gained from borrowing is greater than the utility gained from not borrowing.

Given that these utilities are unobservable, we can develop a latent variable model with a function of observable elements as follows.

$$U_{it}^* = \beta X_{it} + \varepsilon_{it} \qquad U_{it} = \begin{cases} 1 \;\; if \;\; U_{it}^* > 0 \\ 0 \;\; otherwise \end{cases} \tag{1}$$

where U is a binary indicator variable in time t, which is 1 if the farmers borrow and zero if otherwise. β is a vector of parameters to be estimated, X is a vector of explanatory variables, and ε is the error term.

According to Fletschner *et al.* (2010), lenders' responses to asymmetric information go beyond deciding whether or not and how much to lend. They reduce information asymmetries by screening applications and monitoring borrowers. When a farmer is transaction cost-rationed, the non-interest monetary and time costs associated with an application for and the administration of loans are sufficiently large that they cause a farmer to refrain from borrowing. On the other hand, lenders may indirectly address incentive problems by requiring that borrowers post collateral. A farmer is risk-rationed if he has access to an expected income-enhancing credit contract but does not take it because the collateral requirement implies that he bears too much risk. These three forms of non-price rationing affect a household's endowments and resource allocation decisions. Unconstrained farmers operate at the profit-maximising level of inputs per hectare. An increase in their endowment of land or liquidity would have no effect on either output or profit per hectare. In contrast, for credit-constrained households, a change in endowments will affect output per hectare (Guirkinger and Boucher, 2008).

Linking these concepts to empirical evidence and determining which households are voluntarily or involuntarily rationed presents its own challenges. The literature has focused on two approaches: indirect inference and survey-based direct elicitation. The first method infers the presence of credit constraints from violations of the assumptions of the life-cycle or permanent income hypothesis, while the second collects information directly from household surveys regarding whether or not households perceive themselves to be credit-constrained (Diagne *et al.*, 2000). Using qualitative questions that focus on responses based on loan applications or rejections, households can be classified as credit-constrained or credit-unconstrained. Based on this classification, we can develop regression equations to analyse the determinants of the likelihood of a household being credit-constrained and the effects of this likelihood on various household outcomes. This method has been used by numerous authors such as Jappelli (1990) using data from the U.S., Feder *et al.* (1990) using data from a household survey in China, Guirkinger and Boucher (2008), Fletschner *et al.* (2010), For Peru, Reyes and Lensink, (2011) using data for Peru, Dong *et al*. (2012) using

data for Chile, Kumar *et. al.* (2013) using data for China and India, and Ali *et al.* (2014) using data for Rwanda.

As shown in Fletschner *et al.* (2010) there are several important issues with this approach. The first three involve choices about how to define units of analysis when designing the questionnaire. The second two are more conceptual.

The first issue is based on the definition of loan sectors. In many developing countries, lenders form a heterogeneous group. These lenders have different contract terms, and while a household can be unconstrained with respect to one type of lender, it may not be constrained with respect to the other types of lenders. As a result, constraints will be binding and adversely affected by household resource allocation. Given this concern, lenders should be grouped into distinct sectors, or segments, of the credit market, and the language of the qualitative questions in the perceptions module should be cast with respect to these sectors (as shown in Table 1). One of the questions in the questionnaires asks respondents: *"Over the past 12 months, did you or anyone else in this household borrow from someone outside the household or from an institution receiving cash, goods, or services?"*

Another reason to define distinct loan sectors is to test sector-specific hypotheses. For example, using datasets from rural Thailand, Giné (2011) analyses the mechanism underlying access to credit. Gine's study shows that money lenders and other informal lenders coexist with formal lending institutions such as government or commercial banks and, more recently, micro-lending institutions. In addition, the study found that the limited ability of banks to enforce contracts, more than transaction costs, is crucial in understanding the observed diversity of lenders.

The second issue is based on household versus individual constraints. We focused on household heads in the datasets used. As Fletschner *et al.* (2010) argue, household resource allocation is consistent with the utility model for the households in which endowment and incomes are pooled amongst household members.

The third issue relates to households' classification as constrained or unconstrained classification and is based on household perceptions. When the households face a question that focuses on whether the bank would lend them, it is possible that they might not understand the question; sometimes careful selection and training of enumerators is necessary in order to convey the idea.

The fourth issue is that identification of a binding supply constraint relies on the respondent's perception of the lender's willingness to offer them a loan. This perception may be incorrect. When we do not have such a question, it is not possible to determine whether a household is constrained.

Finally, there could be an issue with identifying non-borrowers' notional demand via subjective questions. To be able to identify constrained or unconstrained households, the first question is based on whether or not a household borrowed in the informal or the formal sector. For example, when there is a question that

allows for a joint outcome for the respondent's action (loan application) and the lender's action (approval or rejection), the researcher can sort the application in terms of price rationed versus quantity rationed. However, some households may not tell the truth, especially when the loan application is rejected. For non-applicants, it is also not easy to determine why they did not apply for the loan, especially when there is no other question addressing this reason.

4. Dataset and Context

4.1 Context

The East African countries examined in this study – Tanzania and Uganda – can be characterized as "agriculture-based"; that is, agriculture forms the backbone of these economies. In addition, agriculture in these countries remains dominated by smallholder farmers. In East Africa as a whole, agriculture accounts for about 75 percent of the labor force and plays an important role in job creation and poverty reduction. Smallholder farmers account for about 75 percent of agricultural outputs, with farm sizes of about 2.5 hectares on average. These farmers generally produce mainly for home consumption and use traditional technologies. In addition, less than 4 percent of total land area is irrigated in East Africa. Major crops include cereals, root crops, banana tea, pyrethrum, sisal, cut flowers, coffee, cotton, and tobacco. Coffee, cotton, horticulture produce and tea form the main export crops. Cattle and poultry dominate the livestock sub-sector. Other important livestock produced are sheep, pigs, and goats. Forestry, horticulture, and fishing are also important economic activities in the study countries. In these countries, food security remains a challenge, as does low productivity in agriculture (Salami *et al.*, 2010).

In terms of finance, smallholder farmers in East Africa depend on savings from their low incomes, which limits opportunities for expansion. Because of the lack of collateral and/or credit history, most farmers are bypassed not only by commercial and national development banks but also by formal micro-credit institutions. In addition to their own resources, farmers often rely on the incomes of friends and relatives, remittances, and informal money lenders. Access to formal credit in Tanzania is mainly confined to large urban centers, where collateral requirements are high. In Uganda, high interest rates inhibit agricultural investments. While more recently, micro-finance institutions have provided financial services to millions of previously un-bankable clients using innovative instruments, these programs have so far largely failed to reach poorer rural areas and/or smallholder agricultural producers whose livelihoods are characterized by highly seasonal investments, risks, and returns (Peacock *et. al.*, 2004).

4.2 Datasets

The data used is obtained from the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA), established by the Bill and Melinda Gates Foundation and implemented by the Living

Standards Measurement Study (LSMS) within the Development Research Group at the World Bank. The Uganda and Tanzania National Panel Survey sample, taken over three periods for each country, includes economic and social information for households. These households were previously interviewed in the 2005-2006, 2009-2010, and 2010-2011 Uganda National Household Surveys and in the 2007-2008, 2010-2011 and 2011-2012 Tanzania National Household Surveys.

4.2.1 Sampling and Survey Design

For Tanzania, the first-round sample included 3,265 households, had sample representation for the nation as a whole, and provides reliable estimates of key socioeconomic variables for mainland rural areas, Dar es Salaam, other mainland urban areas, and Zanzibar. In the second round, all original households were targeted for revisiting. Those members still residing in their original location were re-interviewed, and all adults who had relocated were tracked and re-interviewed in their new location with their new households. The sample size for the second round subsequently expanded to 3,924; for the third round, the sample reached a size of 5,015 households.

In Uganda, the first round of the sample had about 3,200 households, all of whom had been previously interviewed as part of the 2005-2006 Uganda National Household Survey (UNHS). The sample was representative at the national, urban/rural, and main regional levels (North, East, West, and Central regions). This sample was visited for two consecutive years (2009-2010 and 2010-2011). The surveys focus on a community-level questionnaire with the following units of analysis: individuals, household, and communities. All the regions sampled are in Appendix 1.

In this study, we focus on the household; however, we are not able to determine whether households are constrained and unconstrained because the datasets in Tanzania do not include questions that help to make that determination. Others such as Carter (1989) in Nicaragua focused on to determine the impact of credit on small food production using an endogenous regression. Similar to Carter (1989), who focuses on the impact of credit on smallholder food production in Nicaragua using an endogenous regression, we focus on the impact of credit on the agricultural productivity and the magnitude of this impact. We do not need an endogenous switching model to do this, however, and we instead follow Boucher et al. (2009), as laid out in the next section.

4.2.2 Panel Attrition

As with most panel surveys, a certain portion of panel respondents are not able to be re- interviewed over time. This attrition of panel respondents can lead to attrition bias in which respondents drop out of the survey non-randomly and in which the attrition is correlated with variables of interest. Household panel survey weights can be used to address the problem of attrition, i.e. where survey observations (household or individual members) are selected for re-interview but cannot be located or refuse to be interviewed. The

methodology used to adjust weights for attrition in the LSMS-ISA surveys follows Rosenbaum & Rubin (1984) and Gouskova *et al* (2008). Predicted response probabilities from a logistic regression model based on the covariates are used to form the weighting classes or cells (see Himelein, 2013). In the Tanzania National Panel Survey, datasets have fortunately maintained low attrition over the waves, thus minimizing the potential for attrition bias within the datasets. Total household attrition for the datasets from the three years is 4.84 percent.[5] However, in Uganda the weights were very important, especially for 2013-2014. Only two-thirds of the households in the 2005 Uganda National Panel Survey (UNPS) were included in the subsequent 2013-2014 survey (UNPS, 2013).

5. Empirical Model and Variables

The first objective of the econometric analysis is to evaluate whether or not the relationship between farm productivity and productive endowments differs across borrowing and non-borrowing households.

We use linear specification of farm productivity as follows:

$$y_{it} = \alpha + \beta C_{it} + \gamma Z_{it} + n_i + \delta_t + \theta_i + \varepsilon_{it} \qquad (2)$$

The dependent variable is y_{it} is the per-hectare value of farm output for household *i* in period *t*. The binary variable C_{it} takes value 1 if the household decides to borrow from any sources in period *t* and zero if they do not decide to borrow. We also use credit from formal and semi-formal sources to see the impact on agricultural productivity. Following Guirkinger and Boucher (2008), formal credit institutions include commercial banks, insurance companies, and government institutions. Semi-formal institutions are microfinance facilities, building societies, and non-governmental organizations. Informal sources include neighbors and friends, grocery/local merchants, money lenders, employers, religious institutions, and self-help groups. The survey focuses on how many households used any of these sources in each year. This is shown in Table 4.

The household fixed effect n_i captures the impact of the time-invariant household characteristics affecting productivity. The time fixed effects δ_t, captures the impact of the time-variant household characteristics that can affect productivity. We also use regional effects θ_i, which captures regional effects that could have affect productivity. The ε_{it} is the error term.

Finally, Z_{it} includes variable farm size, liquidity, dependency ratio, number of adults holding a salaried job, herd size, and dummy variables indicating which crops are grown. The study includes the first four variables because farm productivity may be affected by the amount of the available family labor. The herd size and crop choice variables are included to control for differences in input requirements and expenditures across households.

[5] http://microdata.worldbank.org/index.php/catalog/2252/sampling

Table 1: Tanzania Means and standard deviations of explanatory variables

Variable	Definition	Total		Borrowers		Non-borrowers		t test
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
FARM CHARACTERISTICS								
Farmsizeha	Farm size (ha)	0.98	1.82	1.21	2.22	0.96	1.78	-2.91**
Totalwagesdollars	Total wages paid for labour in dollars	5.06	20.30	12.56	39.46	4.46	17.74	-8.47***
Totallabourdays	Number of days worked on the farm by employees	6.67	20.85	14.18	32.79	6.06	19.45	-3.44***
Totallivestockowned	Number of animals owned	0.93	8.70	2.24	24.34	0.83	5.82	-0.48***
Soilquality	Quality of the soil, 1 if poor, 2 if fair, and 3 if good	1.58	0.60	1.58	0.61	1.58	0.60	0.03
Seedtype	1 if improved quality, 0 if traditional	0.24	0	0.30	0.02	0.24	0.43	-2.97**
Fertilizer	0 if organic, 1 if inorganic	0.08	0.27	0.12	0.32	0.08	0.27	-3.03**
Maize	1 if cultivates maize	0.38	0.48	0.34	0.48	0.38	0.49	1.65***
Paddy	1 if has paddy	0.10	0.30	0.07	0.01	0.10	0.30	1.78*
Sorghum	1 if cultivates sorghum	0.03	0.17	0.02	0.15	0.03	0.17	0.84
Cassava	1 if cultivates cassava	0.12	0.33	0.10	0.29	0.12	0.33	1.87*
Beans	1 if cultivates beans	0.03	0.17	0.04	0.19	0.03	0.17	-0.96
Bananas	1 if cultivates bananas	0.05	0.21	0.06	0.23	0.04	0.21	-1.40
Othercrops	1 if cultivates other crops	0.33	0.47	0.40	0.49	0.32	0.47	-3.49***
HOUSEHOLD CHARACTERISTICS								
Liquidity (Dollars)	Credit + Savings	27.39	4.11	303.75	52.25	5.03	0.86	-19.71***
DepRat	Dependency Ratio (Children 14 years+ Elderly 65 years)/ household size	0.64	0.42	0.63	0.42	0.64	0.42	0.51
Age	Age of Household Head	40.67	21.30	36.87	19.30	40.97	21.43	4.07***
Education	Years of schooling	2.72	3.60	3.81	3.82	2.63	3.56	-6.98***
Durables	Number of items owned	2.17	13.87	2.25	7.37	2.16	14.27	-0.14
Male	1 if household head is male	0.69	0.01	0.72	0.45	0.68	0.47	-1.54
Shock	1 if household experienced shock (death, floods, e.t.c in recent past	0.35	0.48	0.29	0.45	0.35	0.48	2.75**
Otherincomesource	1 if household has other income source	0.33	0.47	0.40	0.02	0.32	0.47	-3.49**
INSTITUTIONAL CHARACTERISTICS								
Network	Proportion of neighbors w/ formal loan	0.86	0.22	0.14	0.22	0.92	0.05	258.19***
Titledeedownership	1 if has a title	0.07	0.25	0.09	0.29	0.07	0.25	-2.11*
ExtensionServices	1 if accessed extension services	0.99	0.12	0.98	0.15	0.99	0.12	1.68*

Table 2: Uganda Means and standard deviations of explanatory variables

Variable	Definition	Total		Borrowers		Non-borrowers		t test
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
FARM CHARACTERISTICS								
Farmsizeha	Farm size (ha)	1.50	10.52	1.20	3.38	1.59	11.82	1.28
Totalwagesdollars	Total wages paid for labour in dollars	4.44	17.36	5.05	16.90	4.26	17.48	-1.60
Totallabourdays	Number of days worked on the farm by employees	6.68	20.56	7.51	23.67	6.43	19.55	-1.81*
Totallivestockowned	Number of animals owned	0.45	4.00	0.27	1.43	0.50	4.48	2.00*
Soilquality	Quality of the soil, 1 if poor, 2 if fair, and 3 if good	1.53	0.64	1.57	0.65	1.52	0.64	-2.30*
Seedtype	1 if improved quality, 0 if traditional	0.06	0.24	0.06	0.24	0.06	0.24	-0.55
Fertilizer	1 if organic, 2 if inorganic	0.05	0.22	0.05	0.22	0.05	0.22	-0.38
Maize	1 if cultivates maize	0.22	0.42	0.25	0.43	0.22	0.41	-2.58*
Sorghum	1 if cultivates sorghum	0.07	0.26	0.07	0.26	0.07	0.25	-0.64
Cassava	1 if cultivates cassava	0.21	0.41	0.23	0.42	0.20	0.40	-1.94*
Beans	1 if cultivates beans	0.19	0.40	0.24	0.42	0.18	0.39	-4.78***
Bananas	1 if cultivates bananas	0.16	0.36	0.19	0.36	0.14	0.35	-4.85***
Groundnuts	1 if cultivated Groundnuts	0.06	0.24	0.06	0.24	0.06	0.24	-0.12
Othercrops	1 if cultivates other crops	0.25	0.43	0.20	0.40	0.26	0.44	5.01***
HOUSEHOLD CHARACTERISTICS								
Liquiditydollars	Credit + Savings	39.55	38.97	44.79	32.22	38.00	52.49	-0.81**
DepRat	Dependency Ratio (Children 14 years+ Elderly 65 years)/ household size	0.49	0.39	0.49	0.36	0.50	0.40	0.84
Age	Age of Household Head	45.72	15.41	43.49	13.96	46.37	15.75	6.53***
Education	Years of schooling	1.34	2.89	1.16	2.68	1.39	2.94	2.72**
Durables	Number of items owned	1.21	0.80	1.57	0.58	1.10	0.83	-21.06***
Male	1 if household head is male	0.72	0.45	0.76	0.43	0.71	0.46	-4.26***
Shock	1 if household experienced shock (death, floods, e.t.c in recent past	0.06	0.24	0.07	0.25	0.06	0.24	-0.84
Otherincomesource	1 if household has other income source	0.25	0.24	0.20	0.40	0.26	0.44	5.01***
INSTITUTIONAL CHARACTERISTICS								
Network	Proportion of neighbors w/ formal loan	0.40	0.25	0.40	0.19	0.82	0.17	85.42***
Titledeedownership	1 if has a title	0.08	0.27	0.07	0.26	0.08	0.27	1.32
ExtensionServices	1 if accessed extension services	0.11	0.31	0.09	0.29	0.12	0.32	2.98**

These variables affect agriculture productivity, and we provide their means and standard deviations for both borrowers and non-borrowers based on the literature. We focus on β, which gives the impact of borrowing on farm productivity. In estimating β, we face several potential sources of bias. First, the households' fixed effects are unobserved and potentially correlated with the other regressors. Second, unobserved time-variant factors, such as shocks to land quality or health, might be correlated with productivity and households' credit status. To address this source of endogeneity, the study uses an instrumental variable approach. The study uses three instruments for the household's status. The first variable, *Title*, is a dummy variable indicating whether or not the household owns at least one parcel with a registered property title. While title is the primary form of collateral for formal lenders, *Durable Goods* can also be used as collateral, especially in the informal credit markets found in developing countries in East Africa. Therefore households that have this second type of variable should borrow more compared to those that do not. The third variable, *Network*, measures the proportion of the household's neighbors with a formal loan. A higher fraction of neighbors participating in the formal credit market is also anticipated to relax credit constraints, as it likely reduces both the transaction costs associated with loan application and the uncertainty resulting from an incomplete understanding of contractual terms. In particular, focus group sessions suggest that borrowers with minimal experience and information about formal credit contracts overestimate the probability of foreclosure; they are less aware than experienced borrowers that lenders exhaust all options, including loan restructuring, before initiating foreclosure.

Other studies related to this study, such as Kumar *et al*. (2017), use the portion of farmers using institutional credit in a village as the instrumental variable. Dong *et al*. (2010) use "whether a loan had been received before (*preloan*) and whether the needed collateral (*collateral*)", while Guirkinger and Boucher (2008) and Boucher *et al.* (2009) and use title and networks. Akudugu (2016) uses community- and district-level average years of formal schooling, community- and district-level average household savings, and the average amounts of formal and informal credit borrowed by computing households at the community and district levels, while Khandker and Faruqee (2003) use competitors' characteristics as possible instruments in the borrowing equation.

We also quantify the magnitude of credit's impact on farm productivity. The specific question we ask is: By how much would the productivity of farmers increase if credit constraints were removed? To do this, the study follows Guirkinger and Boucher (2008), Dong *et al*. (2012), and Ali *at al*. (2014) to estimate this model. The study assumes that fixed and regional effects affect households in the same way; therefore we can focus on the magnitude of the change of borrowing on agriculture productivity for all households. The predicted impact for each household that does not borrow is thus computed as:

$$y_{it}^{b} - y_{it}^{ub} = \mu + (\gamma^{b} - \gamma^{ub})Z_{it} \qquad (3)$$

However, as shown by Wooldridge (2012, pp.235), if the β is a dummy as shown in equation 1, the exact percentage change can be calculated as follows:

$$100 * [exp(\beta) - 1] \quad (4)$$

This estimate can be positive or negative, and it is important to preserve its sign.

6. Results and Discussion

6.1 Descriptive statistics

As shown in Table 3, the total number of households in Tanzania that borrow from various sources, while low, has increased over time, from 6.19 percent in 2008 to 11.02 percent in 2012. Farming households in Tanzania increased borrowing from 5.93 percent in 2008 to 10.48 percent in 2012. Households in Uganda use credit more than households in Tanzania. Total household borrowing in Uganda increased from 19.79 percent in 2005 to 26.13 percent in 2010, while borrowing from agricultural households increased from 20.06 percent in 2005 to 25.90 percent in 2010. As shown in Adjognon *et al.* (2017), the use of traditional credit, both formal and informal, remains extremely low throughout Africa. However, our results show that there has been an uptake of credit by Ugandan and Tanzanian farming households in the period surveyed.

Table 3: Tanzania Borrowers and Non-borrowers for All Households and Agricultural Households

	Total Households					**Agricultural Households**				
Year	**Borrowers**		**Non-Borrowers**		**Total**	**Borrowers**		**Non- Borrowers**		**Total**
	%	**Frequency**	**%**	**Frequency**		**%**	**Frequency**	**%**	**Frequency**	
2008	6.19	202	93.81	3063	3265	5.93	144	94.07	2285	2429
2010	9.28	364	90.72	3560	3924	8.74	242	91.26	2527	2769
Original HH 2010	8.62	273	91.38	2895	3168	8.29	189	91.71	2092	2092
2012	11.02	553	88.98	4464	5017	10.48	349	89.52	2982	89.52
Original HH 2012	8.94	221	91.06	2250	2471	8.62	148	91.38	1569	1717

Source: Author's Computations.
Note: Original HH 2010 and Original HH 2012 denote the number of households that existed in the original sample taken in 2008

Table 4: Uganda Borrowers and Non-borrowers for All Households and Agricultural Households

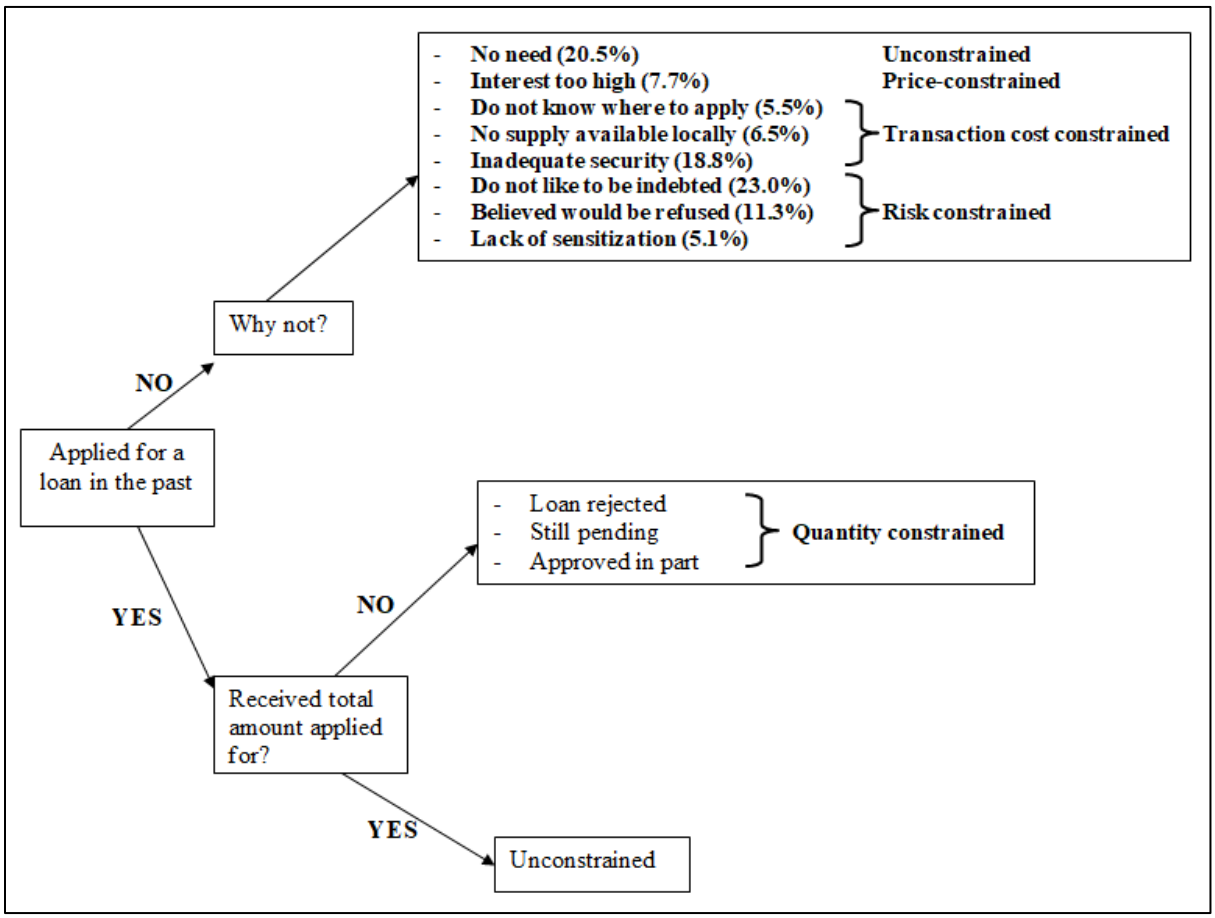
	Total Households					Agricultural Households				
Year	**Borrowers**		**Non-Borrowers**		**Total**	**Borrowers**		**Non- Borrowers**		**Total**
	%	**Frequency**	**%**	**Frequency**		**%**	**Frequency**	**%**	**Frequency**	
2005	19.79	618	80.21	2505	3123	20.06	465	79.94	1853	2318
2009	21.58	642	78.42	2333	2975	22.12	522	77.88	1838	2360
Original HH 2009	21.21	553	78.79	2054	2607	23.21	496	76.79	1641	2137
2010	26.13	709	73.87	2004	2713	25.90	571	74.10	1634	2205
Original HH 2010	25.60	682	74.40	1982	2664	25.80	562	74.20	1616	2178

Source: Author's Computations

Note: While surveys were conducted for 2011 and 2013 in Uganda, the questionnaire and data did not contain segments on credit access. Original HH 2009 and Original HH 2010 denote the number of households that existed in the original sample taken in 2008

Figure 1 summarizes the extent of credit constraints in Uganda, which in most cases is similar to Tanzania. We use the 2005-2006 dataset for this purpose. Twenty percent of households are not constrained; 36 percent of households do not borrow because of transaction cost factors, while 34 percent of households do not borrow due risk factors. Eight percent of households are affected by price factors such as interest rate. Similar studies, such as Mukasa *et al*. (2017) in Ethiopia, found that around 66.6 percent of the households were credit constrained. Of these households, a majority of them (71.9 percent) were due to risk factors, and 14.33% were due to transaction costs.

Figure 1: Reasons for not applying for loan in Uganda



Source: Author's compilation

In terms of the sources of household credit, Table 5 show that households use formal, semi-formal, and informal resources; therefore these lenders co-exist, as shown by Gine (2011). In both countries, urban households mainly use formal credit, while rural households tend to use informal credit. This trend has increased with time in Tanzania, with only 6.79 percent of rural households using formal credit in 2012. In addition, there has been an increase in the households in Tanzania that use semi-formal credit over the study period. In Uganda, there has been an increase in the households that use formal credit, from 11.40 percent (urban) and 6.67 percent (rural) in 2005 to 17.26 percent (urban) and 16.19 percent (rural) in 2010. In addition, there has been decrease in the households that use semi-formal credit in Uganda's rural areas and an increase in the use of semi-formal credit in the country's urban areas. Moreover, there has a reduction in households using informal credit in urban areas compared to rural areas. The results show that households in rural areas use different sources of credit, although most go for informal sources. As shown by Ali *et al.* (2014), in Rwanda, only 3 percent of the sampled households applied for a bank loan during the 12-month period preceding the survey. Such limited formal credit market activity is not uncommon in rural areas of

developing countries due to limited outreach of the formal system. To access extra liquidity, rural households are then restricted to borrowing from the informal and the semi-formal sectors.

Table 5: Sources of Loans in Tanzania and Uganda

			Formal Sources		Semi-formal Sources		Informal Sources	
			Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Tanzania	**Urban**	**2008**	51	35.42	10	6.94	16	11.11
		2010	45	23.81	26	13.76	26	13.76
		2012	46	31.08	25	16.89	14	9.46
	Rural	**2008**	17	11.81	18	12.5	32	22.22
		2010	21	11.11	31	16.40	40	21.16
		2012	10	6.76	16	10.91	37	25
Uganda	**Urban**	**2005**	53	11.40	69	14.84	83	17.85
		2009	79	15.93	89	17.94	61	12.30
		2010	97	17.26	106	18.86	88	15.66
	Rural	**2005**	31	6.67	113	24.30	116	24.95
		2009	77	15.52	96	19.35	94	18.95
		2010	91	16.19	79	14.06	101	17.97

Source: Author's Computations

Looking at the pooled sample in Table 6, agricultural productivity seems to be higher for households that borrow than for non-borrowers. However, households that use credit in Tanzania have higher net revenue compared to credit-using households in Uganda.

Table 6: Productivity indicators: pooled sample means and standard deviations (in parentheses)

	Tanzania			Uganda		
	Revenue per ha	**Cost per ha**	**Net Revenue per ha**	**Revenue per ha**	**Cost per ha**	**Net Revenue per ha**
Total	\$69.05 (7.55)	\$22.21 (1.64)	\$46.84 (6.86)	\$31.29 (1.96)	\$17.16 (0.60)	\$14.13 (1.93)
Borrowers	\$170.66 (53.30)	\$52.42 (10.36)	\$118.24 (50.91)	\$31.71 (2.26)	\$21.44 (1.52)	\$15.81 (2.21)
Non-borrowers	\$61.00 (6.96)	\$19.81 (1.56)	\$41.18 (6.20)	\$29.87 (3.84)	\$15.89 (0.63)	\$8.43 (1.93)
t test	-3.79***	-5.21***	-2.93**	0.39	-3.89***	1.61*

Source: Author's Computations

In the next section, we give the results of the econometric model for both Tanzania and Uganda.

6.2 Results

The results are based on a logarithm of the variables, shown in Tables 7 and 8 for Tanzania and Uganda, respectively; the Appendix provides level results. First we will discuss the results for the impact of credit on agricultural productivity for the two countries. The results are initially based on the baseline equation based on the OLS. This is followed by both random and fixed effects models. As shown in the Tables 7 and 8, the fixed effects model is the best, given the Haussmann test at 40.37 and 48.18 for Tanzania and Uganda,

respectively; the model is significant at the 1 percent level. However, when we have a variable that is endogenous, as in the case of borrowing when estimating the value of harvest, this tends to be correlated with the disturbance term, hence violating the Gauss Markov assumptions and making OLS estimates biased. As a result, the study uses three instruments in a two-stage least squares regression (2SLS). Using the first stage, the best instruments tend to be the best linear predictor of the exogenous variables, using F statistics 10905.1 and 2893.29 for Tanzania and Uganda, respectively; this is significant at the 1 percent level. We use two instruments for both countries. The test for endogeneity also shows that the 2SLS is preferred at the 1 percent for both Durbin chi-square test and Wu-Haussmann F statistics. Therefore both 2SLS and fixed effects models give us the unbiased estimates.

6.2.1 The impact of credit on agricultural productivity in Tanzania.

The last column of Table 7 shows a model in which we have both 2SLS and fixed effects for Tanzania. The results show that household borrowing has no significant effect on agricultural productivity. In addition, farm size affects yields negatively and significantly at the 1 percent level. Similarly, extension services and other income sources affect agricultural productivity significantly and negatively at the 10 percent level.

Table 7: The impact of credit on agricultural productivity in Tanzania (Dependent variable: log of Yield)

	OLS		**Random Effects**		**Fixed Effects**	
Log Yield	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Borrower	-0.16*	0.09	-0.19**	0.09	-0.15	0.12
Log Farm size ha	-0.29***	0.01	-0.30***	0.01	-0.30***	0.02
Log Total wages dollars	0.05***	0.02	0.05***	0.02	0.03	0.02
Log Total labour days	-0.01	0.02	-0.01	0.02	-0.01	0.02
Log Loan value dollars	0.04**	0.02	0.04**	0.02	0.03	0.03
Log Dependency Ratio	-0.01	0.01	0.00	0.01	0.01	0.01
Log Total livestock owned	0.05***	0.02	0.03*	0.02	0.03	0.03
Log Age	-0.03*	0.02	-0.03**	0.02	0.01	0.02
Log Age squared	0.00	0.00	0.00	0.00	0.00	0.00
Log Durables	0.00	0.01	0.01	0.01	0.00	0.02
Log Education	0.02**	0.01	0.02**	0.01	0.00	0.02
Extension Services	-0.30***	0.09	-0.37***	0.10	-0.25*	0.15
Male	0.04*	0.02	0.03	0.02	0.00	0.04
Shock	-0.04	0.02	-0.03	0.06	-0.02	0.08
Other income source	0.02	0.04	-0.01	0.04	-0.12**	0.05
UrbanRural	0.05*	0.03	0.02	0.03	0.02	0.03
Maize	0.08	0.07	0.03	0.07	0.02	0.09
Paddy	0.21***	0.07	0.20***	0.07	0.11	0.10
Sorghum	-0.01	0.09	0.00	0.09	0.06	0.12
Cassava	0.05	0.07	0.06	0.07	0.10	0.09
Beans	-0.01	0.07	-0.06	0.07	-0.02	0.09
Bananas	0.01	0.07	-0.02	0.08	-0.03	0.10
Other crops	0.19***	0.07	0.17**	0.07	0.13	0.09
Constant	-0.23*	0.12	-0.08	0.16	0.16	0.47
Year			Yes		Yes	
regions			Yes		Yes	
Hausman test					40.37	
First Stage	10905.1***					
Endogenous	5.25					
overid	0.64					
R2	0.13		0.13		0.04	
Observation	6351		6,272		6,272	
Group			2,550		2,550	

***,** and* significant at the 1,5 and 10 percent level.

6.2.2 The impact of credit on agricultural productivity in Uganda

Table 8 below shows the results for Uganda. The results show that borrowers that use credit have higher agricultural productivity, significant at the 5 percent level. In addition, agricultural productivity is correlated extension services and other income sources at the 1 percent level of significance.

Table 8: The impact of credit on agricultural productivity in Uganda (Dependent variable: log of Yield)

	OLS		**Random effects**		**Fixed effects**	
Log Yield	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Borrower	2.56***	0.15	0.17	0.14	0.03**	0.77
Log Farm size ha	-0.66***	0.04	-0.67***	0.03	-0.77	-0.56
Log Total wages dollars	0.18**	0.08	0.03	0.06	-0.18	0.17
Log Total labour days	-0.03	0.07	-0.04	0.05	-0.13	0.16
Log Liquidity dollars	-0.12***	0.03	0.02	0.02	-0.05	0.07
Log Dependency Ratio	0.08**	0.04	-0.01	0.03	-0.13	0.03
log Total livestock owned	-0.34***	0.13	-0.01	0.1	-0.32	0.24
Log Age	0.47***	0.13	0.01	0.1	-0.31	1.01
Log Age squared	0.00	0.00	0	0	0	0
Log Durables	2.65***	0.13	-0.06	0.12	-0.33	0.31
Log Education	-0.27***	0.06	0.08*	0.05	-0.11	0.16
Extension Services	-0.46***	0.14	0.27***	0.11	0.10***	0.67
Male	0.08	0.10	0.05	0.08	-0.49	0.4
Shock	-0.57***	0.18	-0.15	0.14	-0.49	0.22
Other income source	-1.02***	0.10	0.11	0.08	0.07***	0.52
UrbanRural	0.27**	0.13	-0.1	0.1	-0.86	0.98
Maize	0.14	0.15	-0.11	0.12	-0.26	0.34
Sorghum	-0.43**	0.20	-0.62***	0.16	-0.81*	0.05
Cassava	1.04***	0.15	0.49***	0.12	0.19***	0.81
Beans	0.02	0.15	-0.21*	0.12	-0.45	0.15
Bananas	0.43***	0.16	0.28**	0.13	-0.2	0.48
Groundnuts	-0.18	0.20	-0.45***	0.16	-0.61	0.21
Other crops	0.25	0.17	0.17	0.14	-0.15	0.55
Constant	-4.27***	0.53	-2.48***	0.53	-2.93*	1.68
Year			Yes		Yes	
Regions			Yes		Yes	
First stage	2893.29***					
Endogenous	3.36					
Overind	0.50*					
Overall R^2	0.19		0.51		0.24	
Hausman test					48.18***	
Wald chi2	1613.92		7241.81		6931.38	
observation	6,883		6,883		6,883	
Groups			2776		2776	

***,** and* are significant at the 1,5 and 10 per cent level respectively.

In Table 9, the results show that formal and semi-formal credit affects agricultural productivity. The results show that borrowing credit from these sources in Tanzania has a significant effect on agricultural productivity at the 10 percent level. However, in Uganda, these sources have a positive and significant effect at the 1 percent level. This shows that although borrowing from formal and semi-formal credit influences productivity, this is more significant in Uganda than in Tanzania.

Table 9: The impact of formal and semiformal credit on agricultural productivity in Tanzania and Uganda.

Log Yield	**Tanzania**		**Uganda**	
	Coef.	**Std. Err.**	**Coef.**	**Std. Err.**
Borrower	5.77*	3.13	1.56***	0.46
Log Farm size ha	-0.29*	0.18	-0.86***	0.12
Log Total wages dollars	0.24	0.20	-0.11	0.19
Log Total labour days	0.06	0.19	0.19	0.16
Log Loan value dollars	-0.03	0.17	0.03	0.07
Log Dependency Ratio	0.07	0.17	-0.09	0.10
Log Total livestock owned	0.34	0.28	0.29	0.34
Log Age	0.07	0.30	1.09*	0.61
Log Age squared	0.00	0.00	0.00	0.00
Log Durables	0.21	0.25	0.13	0.30
Log Education	-0.37**	0.19	0.20	0.14
Extension Services	0.00	0.00	0.05	0.35
Male	0.42	0.48	-0.63	0.48
Shock	2.86**	1.28	-0.21	0.36
Other income source	0.13	0.92	0.17	0.24
UrbanRural	-0.02	0.36	2.16	1.70
Maize	-0.77	1.25	0.34	0.31
Paddy/Ground nuts	-0.43	1.43	-0.17	0.39
Sorghum	-1.58	2.16	-0.76	0.48
Cassava	-0.54	1.27	0.73**	0.32
Beans	-0.14	1.05	-0.34	0.30
Bananas	-1.48	2.00	-0.07	0.34
Othercrops	-0.61	1.24	-0.07	0.40
Constant	-8.80**	4.18	-7.57***	2.33
Year	Yes		Yes	
Regions	Yes		Yes	
R^2	0.04		0.44	
Observation	460		3397	
Groups	388		2,473	

***,** and * significant at the 1,5 and 10 percent level.

6.2.3 The efficiency of credit on agricultural productivity in Tanzania and Uganda

The results from the above estimations show that there is a difference between the impacts of credit on agriculture productivity in the two study countries. The decision to borrow among households does not affect agricultural productivity in Tanzania, but it does affect productivity in Uganda. Using equation 3, the decision to borrow for each year affects agricultural productivity in Uganda by almost 13.88 percent. In addition, Ugandan households that use formal and semi-formal sources each year increase agricultural productivity by 375.88 percent. However, in Tanzania, while the decision to borrow each year from formal and semi-formal sources can increase agricultural productivity, it is not significant at the 5 percent level.

6.3 Discussion

The results for the two countries reveal several important points. First, credit impacts agricultural productivity differently in the two countries. In Tanzania, households that borrow credit have lower agricultural productivity compared to those that do not. In addition, the results also show that households in Tanzania that use formal and semi-formal credit see a significant reduction in agricultural productivity. In Uganda, however, credit has a positive impact on agricultural productivity. Ugandan households that borrow credit have higher productivity compared to those that do not borrow. In addition, households that borrow from formal and semi-formal sources also have higher agricultural productivity. As shown in Gine (2011), expanding formal credit in rural areas can be crucial, largely because informal credit tends to exploit poor borrowers. It could thus be important to devote considerable resources to helping supply credit to poor farmers and entrepreneurs who are otherwise denied formal credit. However, the results from this study show that both formal and semi-formal credit in Tanzania could be having undesired effects on agricultural productivity. This is in contrast with findings in other countries. For instance, formal and semi-formal credit improves agricultural productivity in Peru by 26 percent (Guirkinger and Boucher, 2008), in China by 23.3 per cent (Reyes and Lensink, 2011), and Rwanda by 17 percent (Ali *et al.*, 2014). Adjognon *et al.* (2017) shows that farmers in Sub-Saharan Africa use the cash from non-farm activities and crop sales to purchase inputs and that few households use formal and informal credit. In this paper, households' decision to borrow each year does not affect agricultural productivity in Tanzania and the decision to borrow from formal and semi-formal sources does not significantly increase agricultural productivity in this country. In Uganda, however, rural households' decision to borrow each year affects productivity significantly, by about 13.88 percent and about 375.88 percent when using formal and semi-formal sources of credit, respectively.

Farm sizes in all of the estimations are negatively and significantly related to agricultural productivity. While many papers find an inverse relationship between farm size and agricultural productivity, Sara and Scandizzo (2017) show that less productive farmers and more productive farmers show a u-shaped relationship. As shown in Ali *et al.* (2014) for Rwanda, the translation of labor market imperfections into

low labor opportunity cost for small farm holders suggests that having access to credit markets only partially offsets the effects of imperfection in other markets.

The impact of low liquidity on agricultural productivity is negative but not significant at the 10 percent level in Uganda, while it is positive but also not significant in Tanzania. As shown in Ali *et al.* (2014), these results suggest that access to liquidity can affect borrowers' agricultural productivity. Barrett *et al.* (2017) shows that pervasive financial liquidity constraints and non-farm enterprises are considered a primary vehicle for increasing investments and productivity. However, the results for non-income sources in this study show that the effect is positive and significant at the 1 percent level in Uganda but negative and significant at 10 percent level in Tanzania. Some other studies show that credit constraints can affect rural development by preventing households from taking up non-agricultural activities (Boucher *et al.*, 2009).

The impact of age on agricultural productivity is positive and significant at the 10 percent in Uganda but not in Tanzania. Older farmers in Uganda have higher productivity compared to young farmers. Similarly, Ali *et al.* (2014) shows that in Rwanda, age squared is significant and negative at the 10 percent level. Our result in Tanzania shows that young farmers do better in agricultural productivity compared to the older farmers. This is similar to the findings of Dong *et al.* (2012) for China. Gender does not seem to be important to agricultural productivity in either country. However, some other studies show that female farmers tend to have limited access to resources and thus low productivity (Karamba and Winters, 2015). Shocks affect Tanzania than Uganda, at the 10 percent level; this is positively correlated with agriculture productivity.

Education affects agricultural productivity negatively and significantly in Tanzania at the 5 percent level but does not affect agricultural productivity in Uganda. In some cases, more educated household heads would engage in non-farm activities and spend less time on the farm. Therefore, there is an opportunity cost of working on the farm for educated households. Similarly, durable goods affect agricultural productivity positively but not significantly in both countries. Durables are important for informal sources of credit, especially for rural households who do not have collateral. In Uganda, the dependency ratio is negative; this variable is positive in Tanzania but not significant at the 10 percent level. Households with a higher dependency ratio tend to have more family responsibilities; therefore some of the members of the family could involve themselves on the farm. A higher dependency ratio can also result in more non-farm work to supplement the household's agricultural income. Extension services are positive and significant at the 1 percent level in Uganda, while in Tanzania, they are negative and significant at the 10 percent level. There results show that extension services have not been effective in helping farmers increase agricultural productivity in Tanzania, while they have in Uganda.

7. Conclusion

In this paper, we examined the effect of credit on agricultural productivity in East Africa, as well as efficiency losses in agriculture. In East Africa, credit constraints are widespread and affect the efficiency of agricultural production, as well as the likelihood of participating in higher return non-farm economic activities. The results show that households' decision to borrow each year affects agricultural productivity in both countries. In Uganda, the decision to borrow from different sources each year increases agricultural productivity significantly. In addition, borrowing from formal and semi-formal sources increases agricultural productivity. These results are in comparison to Tanzania, where the use of credit decreases agricultural productivity. Similarly, households that use credit in Uganda gain in efficiency compared to Tanzania.

In both countries, agricultural productivity is affected by farm size, extension services, and non-farm income. Other variables that affect agriculture productivity include shocks and education; in Uganda, age is also important, mainly for households interested in formal and semi-formal loans.

A key policy recommendation is to look at why formal and semi-formal credit seems to have a significant effect on agricultural productivity in East Africa, especially in Tanzania compared to Uganda. This could explain why most of the households in the rural areas still use informal credit. A second recommendation would be to look at ways in which households can stop reducing their farm size, as this affects agricultural productivity. Thirdly, policymakers need to see how extension services can be used to help farmers increase their agricultural productivity. Finally, rather than focusing on credit in rural areas, perhaps the best way to increase agricultural productivity would be to have incentives that enhance household labor participation in agriculture.

References

Adjognon, S. G., S. O. L.Tasie, and T. A. Reardon. 2017. "Agriculture input credit in Sub-Saharan Africa: Telling myth from facts." *Food Policy* 67:93-105.

African Union (AU). 2003. "Maputo Declaration on Agriculture and Food Security." Available at: http://www.nepad.org/nepad/knowledge/doc/1787/maputo-declaration

_____. 2014. "Decisions, Declarations, and Resolution of the Assembly of the Union Twenty-Third Ordinary Session." Available at: http://www.au.int/en/content/ malabo-26-27-june-2014-decisions-declarations-and-resolution-assembly-union-twenty-third-ord

Akudugu, M. A. 2016. "Agricultural productivity, credit and farm size nexus in Africa: a case study of Ghana." *Agricultural Finance Review* 76(2): 288-308. Available at https://doi.org/10.1108/AFR-12-2015-0058

Ali, D.A., K. Deininger, and M. Duponchel. 2014. "Credit Constraints, Agricultural Productivity, and Rural Nonfarm Participation: Evidence from Rwanda." *The Journal of Development Studies* 50(5): 649-665.

Asfaw, S., B. Shiferaw, F. Simtowe, and L. Lipper. 2012. "Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia." *Food Policy* (37)3: 283–295.

Barrett, C. B., P. Christian, and B. S. Shiferaw. 2017. "The structural transformation of African agriculture and rural spaces: introduction to a special section." *Agricultural Economics* 48(S1): 5-10.

Barrett, C. B., M. F. Bellemare, and J. Y. Hou. 2010. "Reconsidering Conventional Explanations of the Inverse Productivity–Size Relationship." *World Development* 38(1):88-97.

Barry, P. J. and L. J. Robison. 2001. "Agricultural finance: Credit, credit constraints, and consequences." *Handbook of agricultural economics* 1: 513-571.

Boucher S., Guirkinger, C., and C. Trivelli. 2009. "Direct elicitation of credit constraints: conceptual and practical issues with an application to Peruvian agriculture." *Economic Development and Cultural Change* 57(4): 609–640.

Carter, M.R., (1989). "The impact of credit on peasant productivity and differentiation in Nicaragua." *Journal of. Development. Economics* 103: 13–36.

Chayanov, A. V. 1965. *Peasant Farm Organization.* Homewood, IL: Richard Irwin Press.

Davis, K., E. Nkonya, E. Kato., D. A. Mekonnen, M. Odendo, and R. Miiro. 2012. "Impact of Farmer Field Schools on Agricultural Productivity and Poverty in East Africa." *World Development* 40 (2): 402–413.

Diagne, A., M. Zeller, and M. Sharma. 2000. “Empirical measurements of households' access to credit and credit constraints in developing countries: methodological issues and evidence.” Food Consumption and Nutrition Division Discussion Paper No. 90, International Food Policy Research Institute, USA.

Dong, F., J. Lu, and A. M. Featherstone. 2012. "Effects of credit constraints on household productivity in rural China." *Agricultural Finance Review* 72(3): 402 – 415.

Dryden, S. 2015. “Smallholders Hold the Keys Africa’s Food and Nutrition Security.” In Eds. E. Zedillo, O. Cattaneo, and H. Wheeler, *Africa at a Ford in the Road. Taking Off or Disappointment once again?* Yale Centre for the Study of Globalization.

Feder, G., L. J. Lau, J. Y. Lin, and X Luo. 1990. “The relation between credit and productivity in Chinese agriculture: A model of disequilibrium.” *American Journal of Agricultural Economics*.72(5): 1151–1157.

Fidrmuc, J., P. Ciaian, D. A. Kancs, and J. Pokrivcak. 2013. “Credit constraints, heterogeneous firms and loan defaults.” *Annals of Economics and Finance* 14(1): 53-68.

Fletschner, D., C. Guirkinger, and S. Boucher. 2010. “Risk, Credit Constraints and Financial Efficiency in Peruvian Agriculture.” *Journal of Development Studies* 46(6):981-1002.

Giné, X. 2011. “Access to capital in rural Thailand: An estimated model of formal vs. informal credit.” *Journal of Development Economics* 96:16–29.

Guirkinger, C. and S. R. Boucher. 2008. “Credit constraints and productivity in Peruvian agriculture.” *Agricultural Economics* 39: 295-308.

Hussain, A. and G. B. Thapa. 2012. “Smallholders’ access to agricultural credit in Pakistan.” *Food Security* 4(1): 73-85.

Jappelli, T. 1990. “Who is credit constrained in the U.S. economy?” *Quarterly Journal of Economics* CV (1): 219–234.

Karamba, R. W. and P. C. Winters. 2015. “Gender and agriculture productivity: implication of farm input subsidy program in Malawi.” *Agriculture Economics* 46(3): 357-374.

Karlan, D., R.Osei, I. O.Akoto, and C. Udry. 2014. “Agricultural decisions after relaxing credit and risk constraints.” *The Quarterly Journal of Economics* 129 (2): 597-652.

Khandker, S. R. and R. R. Faruqee. 2003. “The impact of farm credit in Pakistan.” *Agricultural Economics* 28(3): 197-213.

Kumar, C. S., C. G. Turvey, and J. D. Kropp. 2015. “The Impact of Credit Constraints on Farm Households: Survey Results from India and China.” *Applied Economic. Perspective Policy* 35(3): 508-527.

Lori B., D. Karlan, B. Thuysbaert, and C. Udry. 2014. "Self-Selection into Credit Markets: Evidence from Agriculture in Mali." NBER Working Paper No. 20387. National Bureau of Economic Research, 1050 Massachusetts Ave., Cambridge.

Mukasa, A. N., A. M. Simpasa, and A. O. Salami. 2017. "Credit constraints and farm productivity: Micro-level evidence from smallholder farmers in Ethiopia." ADB Working Paper Series No. 247. Abidjan, Côte d'Ivoire: African Development Bank.

Peacock, C., A. Jowsett, A. Dorward, C. Poulton, and I. Urey. 2004. "Reaching the Poor, A Call to Action: Investment in Smallholder Agriculture in sub-Saharan Africa." FARM-Africa, Harvest Help, and Imperial College London.

Reyes, A. and R. Lensink. 2011. "The Credit Constraints of Market-Oriented Farmers in Chile." *Journal of Development Studies* 47(12): 1851-1868.

Sara, S. and P. L. Scandizzo. 2017. "Farm Size and Productivity A "Direct-Inverse-Direct" Relationship." World Bank Policy Research Working Paper 8127. Washington DC: World Bank.

Salami, A., A. B. Kamara, and Z. Brixiova. 2010. "Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities." African Development Bank Working Group Working Paper Series No. 105. Abidjan, Côte d'Ivoire: African Development Bank.

Singh, I., L. Squire, and J. Strauss. 1986. *Agricultural Household Models*. Baltimore: Johns Hopkins University Press.

Stiglitz, J. and Weiss, A. 1981. "Credit rationing in markets with imperfect information." *America Economic Review* 73(3): 383–410.

Udry, C. 2015. "Finance Market, Investment and Productivity in African Agriculture." In Eds. E. Zedillo, O. Cattaneo and H. Wheeler, *Africa at a Ford in the Road. Taking Off or Disappointment once again?* Yale Centre for the Study of Globalization.

Vance, C. and Geoghegan, J. 2004. "Modeling the determinants of semi-subsistent and commercial land uses in an agricultural frontier of southern Mexico: A switching regression approach." *International Regional Science Review* 27(3): 326-347.

Zedillo, E. 2015. "Overview." In Eds. E. Zedillo, O. Cattaneo and H. Wheeler, *Africa at a Ford in the Road. Taking Off or Disappointment once again?* Yale Centre for the Study of Globalization.

Appendix 1: Tanzania and Uganda Sampled regions

Tanzania	**Uganda**			
Dodoma	Kisoro	Adjumani	Arua	Bukomansimbi
Arusha	Kitgum	Alebtong	Arua	Bukwo
Kilimanjaro	Mpigi	Amolatar	Budaka	Bulambuli
Tanga	Mubende	Amudat	Bududa	Buliisa
Morogoro	Mukono	Amuria	Bugiri	Bundibugyo
Pwani	Masaka	Amuru	Buhweju	Bushenyi
Dar Es Salaam	Nakapiripirit	Apac	Buikwe	Busia
Lindi	Nakaseke	Kabale	Bukedea	Butaleja
Mtwara	Nakasongola	Kabarole	Koboko	Buvuma
Ruvuma	Namayingo	Kalangala	Kole	Buyende
Iringa	Sironko	Kaliro	Kotido	Bukomansimbi
Mbeya	Soroti	Kalungu	Kumi	Dokolo
Singida	Ssembabule	Kampala	Kyankwanzi	Gomba
Tabora	Tororo	Kamuli	Kyegegwa	Gulu
Rukwa	Wakiso	Kamwenge	Kyenjojo	Gomba
Kigoma	Yumbe	Kanungu	Kalanga	Gulu
Shinyanga	Zombo	Kapchorwa	Lamwo	Hoima
Kagera	Masindi	Kasese	Lira	Ibanda
Mwanza	Mayuge	Katakwi	Luuka	Iganga
Mara	Mbale	Kayunga	Luweero	Isingiro
Manyara	Namutumba	Kibaale	Lwengo	Iganga
Kaskazini Unguja	Napak	Kiboga	Lyantonde	Jinja
Kusini Unguja	Nebbi	Kibuku	Manafwa	Kaabong
Mjini/Magharibi Unguja	Ngora	Kiruhura	Maracha	Mbarara
Kaskazini Pemba	Ntoroko	Kiryandongo	Masaka	Mitooma
Kusini Pemba	Ntungamo	Mitooma	Rubirizi	Mityana
	Namayingo	Gulu	Rukungiri	Moroto
	Iganga	Apac	Serere	Moyo
	Kampala	Bushenyi	Sheema	Otuke
	Kiruhura	Busia	Amolatar	Oyam
	Kiryandongo	Buyende	Rakai	Pallisa
	Mbarara			

Appendix 2: Correlation matrix for Uganda

	Value	Farmz	Ladays	Loans	Wages	Deps	Adults	Animals	Durables	Titles	Netwk	Maize	Sorghum	Beans	Nuts	Cassava
Value of harvest	1															
Farm size	-0.0020	1														
Labour days	0.0078	0.0510	1													
Value of loans	-0.0010	-0.0046	-0.0185	1												
Wages	0.0023	0.0608	0.2275	-0.0021	1											
Dependency Ratio	0.0015	-0.0196	0.0711	-0.0087	0.0111	1										
Adults with job	0.0055	0.0147	0.0880	-0.0027	0.0141	0.0917	1									
Number of animals	-0.0001	0.0001	-0.0007	-0.0003	-0.0003	-0.0035	0.0024	1								
Number of durables	0.0007	0.0081	0.0215	-0.0053	0.0284	-0.0020	0.0248	0.0003	1							
Title deeds	0.0019	0.0174	0.1265	0.0032	0.0710	0.0190	0.0310	-0.0012	0.0074	1						
Network	-0.0058	-0.0251	-0.0560	0.0291	0.0357	-0.0405	-0.0048	0.0002	0.0418	0.0290	1					
Maize	0.0009	-0.0001	-0.0001	0.0001	-0.0001	-0.0007	-0.0025	0.0000	-0.0004	-0.0004	-0.0002	1				
Sorghum	-0.0002	-0.0007	-0.0024	-0.0003	-0.0008	-0.0043	0.0004	0.0000	-0.0009	-0.0006	-0.0033	0.0000	1			
Beans	-0.0007	0.0226	0.0956	-0.0072	0.0043	0.0420	0.0211	-0.0015	0.0050	0.0271	0.0195	-0.0004	-0.0018	1		
Groundnuts	-0.0004	-0.0054	0.0918	0.0004	0.0170	0.0252	0.0120	-0.0015	0.0015	0.0339	0.0190	-0.0004	-0.0018	-0.0877	1	
Cassava	-0.0010	-0.0024	0.0238	0.0072	0.0100	-0.0033	0.0051	0.0003	0.0067	0.0222	0.0026	-0.0001	-0.0003	-0.0163	-0.0161	1

Appendix 3: Correlation matrix for Tanzania

	Value	Farmz	Ladays	Loans	Wages	Deps	Adults	Animals	Durables	Titles	Netwk	Maize	Paddy	Sorghum	Cassava	Beans	Bananas
Value of harvest	1																
Farm size	0.0065	1															
Labour days	0.0688	0.2991	1														
Value of loans	-0.0036	-0.0182	-0.0281	1													
Wages	0.0793	0.2316	0.1993	-0.0073	1												
Dependency Ratio	0.0306	0.0866	0.1013	-0.0328	0.0536	1											
Adults with job	-0.0101	-0.0135	0.0105	-0.0121	-0.0226	-0.1831	1										
Number of animals	0.0009	0.0088	0.0071	-0.0008	0.0035	-0.0008	0.0021	1									
Number of durables	0.0003	0.0149	0.0259	0.0134	0.0059	-0.0276	0.0216	0.0032	1								
Title deeds	0.0395	0.2866	0.4416	-0.0368	0.096	0.0276	0.0561	0.0164	0.0469	1							
Network	-0.025	-0.0928	-0.1287	0.1112	-0.0429	-0.1411	0.0307	-0.0034	0.0204	-0.1432	1						
Maize	0.0169	0.209	0.2689	-0.0266	0.102	0.1053	-0.0286	0.0072	0.0124	0.3971	-0.133	1					
Paddy	0.0518	0.0572	0.1981	-0.0141	0.1008	0.0624	-0.016	0.0033	0.0045	0.156	-0.0647	-0.0529	1				
Sorghum	0.0103	0.0631	0.0951	-0.0086	0.003	0.0389	-0.0103	0.0007	0.0034	0.1407	-0.0407	-0.0301	-0.0155	1			
Cassava	0.0169	0.0547	0.2623	-0.0153	0.038	0.0449	-0.0045	0.0002	0.0069	0.211	-0.0583	-0.0596	-0.0306	-0.0174	1		
Beans	0.0243	0.0266	0.1275	-0.0077	0.0209	0.0427	0.0013	0.0007	0.006	0.1173	-0.0409	-0.0276	-0.0142	-0.0081	-0.016	1	
Bananas	0.0297	0.0267	0.154	-0.0088	0.0471	0.0515	-0.0167	0.0004	-0.0018	0.1216	-0.0404	-0.0338	-0.0173	-0.0099	-0.0195	-0.009	1

Appendix 4: Tanzania-Level (Dependent variable-Value of harvest in dollars)

	OLS		Random Effects		Fixed Effects		2SLS		2LS Fixed Effects	
Yield(Dependent variable)	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err**	**Coef.**	**Std. Err**	**Coef.**	**Std. Err**	**Coef.**	**Std. Err**
Borrower	-0.41	3.52	-0.41	3.52	0.70	5.66	0.22	1.09	-1.05	1.62
Farm size ha	-0.18	0.14	-0.18	0.14	-0.16	0.22	-0.18	0.13	-0.16	0.22
Total wages dollar	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03
Total labour days	-0.01	0.02	-0.01	0.02	0.00	0.03	-0.01	0.02	0.00	0.03
Loan value dollar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dependency Ratio	-1.90***	0.64	-1.90***	0.64	-1.83*	1.01	-1.90***	0.64	-1.84*	1.01
Total livestock owned	0.00	0.01	0.00	0.01	0.01	0.08	0.00	0.01	0.01	0.08
Age	-0.38***	0.07	-0.38***	0.07	-0.67***	0.11	-0.38***	0.07	-0.67***	0.11
Age squared	0.00***	0.00	0.00***	0.00	0.01***	0.00	0.00***	0.00	0.01***	0.00
Durables	-0.01	0.03	-0.01	0.03	0.00	0.05	-0.01	0.03	-0.01	0.05
Education	0.05	0.08	0.05	0.08	0.18	0.13	0.05	0.08	0.18	0.13
Extension Services	1.20	2.29	1.20	2.29	1.10	4.25	1.15	2.28	0.66	4.23
Male	0.89	0.58	0.89	0.58	0.75	1.03	0.88	0.57	0.74	1.03
Shock	1.31**	0.61	1.31**	0.61	1.48	2.16	1.30**	0.60	1.44	2.16
Other income source	3.02***	1.07	3.02***	1.07*	5.33	1.64	3.01***	1.07	5.31***	1.64
Rural	-0.45	0.67	-0.45	0.67	-0.57	0.95	-0.48	0.66	-0.63	0.94
Maize	10.12***	1.71	10.12***	1.71***	11.00	2.43	10.14***	1.70	11.12***	2.43
Paddy	9.55***	1.87	9.55***	1.87***	10.82	2.79	9.57***	1.87	10.91***	2.79
Sorghum	8.80***	2.19	8.80***	2.19***	9.61	3.32	8.83***	2.18	9.76***	3.32
Cassava	10.97***	1.77	10.97***	1.77***	13.01	2.58	10.98***	1.77	13.14***	2.58
Beans	5.30***	1.81	5.30***	1.81**	5.53	2.61	5.29***	1.80	5.54**	2.61
Bananas	7.32***	1.83	7.32***	1.83	8.17	2.81	7.32***	1.83	8.25***	2.81
Other crops	10.00	1.79	10.00	1.79***	9.67	2.55	10.00***	1.79	9.80***	2.55
Title deed ownership	-0.41	1.04	-0.41	1.04*	-2.77	1.53				

Network	-0.74	4.26	-0.74	4.26	1.97	6.91				
Constant	-5.86	4.86	-5.86	4.86	-6.30	14.77	-6.45**	3.09	-4.41	12.96
Year					Yes				Yes	
Regions					Yes				Yes	
Hausman test					91.74	0.000			91.74	0.000
R2	0.02		0.02		0.01		0.02		0.01	
First Stage F(2,6326)							32762.3***	0.000		
Endogenous Wu-HausmanF(1,6326)							0.03			
Over id (Sargan (score) chi2(1))							0.16			
Observation	6,351		6,351		6272		6,351		6272	
Groups			2580		2550				2550	

***,** and * significant at the 1,5 and 10 percent level.

Appendix 5: Uganda-Level (Dependent variable-Value of harvest in dollars)

	OLS		Random Effects		Fixed Effects		2SLS		2SLS Fixed Effects	
Variables	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Total land owned ha	-0.86*	0.50	-0.68	0.60	-0.69	0.61	-0.27	0.52	-0.65	0.63
Total labour days	0.19***	0.04	0.00	0.05	-0.02	0.05	0.17***	0.04	-0.02	0.05
Value of loan dollars	-0.01	0.04	-0.06	0.04	-0.06	0.05	0.39***	0.12	-0.04	0.12
Total wages dollars	0.07	0.13	-0.20	0.19	-0.25	0.19	0.11	0.13	-0.21	0.21
Dependency Ratio	1.49	9.23	33.76	33.05	0.00	(omitted)	-21.15*	11.40	0.00	(omitted)
Adults with jobs for past yr	18.07***	5.61	-3.23	7.13	-5.59	7.36	10.77*	5.99	-5.95	7.44
Number of animals owned	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of durables	0.92	2.06	-1.24	2.06	-1.38	2.06	-0.93	2.11	-1.45	2.07
Maize	1105.66	1763.37	964.34	1655.32	955.12	1655.14	1571.53	1776.76	975.56	1658.06
Sorghum	-57.91	440.86	-96.36	419.39	-98.63	420.99	15.88	443.44	-101.62	421.38
Beans	-9.20	9.75	-48.87***	11.03	-50.90***	11.17	21.66	13.16	-50.43***	11.18
Groundnuts	-7.91	9.81	-34.01***	11.16	-36.11***	11.30	24.12*	13.40	-36.31***	11.40
Cassava	-41.14	48.31	-479.37***	54.77	-503.55***	55.47	-35.61	48.56	-505.60***	56.40
Bananas	-60.83	719.90	-206.72	675.90	-213.92	675.85	55.61	724.12	-207.01	675.88
borrower	-6.58	8.06	-30.84***	10.14	-33.17***	10.44	-545.54***	149.42	-71.81	178.91
Title deed ownership	5.55	7.48	23.83***	9.19	24.23***	9.40				
Network	-118.88***	33.14	41.52	52.67	60.50	55.39				
Constant	21.50	11.28	44.21	30.11	65.70	44.20	104.11***	26.95	78.18	60.48
Years			Yes		Yes				Yes	
Region			Yes		Yes				Yes	
Haus test					24.55					
First Stage							660.30***			
Endogenous							13.01***			
Overid							0.15			
Number of Observations	6887		6805		6805		6887		6805	
Groups			2759		2759				2759	

***,** and * are significant at the 1,5 and 10 per cent level respectively

AGRODEP Working Paper Series

0026. Informal Trade and the Price of Import Bans: Evidence from Nigeria. Sami Bensassi, Joachim Jarreau, and Cristina Mitaritonna. 2016.

0027. The European Union's and United States of America's Non–Tariff Measures: Impacts on African Exports. Kareem, Olayinka Idowu. 2016.

0028. An Exploration of the Determinants of Bribery in Benin's Transborder Trade. Sami Bensassi, Joachim Jarreau, and Cristina Mitaritonna. 2016.

0029. Natural Resource Curse in Africa: Dutch Disease and Institutional Explanations. Richard Mulwa and Jane Mariara. 2016.

0030. Have Migrant Remittances Influenced Self-Employment and Welfare among Recipient Households in Nigeria? Kabir Kayode Salman. 2016.

0031. Does Distance Still Matter for Agricultural Trade? Christian Ebeke and Mireille Ntsama Etoundi. 2016.

0032. Analyzing Trade Integration in North African Markets: A Border Effect Approach. Houssem Eddine Chebbi, Abdessalem Abbassi and Lota D. Tamini. 2016.

0033. Trade Performance and Potential of North African Countries: An Application of a Stochastic Frontier Gravity Model. Lota D. Tamini, Houssem Eddine Chebbi and Abdessalem Abbassi. 2016.

0034. Determinants of Cross-Border Informal Trade: The Case of Benin. Sami Bensassi, Joachim Jarreau, and Cristina Mitaritonna. 2016.

0035. The Welfare Effects of ICTs in Agricultural Markets: A Case of Selected Countries in East Africa. Mercyline Kamande and Nancy Nafula. 2016.

0036. Does an Inorganic Fertilizer Subsidy Promote the Use of Organic Fertilizers in Nigeria? Reuben Adeolu Alabi, Oshobugie Ojor Adams, and Godwin Abu. 2016.

0037. Why Can't MENA Countries Trade More? The Curse of Bad Institutions. Reuben Fida Karam and Chahir Zaki. 2016.

0038. Female Labor Outcomes and Large-scale Land Investments in Tanzania. Evans S. Osabuohien, Raoul Herrmann, Uchenna R. Efobi, and Ciliaka M. W. Gitau. 2016.

0039. Assessing the Impact of Rice Sector Policy Reforms on the Income Mobility of Rural Households in Nigeria. Henry Okodua. 2017.

0040. Credit Constraints and Agricultural Productivity in Developing Countries: The Case of East Africa. Bethuel Kinyanjui Kinuthia. 2018.