



# The impact of credit constraints on agricultural productivity in Tanzania

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Baraka Msulwa

For the farmer

# The impact of credit constraints on agricultural productivity in Tanzania

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## **Abstract**

This paper uses a nationally representative sample of agricultural businesses in Tanzania to empirically investigate the determinants of credit constraint status and its impact on agricultural productivity. In particular, we directly elicit the nature of the credit constraints experienced by crop producers. Subsequently, we evaluate the effect on crop output value per hectare using an endogenous switching regression model, which simultaneously estimates the likelihood of being credit constrained and its impact on productivity. The results provide evidence that the relaxation of all credit constraints would significantly enhance agricultural productivity; hence, contributing favourably to rural development, poverty alleviation, and the improvement of living standards in Tanzania. Moreover, consideration of only quantity constraints was shown to underestimate the full impact of credit constraint status in the presence of transaction costs and risk constraints. We advocate for the Tanzanian agricultural policy framework to adopt a broader definition of credit constraint status in pursuit of agricultural and economic development.

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## **Glossary of relevant acronyms**

AITF	Agricultural Input Trust Fund
AgFims	Agricultural Finance Market Scoping Survey
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
DEM	Direct Elicitation Method
FAO	Food and Agriculture Organization
FAOSTAT	FAO Statistics Division
FINCA	Foundation for International Community Assistance
FSDT	Financial Sector Deepening Trust
MoAFSC	Ministry of Agriculture, Food Security, and Cooperatives
MoF	Ministry of Finance
MoFEA	Ministry of Finance and Economic Affairs
NAP	National Agricultural Policy
NBS	National Bureau of Statistics
OECD	Organization for Economic Co-operation and Development
PRIDE	Promotion of Rural Initiatives and Development Enterprise
ROSCA	Rotating Savings and Credit Association
SACCOS	Savings and Credit Cooperative Societies
SIDO	Small Industries Development Organization
TADB	Tanzania Agricultural Development Bank
TIB	Tanzania Investment Bank
TNBC	Tanzania National Business Council
TNFCI	Tanzania National Council for Financial Inclusion
TZS	Tanzanian Shilling
UNCTADStat	UN Conference on Trade and Development Statistics
URT	United Republic of Tanzania
USD	United States Dollar
VICOBA	Village Community Bank
VSLA	Village savings and loans associations

# **Chapter 1. Introduction**

## **1.1 Background**

In Tanzania, living standards are inextricably linked to agricultural development, however the performance of the agricultural sector has been steadily deteriorating over time. Around three quarters of the labour force are involved in the sector, typically on a semi-subsistence basis; and a substantial portion of aggregate economic output and export activity is attributable to agricultural activity. The importance of the sector is indisputable, however its development has been persistently constrained by underinvestment; sustained by uncertainty and instability in the broader economy, in addition to concerns about the real and perceived risks of rural sector activity.

The allocation of commercial credit to agricultural activity has been relatively low as compared to other sectors of the economy. Credit rationing and the proliferation of short-term loan facilities, with limited offerings for medium to long-term capital, characterize the Tanzanian agricultural financing landscape. Commercial banks account for the largest share of disbursements to the sector; and informal and semiformal financial institutions such as family and friends, savings and credit groups, and microfinance institutions play a significant role in the provision of credit. The livelihoods of agricultural households are directly related to their farm activity, which may be influenced by their access to credit. Hence, the consideration of credit constraint status and its effects on the productivity of agricultural producers presents an opportunity to clearly define and address the economic development challenges of Tanzania.

The agricultural policy framework aims to guide the efforts and resources of Tanzania towards the sustainable eradication of poverty and the improvement of living standards over the long term, by creating an enabling and conducive policy environment for enhanced activity in the sector. The government's role will be critical to improve the capacity and coordination efforts of financial institutions and intermediaries in order to enhance awareness, access, and accessibility of finance to farmers. The collaborative efforts of private and public stakeholders will be required in order to advance the agricultural sector towards being a modern, commercial driver of the economy, which is efficient, productive, and competitive.

## **1.2 Problem statement**

The implications of credit rationing in developing markets with imperfect information have been investigated in theoretical credit market literature; which postulates that imperfect and costly information and enforcement induces the suppliers of loanable funds to ration credit despite the presence of excess demand (Stiglitz and Weiss 1981, Jaffee and Stiglitz 1990). Consequently, the inefficient allocation of capital resources and the resultant underinvestment in the economy are expected to ensue and persist. Hence, credit rationing as an equilibrium phenomenon presents a departure from the classical economics argument that an equilibrium price is expected to clear the market and ensure an efficient allocation of resources when supply equates to demand.

The agricultural household model provides theoretical insights into the simultaneous consumption and production decisions made by semi-commercial agricultural households (Singh et al 1986; Sadoulet and de Janvry 1995). In particular, the implications of an agricultural household's credit constraint status may be coherently modeled to account for decisions at the farm and household levels, respectively. The literature posits that unconstrained households are able to separate these decisions, while constrained households tend to exhibit non-separability in their decision-making. Non-separability may result in the consumption and production needs of a household competing for liquid capital resources, while separability enables decisions to be made independently and optimally (Foltz 2004).

In their seminal paper, Feder et al (1990) postulate that rationing in credit markets may result in liquidity being a binding constraint on agricultural productivity. As a result of the biological lag arising from the transformation of inputs obtained at the start of the production period into agricultural outputs yielded at the end of the production cycle, there is a timing mismatch between when capital is required and when the returns on agricultural activity are realized. The quality and volume of agricultural inputs available to a producer may be constrained by the extent of access to credit. Hence, it is expected that improvements in agricultural productivity and farm incomes will be limited by inadequate finance towards productive inputs, land, and physical capital. Further, financing constraints hamper the adoption of modern technologies, which may enhance agricultural activity. Access to credit, in addition to the initial endowment available to an agricultural household, would address the funding gap experienced by agricultural businesses and enable essential investments in working capital and critical factors of production.

The productivity and welfare of Chinese agricultural households was found to be enhanced by increased access to credit, albeit the findings suggested that farm credit was disproportionately allocated toward consumption and investment activities (Feder et al 1990). Petrick (2002; 2004) found that the provision of interest rate subsidies by the government significantly and positively enhanced agricultural production of Polish farms. In Tanzania, Winter-Nelson and Temu (2005) found that enhanced access to credit had a significant impact on agricultural production volumes for coffee farmers that self-identified as liquidity constrained; further, contributing to the alleviation of poverty. Moreover, Foltz (2004) found that credit rationing in Tunisia negatively impacted farm profitability. However, Diagne and Zeller (2004) found that access to microcredit did not improve the welfare of agricultural households in Malawi. Guirkinger and Boucher (2008) found that the elimination of credit constraints, using a broader definition that acknowledges transaction and risk constraints, in addition to quantity constraints, would significantly enhance the productivity of agricultural households in Peru. In Rwanda, Ali et al (2014) made use of a broader definition of credit constraint status and found that the relaxation of credit constraints would significantly enhance agricultural productivity.

Evidence on the agricultural productivity impacts of credit constraint status has been extensively documented, however the empirical approaches adopted by the respective studies are largely inconsistent in their methodological approach and operationalization of credit constraints. Additionally, while empirical studies have focused adequately on credit rationing in developing markets, there has been limited research undertaken on credit rationing in the context of Tanzania.

### **1.3 Research questions and scope**

In view of the aforementioned background and research problem, this study raises the primary research question:

What is the impact of credit constraints on agricultural productivity in Tanzania?

In addressing the research question, this paper raises relevant policy recommendations that may improve farmers' access to credit as a means to enhance agricultural productivity and address the development goals of Tanzania. Hence, this paper poses the ancillary question:

What are the relevant policy recommendations that can enhance smallholder farmers' access to credit financial services?

This paper will undertake a comprehensive and robust study by investigating various specifications in the econometric estimation of the impact of credit constraint status on agricultural productivity and further, by adopting various definitions of the credit constraint status prevalent in the empirical credit rationing literature. We are particularly interested in agricultural activity within the current production period; as such, the implications of our findings are interpretable within the context of a 12-month period. Hence, the medium to long-term implications of intertemporal choices are not evaluated in the context of the current research. Further, an evaluation of the policy implications proposed by this study is beyond the scope.

### **1.4 Research hypothesis**

The null hypothesis for the study is:

$H_0$ : There is no relationship between the credit constraint status and productivity of agricultural businesses in Tanzania.

Which will be tested against the alternative hypothesis:

$H_1$ : Constrained agricultural businesses in Tanzania have a lower productivity than unconstrained agricultural businesses.

## 1.5 Purpose and significance of the study

In this paper we investigate the determinants of credit constraint status and its impact on agricultural productivity, with a particular focus on Tanzanian crop producers. We contribute to the empirical credit rationing literature by using a nationally representative sample of Tanzanian agricultural businesses to evaluate whether credit constraints adversely impact farm productivity. The investigation is based on a cross-sectional dataset of 3,374 agricultural businesses surveyed in 2011.

This paper has implications for agricultural policy makers with interests in advancing agricultural development, financial institutions and private stakeholders with interests in undertaking agricultural investments, and farmers with interests in enhancing agricultural productivity *inter alia*.

The direct elicitation method is used to delineate the credit constraint status of agricultural businesses (Boucher et al 2009; Guirkingner and Boucher 2008). Thereafter, an investigation into its impact on productivity is undertaken using an endogenous switching regression model (Feder et al 1990, Lokshin and Sajaia 2004). We evaluate the treatment effects of the output equation in order to analyze the extent and significance of the relationship between credit constraint status and agricultural productivity (Di Falco et al 2011; Asfaw et al 2012).

In summary, the results show that credit constraint status has a significant impact on agricultural productivity that appears robust across different definitions of credit constraints and specifications. In particular, it is found that unconstrained agricultural businesses earn more than constrained businesses, while borrowers earn more than non-borrowers. The findings suggest that the relaxation of credit constraints may result in constrained agricultural businesses improving their productivity by approximately TZS 793,367 per hectare or 192%.

An examination of the likelihood of being credit constrained reveals that businesses that were located in urban areas, held a title deed, or received a government input subsidy were less likely to be constrained. Further, agricultural business owners that completed higher levels of education and had more dependents are less likely to be constrained. On the contrary, the likelihood of experiencing credit constraints is increased for older agricultural business owners that hold savings, own storage or warehouse facilities, or obtained advice from the government or farming associations.

The estimated treatment effects show that, on average, credit constraint relaxation has a larger impact on those businesses that are actually credit constrained, whereas agricultural businesses observed as unconstrained would not benefit commensurately. Further, we find insufficient evidence to suggest that unconstrained businesses are better producers than their constrained counterparts.

Finally, a comparison of treatment effects across constraint definitions suggests that the impact of credit constraints may be underestimated by an examination of quantity constraints only, i.e. when transactions costs and risk constraints are not taken into account.

## **1.6 Organisation of the study**

This paper is organized in seven main chapters, including this introduction. In what follows, Chapter 2 contains a comprehensive review of the credit market literature and establishes the conceptual framework underlying our investigation. Chapter 3 presents stylized facts about the Tanzanian farm sector and rural credit market. Chapter 4 contains a thorough overview of the research approach and strategy that is used to analyze the determinants of credit constraint status and its impacts on agricultural productivity. Chapter 5 and 6 present the results and discussion, respectively, culminating in a summary of the findings and their policy implications; and Chapter 7 concludes the study.

## **Chapter 2. Literature review**

### **2.1 Introduction**

This chapter will provide a review of the literature on credit rationing, with a particular emphasis on developing markets. A thorough exposition of relevant key terms and definitions is undertaken in section two, in order to provide clarity and consistency on the concepts used in this study. In section three the causes, countermeasures, and consequences of credit rationing are explored within the framework of imperfect information; it is demonstrated that credit rationing is typically an equilibrium phenomenon. The theoretical framework underpinning the investigation into the behavior of and impacts on credit constrained agricultural households is outlined in the fourth section, where we provide motivations for the use of the production side of an agricultural household model to investigate the impact of credit constraints. In section five, relevant empirical literature is canvassed; the key objectives and significant findings are discussed. Various experiences of credit rationing and its effects on productivity are documented; and a brief summary of the salient points concludes the chapter.

### **2.2 Definitions and key concepts**

*Credit* involves an exchange of value or resources now for the promise of compensation later; this exchange may occur in the goods, services, or financial markets. The fundamental basis of credit is trust. Jaffee and Stiglitz (1990, p.838) remark on the heterogeneous nature of promises, making a comparison to the homogeneous nature of commodities in standard markets. In the latter, the exchange of value is typically simultaneous, whereas in credit markets the time lag between delivery of value and compensation presents opportunities for promises to be broken.

The sustainability of credit market activity depends on the credibility of the commitments undertaken and the fulfillment of the agreements set forth (Rao 2003, p.15). The determination of the likelihood that a promise will be kept is both an art and a science; the art of establishing the credibility of a potential borrower and the science of evaluating the degree of uncertainty associated with their activities. Thus, lenders oftentimes take mitigating actions to enhance the likelihood of fulfillment (Hoff and Stiglitz 1990).

Diagne and Zeller (2001, p.64) draw a distinction between *access* to credit and *participation* in credit. The former is concerned with the ability of a loan applicant to borrow from a particular source and the extent to which they can borrow, while the latter denotes the actual borrowing event. A borrower's access to credit is typically represented by a credit limit, while participation is implied by the loans outstanding. Non-borrowers are characterized by a lack of participation in credit, however we may not strictly infer a lack of access.

Access to credit is a necessary condition for participation in credit, however it is not sufficient. Conversely, participation in credit is not necessary to infer access to credit. The extent of participation is bounded by the extent of access, however the borrowing capacity of a loan applicant need not match the desired loan amount. A borrower may elect to borrow less than they are able to or they may desire to borrow more.

The term *credit rationing* is broadly characterized by an excess private demand for loanable funds (Petrick 2005, p.192). The definition of credit rationing may take on different forms based on the degree of persistence of excess demand and the factors inhibiting loan supply.

Stiglitz and Weiss (1981, p.365) and Jaffee and Stiglitz (1990, pp.848-849) provide structured expositions of two forms of credit rationing: pure credit rationing and redlining. *Pure credit rationing* describes circumstances wherein seemingly indistinguishable loan applicants, subject to the same terms of agreement, exhibit varying obtainability of loans. *Redlining* pertains to distinguishable groups of loan applicants. As the number of group classifications increases, with corresponding decreases in the number of borrowers in each group, the characteristics of redlining bear a resemblance to pure credit rationing.

Across groups of risk-classified loan applicants, variability in expected returns relative to the required return may influence the viability of loans. The required return of a lender is a function of the cost of loanable funds, which may serve as an implied hurdle rate for the extension of credit.

Both forms of credit rationing preclude the extension of loans to rejected applicants or an increase in the loan size to particular participants that desire more credit, even if a higher interest rate would be paid. Thus, the interest rate does not necessarily serve as a mechanism to clear the market.

Hence, credit rationing results in circumstances wherein potential borrowers lack access to credit or the extent of borrowers participation is limited; these circumstances are denoted by *credit constraints* (Feder et al 1990, p.1153). That is, the extent of participation may be constrained by the extent of access, for both non-borrowers and borrowers. While credit rationing describes a market-level phenomenon, credit constraints characterize the outcome of this phenomenon as experienced by economic agents.

## **2.3 Causes, countermeasures, and consequences of credit rationing**

### *Causes of credit rationing*

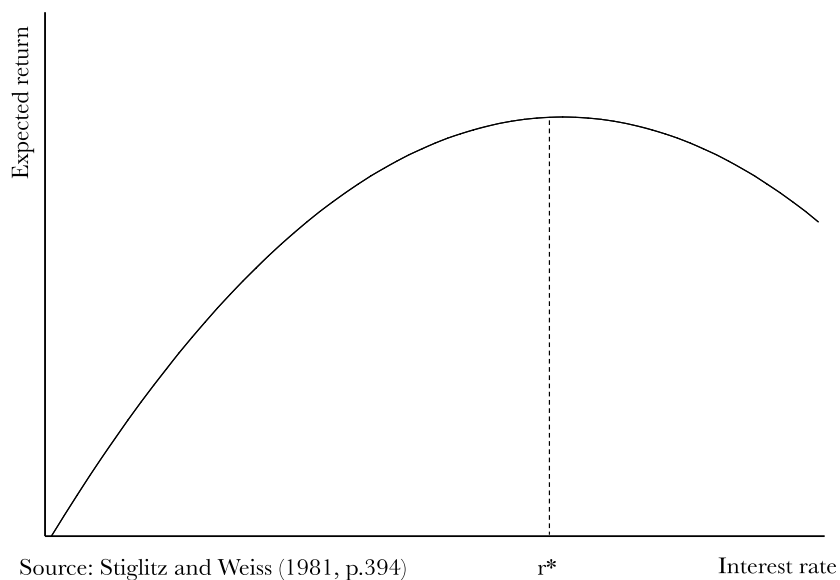
Classical economic analysis argues that the price of a good is determined through the interaction of supply and demand; and the equilibrium price is established where supply and demand equates. It is expected that an excess demand for a good would result in a greater willingness to pay, particularly at higher prices. Consequently, these higher prices are expected to entice suppliers to provide more goods and would iteratively be bid up to the point where supply equals demand at a new, higher equilibrium point.

Within the classical context, an excess demand for credit is expected to result in an increase in the price of credit (i.e. interest rate) up to the point where demand for credit and the supply of funds equate. In the absence of externalities, an efficient credit market is characterized by a lack of incentives to reallocate loans when an individual may be made better off while making another participant in the loan market worse off (Besley 1994, pp.29-30). A reallocation of credit would only occur if there were mutual gains to be achieved.

According to Stiglitz and Weiss (1981, pp.393-394) the price mechanism of interest rates has a direct impact on the demand for credit, while the supply of funds is indirectly impacted through the expected return to lenders. The expected return to a lender is a function of both the interest rate and the riskiness inherent in a loan.

Credit markets are subject to asymmetric information between lenders and loan applicants. Jaffee and Stiglitz (1990, p.850) posit that a lender's access to information, relating to the expected return and riskiness of a borrower's activity, may be constrained to an average account of the activities in the economy. The differential access to information, concerning the characteristics of borrowers' activities, is therefore expected to result in divergent appraisals of risk.

The relationship between the interest rate and the expected return is not necessarily monotonic; it can be observed that an increase in the former need not be matched by a commensurate increase in the latter (see Figure 1). A borrower's return on investment may be enhanced by increasing the riskiness of their activities, while the return that a lender expects to receive from a loan portfolio may be undermined by increases in the riskiness of individual loans. From the lenders perspective, the increased riskiness may result in an increase in a borrower's probability of default, which would counteract any gains from the higher interest rate.



**Figure 1. The relationship between interest rates and lender expected returns**

The optimal interest rate ( $r^*$ ) is the rate at which lenders maximize their expected returns; and beyond  $r^*$ , lenders would expect to receive a lower return. The optimal rate is not necessarily the price of credit where supply equals demand (i.e. the market clearing price), however it reflects the equilibrium rate.

Lenders perceive loan applicants that are willing to pay interest rates above  $r^*$  to represent more risk than the average loan at the optimal rate (Jaffee and Stiglitz 1990, pp.853-854). Hence, loans would not be extended over and above  $r^*$ . Lenders would find it in their interest to lower their interest rate from the market-clearing price to  $r^*$ , despite the optimal rate representing an excess demand for credit. Consequently, credit rationing characterizes markets where the market-clearing price and optimal interest rate are not equivalent; in particular, where the former exceeds the latter.

A lender's imprecision in understanding the particular characteristics of individual borrowers may result in the adverse selection of loan applicants (Besley 1994, p.35). Thus, lenders are faced with a screening problem whereby limited information presents challenges in identifying those potential borrowers who are more likely to repay.

The constrained information set available to a lender limits their understanding of the inherent risks of particular loans; and the interest charged to a pool of loan applicants is based on the average risk of the portfolio (Hoff and Stiglitz 1990, p.239). Individual borrowers, at a given interest rate, may conduct activities across different risk categories. Differential risk characteristics reflect differences in the likelihood that individual borrowers will settle their outstanding obligations, however it may be costly to obtain the relevant information to precisely furcate loan applicants.

Stiglitz and Weiss (1981, p.393) postulate that the interest rate may serve as a screening device, in addition to its role as the price of credit. Loan applicants that are engaged in high-risk activities may be willing to commit to pay higher interest rates, as they perceive their likelihood of repayment to be low. As the interest rate charged to a pool of loan applicants increases, those who perceive themselves to have lower risk relative to the average portfolio may voluntarily remove themselves from the credit market. As such, the composition of loan applicants may change adversely and the nature of activities undertaken may become riskier, potentially compromising a lender's expected return (Jaffee and Stiglitz 1990, p.858).

A lender is not able to directly monitor and control all the actions of a borrower due to the imperfect and costly nature of information. Consequently, a moral hazard or incentives problem arises as the ex post behavior of a borrower is likely to change following the extension of credit.

An increase in the interest rate may induce a borrower to pursue activities that would yield relatively higher returns, if successful (Stiglitz and Weiss 1981, pp.401-402). However, the probability of success of such activities is expected to typically be lower than similar activities with lower returns. While a lender's expected return is determined by considering the actions of a borrower in both a state of default and a state of success, a borrower is typically only concerned with the returns in the latter; as default may absolve the borrower of any obligations.

Therefore, an increase in the interest rate, to accommodate an excess demand for credit, may result in a misalignment of lenders' incentives and borrowers' interests. Hence, credit rationing is further reinforced by lenders' aversion to the inducement of adverse behaviour.

The enforcement problem arises in credit markets as a result of difficulties in compelling repayment. Hence, a legal framework that provides comprehensive guidance on legal enforcement is pivotal (Besley 1994, p.29). The costs and complexity of enforcement may deter lenders from supplying credit, further contributing to the persistence of credit rationing. Enforcement may further be undermined in contexts where legal recourse is limited or ineffective (Jaffee and Stiglitz 1990, pp.863-864).

### *Countermeasures*

Hoff and Stiglitz (1990, pp.237-241) identify various direct and indirect mechanisms to mitigate the risks associated with asymmetric information. Direct mechanisms place the burden on the lender for mitigating risks associated with the extension of credit. Indirect mechanisms place the responsibility and accountability for maintaining the terms of a loan contract with the borrower, while providing the lender with avenues for recourse in the event of default.

The cost implications of direct screening, monitoring and enforcement vary across different lenders, which could result in segmentation in credit markets. Informal lenders may face a low cost burden as a result of their close proximity to sources of information relating to borrowers' activities. On the contrary, formal lenders may find it difficult and costly to gain privy to such information.

The terms explicitly and implicitly specified by loan contracts may be designed as indirect mechanisms to attract applicants with low risks. Further, the stipulated terms are crafted to induce borrowers to align their interests with those of lenders; and settle their obligations as they fall due. Borrowers may be incentivized to avoid the reputational effects of default in order to ensure access to credit in the future.

The moderation of loan size has been suggested as an indirect mechanism to mitigate risky borrower behavior in markets with credit rationing. Jaffee and Stiglitz (1990, p.868) argue that in a context where a borrower's activities are indivisible, a smaller loan size may require that the borrower incur greater liability, however the larger risk exposure may induce adverse borrower behavior.

Increasing collateral requirements may have a positive incentive effect resulting from increased borrower liability; however this could be undermined by a negative selection effect (Stiglitz and Weiss 1981, pp.402-403). It is shown that the sorting effect of an increase in collateral may result in a sub-optimal expected return, under conditions where all individuals have the same utility. It is reasonable to assume that wealthier individuals are more capable of putting up higher collateral requirements; however, these individuals are expected to be less risk averse. Hence, an increase in collateral requirements may have the adverse effect of increasing the riskiness of a lender's loan portfolio.

### *Consequences*

A lender's response to imperfect and costly information and enforcement will be to persistently ration credit when demand exceeds supply, either by reducing the size of the loans that are extended or by rejecting loan applications outright. Jaffee and Stiglitz (1990, p.839) posit that the inefficient allocation of resources would thus result in less investment being made in an economy.

*Underinvestment* occurs when borrowers' private levels of investment are persistently lower than socially desirable levels (Petrick, 2005, p.192); while in the absence of market failures, private investment is consistent with the socially desirable investment required to realize the welfare goals of society. Access to quality information may enhance lenders' willingness to extend credit, which would have a favourable impact on lenders, borrowers, and the economy as a whole.

## 2.4 Conceptual Framework

The agricultural household represents a framework that effectively captures the coinciding consumption and production behavior of semi-commercial farm households. Singh et al (1986) and Sadoulet and de Janvry (1995) present comprehensive theoretical expositions of agricultural household models, which combine the microeconomic behavior of the household and the firm (or farm in this instance).

An agricultural household that has unconstrained access to credit, or a non-binding credit constraint, is able to separate consumption and production decisions. Foltz (2004, p.230) argues that separability presents an opportunity for the household to optimize production by choosing inputs optimally and independent of consumption choices. However, when credit is a binding constraint the separability and independence of these decisions breaks down and the consumption and production sides of the household tend to compete for liquid resources.

Following Petrick (2002), the theoretical treatment of agricultural households adopted in this study will focus on the production side of agricultural household decision-making. Further, this study shall restrict itself to the presentation of a heuristic<sup>1</sup> conceptual framework of the agricultural household. The model in this chapter is developed within a static framework; as such investment decisions with a horizon beyond the current period (i.e. approximately 12 months or a single production cycle) will not be investigated.

Consider an agricultural household producing a single crop,  $y$ , from multiple inputs,  $x_i$ . The transformation of inputs into agricultural outputs tends to occur with considerable biological time lags. The production possibilities are represented by the technology  $f(x_i, y, z^j)$ , where  $x_i$  represents  $i$  non-negative inputs (e.g. labor and fertilizer) and  $y$  is a non-negative representation of crop output. The prices of inputs and outputs are assumed to be exogenously determined,  $w_i$  and  $p$  respectively. Fixed factors of production, such as land and physical capital<sup>2</sup>, are represented by  $z^j$ . Profit,  $\pi$ , is defined as the difference between the gross revenue generated by the agricultural household and the variable costs incurred.

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<sup>1</sup> A complete and rigorous mathematical exposition of credit rationing in agriculture is beyond the scope of this paper. For rigorous static and dynamic treatises on the subject see Sadoulet and de Janvry (1995, pp.133-151), Petrick (2004, pp.79-85), respectively.

<sup>2</sup> “[Physical capital or] capital goods are machines of one sort or another: tractors, buildings, computer or whatever” (Varian 2010, 333).

There is a timing mismatch between when capital investment<sup>3</sup> is required and when the realization of returns is expected, which may result in a funding gap or liquidity problem. While inputs require financing at the start of the production period, outputs are only available at the end of the production cycle. Therefore, access to credit may enable farmers to overcome liquidity problems and make essential investments in working capital.

Access to credit and borrowing activity is constrained by an exogenously determined credit limit  $K$ , which represents the supply of credit available to a particular loan applicant. According to Feder et al (1990, p.1151), credit rationing may result in liquidity being a binding constraint on agricultural operations. The extent of the quality, volumes, and use of inputs may thus be constrained by the extent of access to credit. Consequently, as the output of a borrower's production activities is a function of the inputs available, the income and profit available to a credit constrained borrower is expected to be constrained at suboptimal levels.

Petrick (2002, p.4) captures the consumption side of the agricultural household by defining a catchall variable encapsulating the full liquidity contribution of the farm,  $M(z^h)$ ; with  $z^h$  representing agricultural business owner and farm household characteristics, for example number of dependents, gender, age, schooling, and agricultural experience. While the liquidity contribution implies net directional flows from the farm to the household, it does not preclude net flows from the household to the farm.

The household may further enhance production by making use of its available initial liquidity endowment,  $E$ , and any exogenous net transfers,  $S$ , including government grants and subsidies; it is assumed that they are maintained at constant levels. In the absence of credit, the household would thus make use of its available initial liquidity endowment and endogenous net transfers to support production and consumption activity.

In the event that the initial endowments are inadequate, the funding gap may be addressed through the use of credit. The amount of credit required to fill the funding gap is implicitly interpreted as the demand for credit. The combination of access to credit, endowments, and exogenous transfers provides the household with sufficient liquid resources to service the production needs of the farm and cater to the consumption needs of the household.

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<sup>3</sup> Capital in this instance is pecuniary in nature.

It is assumed that the household's objective is to maximize current period profit with respect to decisions about input and output quantities, and subject to a technology constraint and a budget constraint. The constrained maximization problem may be summarized as follows:

$$\underset{x_i, y}{\text{Max}} \pi = py - \sum_i w_i x_i \quad (1)$$

Subject to the following constraints:

$$f(x_i, y, z^y) = 0 \quad \text{Production technology} \quad (2)$$

$$K + E + S - \sum_i w_i x_i - M(z_h) \geq 0 \quad \text{Budget constraint} \quad (3)$$

The Lagrangian corresponding to the constrained maximization problem is as follows:

$$\underset{x_i, y, \lambda, \eta}{L} = py - \sum_i w_i x_i + \lambda f(x_i, y, z^y) + \eta \left[ K + E + S - \sum_i w_i x_i - M(z_h) \right] \quad (4)$$

The first order conditions of the optimization problem are:

$$\frac{\partial L}{\partial y} = p + \lambda \frac{\partial f}{\partial y} = 0 \quad (5)$$

$$\frac{\partial L}{\partial x} = -w_i + \lambda \frac{\partial f}{\partial x} - \eta w_i = 0 \quad (6)$$

$$\frac{\partial L}{\partial \lambda} = f(x_i, y, z^y) = 0 \quad (7)$$

The derivative of the Lagrangian, with respect to the credit constraint is:

$$\frac{\partial L}{\partial K} = \eta \quad (8)$$

The multiplier  $\eta$  provides a measure of the impact of a change in the constraint on the optimal value of the objective function. In this case,  $\eta$  represents the marginal impact of credit,  $K$ , when the agricultural household's profit is maximized. Hence, here:

$$\frac{\partial \pi}{\partial K} = \eta \quad (9)$$

Given the inequality constraint presented above (3), the Kuhn Tucker conditions are used:

$$\eta \geq 0 \quad (10)$$

$$K + E + S - \sum_i w_i x_i - M(z_h) \geq 0 \quad (11)$$

$$\eta \left[ K + E + S - \sum_i w_i x_i - M(z_h) \right] = 0 \quad (12)$$

We proceed by considering the Kuhn Tucker conditions, and in particular the new condition presented (12), which states that at least one of (10) or (11) must be zero, so that the product should equate to zero; this condition is referred to as the *complementary slackness* constraint. This condition yields the following three cases:

$$\text{Case 1: } \quad \eta = 0, K + E + S - \sum_i w_i x_i - M(z_h) = 0 \quad \text{Unconstrained}$$

$$\text{Case 2: } \quad \eta = 0, K + E + S - \sum_i w_i x_i - M(z_h) > 0 \quad \text{Non-binding constraint}$$

$$\text{Case 3: } \quad \eta > 0, K + E + S - \sum_i w_i x_i - M(z_h) = 0 \quad \text{Binding liquidity constraint}$$

For an unconstrained agricultural household (Case 1) or one where liquidity is not a binding constraint (Case 2), the demand for credit is satisfactorily met by adequate supply, while non-borrowers elect to voluntarily withdraw from the market for credit. Thus, the marginal effect of a change in the credit limit on profit is zero:

$$\frac{\partial \pi}{\partial K} = 0 \quad (13)$$

When the credit constraint is binding (Case 3), inefficiency is introduced into the agricultural production process by way of the multiplier  $\eta$ ; this is the case that we are interested in. As a credit constrained producer, the household behaves as if it were maximizing profits, with the reduced form model presented as follows:

$$\pi^* = \pi^*(p, w, z^y, z^h, K, E, S) \quad (14)$$

A change in output prices impacts output value and influences output quantity. While the former has a direct effect on profits, *ceteris paribus*, the latter has an indirect impact on profits as the farm is induced to adjust output to exploit the price increase. The indirect effect of a price change is assumed to be negligible, allowing the use of Hotelling's Lemma (Varian 1992, pp. 43-45) to take advantage of the direct price effect in order to derive output supply.

Given the profit function, we may apply Hotelling's Lemma in order to deduce the output supply equation:

$$y^* = \frac{\partial \pi^*}{\partial p} = y^*(p, w, z^y, z^h, K, E, S) \quad (15)$$

The result is generalizable to the multiple-output case. As such, the product of  $y^*$  and exogenous prices  $p$  represents gross revenue. *Ceteris paribus*, a change in gross revenue results in a one-to-one change in profits, in the same direction. Given that we assume prices to be exogenously determined the multiplier  $\eta$  represents the marginal productivity of capital, *ceteris paribus*:

$$\frac{\partial y^*}{\partial K} = \eta \quad (16)$$

Therefore, the marginal impact of a change in the credit constraint,  $K$ , is expected to affect gross revenue in the same manner as its effect on profits.

## 2.5 Empirical literature

A seminal paper by Feder et al (1990, p.1152) studies the impact of credit on Chinese agricultural productivity, based on a randomly selected cross-sectional dataset of 200 households. It was found that enhanced credit availability, to credit constrained households, would result in improvements in the overall welfare of agricultural households in China; as a result of increased consumption and enhanced input use into production. In particular, it was reported that a 1% increase in formal credit (from the average level of liquidity) would result in a 0.04% improvement in gross agricultural output (p.1156). This finding suggests that credit was not entirely allocated towards productive activities; rather a significant portion may have been reallocated to consumption and investment activities. Although the welfare of agricultural households would be enhanced from improved access to credit, the fungibility of formal credit undermines the underlying motivation for the extension of agricultural credit.

The aforementioned paper represents a departure from the classical empirical literature of credit markets, premising the impact analysis on the basis that credit rationing as a natural equilibrium phenomenon. Another significant development made by the study lies in its early use of specific, household-level survey data for direct elicitation of the credit constraint status. As opposed to delineating credit constraints by credit participation status, this study classified agricultural households as credit constrained if their survey response indicated a desire for more credit or an inability to participate in credit. Further, the study propagated the use of the endogenous switching regression model for the estimation of credit constraint status and its effects.

Foltz (2004, pp.229-230) investigates credit rationing and its impact on agricultural profitability and investment using a randomly selected sample of 142 farmers in Tunisia. Credit constraint status is elicited by whether a household would take on a new loan, if it were offered by a supplier of capital; placing the emphasis of the study on supply-side constraints involuntarily imposed by lenders. It was found that credit rationing had an adverse impact on profitability, measured by net revenues, however there was no significant effect on investment.

Using a randomly selected sample of 464 semi-commercial farms engaged in crop production or livestock rearing, Petrick (2002; 2004) conducted comprehensive microeconomic analyses of credit rationing in Poland. The studies differ in their application of the agricultural household model. While the former constrains the scope of the study to the production side, the latter explicitly captures the consumption behavior of farm households in its theoretical framework. The distinct objective of both studies was to investigate whether government interventions in rural credit markets, in the form of interest rate subsidies, are justifiable as a means to improve welfare in the Polish agricultural sector. This would be achieved by empirically determining the marginal contribution of credit on agricultural households that are credit constrained, based on subsamples of 43 and 41 observations for the 2002 and 2004 studies, respectively.

The evidence unanimously suggests that credit constraints have a significant impact on output supply. The earlier study reported a 190 percent marginal contribution from an extra unit of credit offered at an average annual rate of 10 percent (Petrick 2002, p.12); while the later study reported that the average farm household was willing to incur an interest charge of 209 percent of principal for additional credit, despite effective interest rates being only 13 percent, on average (Petrick 2004, pp.95-99).

Guirkinger and Boucher (2008, pp.295-299) use a sample of 443 farm households in Peru, from a panel dataset covering the period 1997 to 2003, to investigate how constraints in formal sector credit impact farm productivity. The study contributes to the empirical literature on credit rationing by adopting a broader definition of credit constraints, which encapsulates both supply-side and demand-side constraints. It is found that the productivity of agricultural households in the sample would be enhanced by 26% if all formal credit constraints were eliminated, particularly quantity and risk constraints. It is postulated that disregard for constraints other than those caused by quantity rationing may result in the impact of credit constraints on economic outcomes being understated (p.306).

A nationally representative dataset is used by Ali et al (2014, pp.1-2) to investigate the impact of credit constraints on Rwandan agricultural households. The study focuses on semi-formal<sup>4</sup> suppliers of capital to directly, and comprehensively, elicit credit constraint status. The motivation for framing the study around credit from the semi-formal sector stems from the observation that formal credit represents a small portion of sources of borrowings and informal sector credit is primarily used for activities other than agricultural investment. It is found that credit constraints inhibit agricultural production, measured by the value of crop output per hectare. Focusing on supply-side constraints, it was found that the provision of USD100 additional credit would, on average, be expected to result in an 8.9% improvement in agricultural production. Incorporating both demand- and supply-side constraints, it is demonstrated that the elimination of credit constraints would result in a 17% increase in the gross output value of agricultural households in Rwanda (pp.11-13).

Winter-Nelson and Temu (2005, pp.868-870) use a randomly selected sample of 250 farmers to examine the impact of liquidity constraints on coffee producers in Tanzania, where farmers self-identify as liquidity constrained. It is noted that access to finance is necessary, but not sufficient, to infer the relaxation of liquidity constraints. The study reports that enhanced access to financing would have a significant impact on production, from more effective use of current inputs and an increased opportunity to purchase productivity-enhancing inputs. Furthermore, it is suggested that increased access to credit may contribute favorably to the alleviation of poverty and the realization of inclusive growth. Despite the limited representation of the broader economy, this study provides a benchmark for the empirical estimation of credit constraints and its impacts in the context of Tanzania.

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<sup>4</sup> Semi-formal financial institutions include cooperatives, input suppliers, micro finance institutions, and non-governmental organizations.

In Malawi, in order to investigate the impact of access to microcredit on various agricultural household welfare measures, namely productivity, incomes, and food security, Diagne and Zeller (2004, pp.62-68) branch away from the conventional approach of estimating the marginal effects of credit outstanding or credit programme participation. Instead, the study develops a novel approach that operationalizes access to credit by making use of the credit limit available to the borrower; hence the impacts of increases in this limit are of particular interest. Based on a sample of 404 households the findings of the study suggest that agricultural households in Malawi are typically credit constrained, however participation in microcredit may not necessarily facilitate enhancements in living standards and the alleviation of poverty (pp.100-109). Diagne and Zeller argue that while improvements in the credit limit may enhance the welfare of a household, participation in credit, with its consequential principal repayments and interest obligations, may result in the erosion of gains to the net income of the household.

## **2.6 Summary and conclusions**

This chapter summarizes relevant theoretical and empirical literature on credit rationing in developing markets. Distinctions are drawn between key concepts in the credit rationing literature, followed by an investigation of the causes and consequences of credit rationing. Thereafter, a structured investigation of the conceptual framework underpinning this study is explored; and lastly, key findings from the empirical literature are highlighted.

We define credit rationing as a phenomenon represented by an excess demand for credit; and further define credit constraints as experienced by economic agents and their limitations in accessing or participating in credit. The conventional classical economic notions of equilibrium price setting and the efficient allocation of resources are demonstrated to be inappropriate in the context of asymmetric information, particularly with regards to explaining rationing in credit markets.

The role that adverse selection, moral hazard, and enforcement challenges play in explaining credit rationing as an equilibrium condition is investigated. It is established that imperfect and costly information enable credit-rationing behaviour, which undermines the social welfare and development goals of society. Further, the impact of credit constraints on productivity is explored in the context of the agricultural household model.

We posit that the simultaneity of decision-making may contribute to the misallocation of resources as a result of credit constraints being experienced and non-separable decisions being encouraged. It is argued that binding credit constraints may result in underinvestment in farm production, which would ultimately diminish the earning potential of an agricultural business.

The empirical literature places emphasis on supply-side constraints and is somewhat inconsistent with regards to approach and evaluation of the impact of credit constraints on agricultural productivity. The relaxation of credit constraints is evidenced to aid the short-term operational needs of farmers. However, the fungibility of formal credit may undermine the intention underlying increased access to finance.

The provision of interest rate subsidies does not necessarily translate into the enhanced allocation of credit, which may result from a failure to address information asymmetries. In addition to quantity constraints, considerations of a broader definition of credit constraints that takes into account transaction cost and risk constraints provides support that the elimination of constraints may enhance productivity.

The productivity or welfare of farm households is not necessarily enhanced by access to or the provision of microcredit, as transaction costs and small loan amounts may sustain credit ration behaviour. Improved access to liquidity was found to enhance productivity, and contribute favourably to the alleviation of poverty and inequality.

In light of the reviewed body of knowledge, this study seeks to address the limited empirical evidence on the impact of credit constraints within the context of Tanzania, with a particular focus on providing a nationally representative perspective of credit rationing and its effects.

## **Chapter 3. Tanzania's farm sector and rural credit market**

### **3.1 Introduction**

The following chapter will present an overview of the agricultural sector in Tanzania and is organized in three main sections. The second section describes the macroeconomic performance of the sector with regards to labour, gross domestic product (GDP), and export considerations; in addition to the gross production, harvested area and yield across various food and cash crops. Section three provides an exposition that systematically follows the evolution of the agricultural policy landscape in Tanzania from post-independence and the Arusha declaration period, through the reform era, and towards the current development agendas pertaining to the sector and its financing. The fourth section describes the major characteristics of credit markets in Tanzania. In particular, an emphasis is placed on understanding the formal, semi-formal, and informal financial institutions responsible for supporting the activities of the sector and enabling its transformation into a modern, commercial vehicle for the realization of poverty alleviation and the improvement of living standards. Section five concludes the chapter.

### **3.2 Performance of the Agricultural sector**

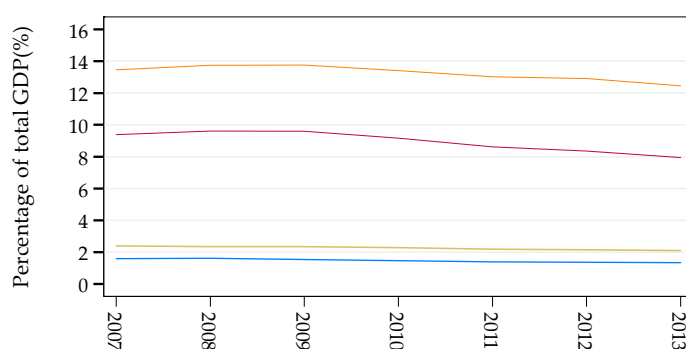
The agricultural sector contributed 77% of the economically active population in 2007, which marginally declined to around 74% in 2014; over the period the sector accounted for an average of 76% of the labour force (FAOSTAT 2015c, 2015d). Between 2007 and 2014, annual average growth of the economically active population exceeded growth of the total population, 3.3% and 3.0% respectively (FAOSTAT 2015e). Annual growth of the economically active population in agriculture averaged at 2.6% over the period.

The percentage distribution of gross domestic product by economic activity is presented in Table 1. Agriculture, hunting, forestry, and fishing is the largest contributor to the GDP of Tanzania, accounting for 23.8% of economic output in 2013, however this share has been declining steadily, falling from 27.3% in 2008 (NBS and MoF, 2014). Annual growth of the agricultural sector averaged around 3.9% from 2007 to 2013, while the total GDP growth over the period averaged 6.3%.

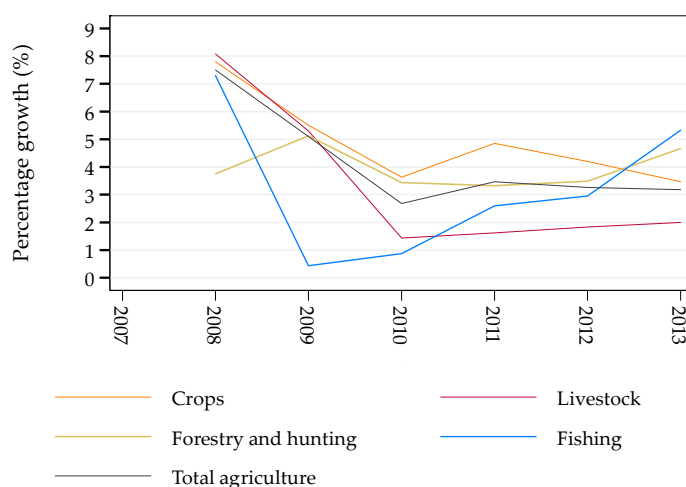
**Table 1. Percentage distribution of GDP at 2007 Prices (%)**

Economic Activity	2007	2008	2009	2010	2011	2012	2013
Agriculture, Hunting, Forestry, and Fishing	26.8	27.3	27.2	26.3	25.2	24.8	23.8
Industry and construction	20.2	20.4	20.0	20.5	21.3	21.0	21.8
Mining and quarrying	3.5	3.0	3.4	3.4	3.3	3.4	3.3
Manufacturing	7.0	7.4	7.4	7.5	7.5	7.4	7.3
Electricity, gas and water supply	1.8	1.8	1.7	1.8	1.6	1.6	1.6
Construction	7.9	8.2	7.5	7.8	8.9	8.7	9.6
Services	47.4	46.8	47.0	47.6	47.8	48.8	48.3
Commerce	11.7	11.8	11.4	11.7	12.0	11.9	11.6
Transport and communications	8.2	8.1	8.7	9.4	9.2	9.7	9.9
Financial intermediation, real estate and business services	13.0	13.1	13.4	13.7	13.6	13.7	13.4
Governments, community, social and personal services	14.6	13.8	13.5	12.7	13.0	13.5	13.4
Net taxes and FISM	5.6	5.5	5.8	5.6	5.7	5.4	6.0
GDP at 2007 prices	100	100	100	100	100	100	100

Source: NBS and MOF (2015)



**Figure 2. GDP share of agricultural sub-sectors at 2007 constant prices**



**Figure 3. Annual GDP growth of agricultural sub-sectors at 2007 constant prices**

Source: BoT

Note: Details on GDP by economic activity available in Appendix Tables 2 - 5.

Over the same period, the minimum agricultural GDP growth was 2.7% in 2009/10, while total GDP growth reflected its period low in 2011/12 at a relatively higher annual growth of 5.2%. The agricultural sectors maximum growth rate was 7.5% in 2007/08, compared to maximum growth of the overall economy at 7.9% in 2010/11. Since 2007, total GDP has grown by approximately 1.44x, while agricultural GDP has grown by 1.28x.

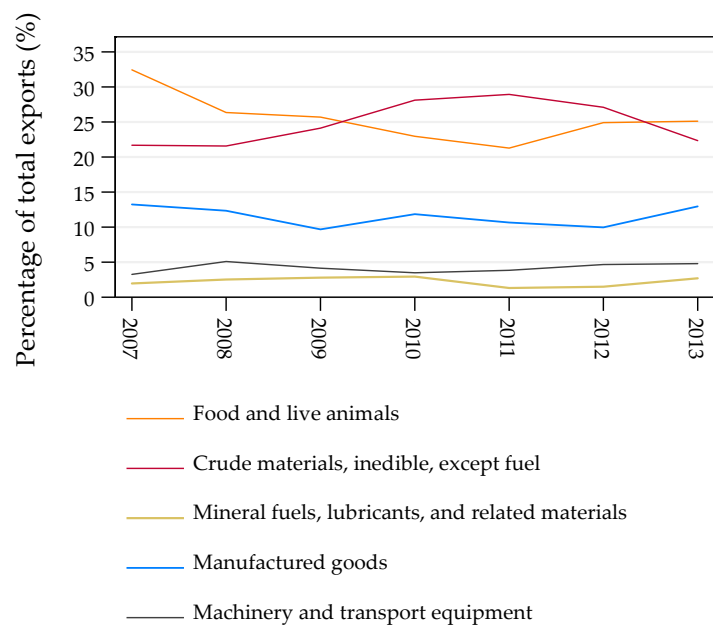
The declining share of agricultural GDP in the economy is attributable to the weak growth of the sector and considerable growth in other segments of the economy. In particular the transport and communications sector has exhibited an average annual growth rate of 7.7%, while exhibiting an increase in share of GDP from 8.2% in 2007 to 9.9% in 2013. The construction industry grew at 6.7% over the period and accounted for 9.6% of total GDP in 2013, up from 7.9% of total GDP in 2007. The manufacturing sector grew at an average annual rate of 6.0% over the period, followed closely by the electricity, gas, and water supply sector, which grew at an average of 5.9%.

The percentage distribution of agricultural GDP and growth of GDP sub-sectors are presented in Figures 2 and 3, respectively. The crop sub-sector accounts for the largest share of agricultural GDP at about 52.3% in 2013, followed by the livestock sub-sector at 33.3%. The former grew at an annual average growth rate of 4.9% between 2007 and 2013, which contributed to the decrease in its contribution to total GDP from 13.5% to 12.4% over the period. Growth in the crop sub-sector was characterized by wide variability and ranged from 3.5% to 7.8% over the period.

The livestock sub-sector saw a more moderate decline in its contribution to Agricultural GDP from 9.2% in 2007 to 7.9% in 2013. The forestry and hunting sub-sector contributed a modest 2.1% to total GDP in 2013, while the fishing sub-sector accounted for 1.5% of total GDP.

Figure 4 below presents the value of selected major exports from Tanzania. Major agricultural exports accounted for about 32.4% of total exports in 2007 before sharply declining to 21.3% in 2011, thereafter rebounding to 25.1% in 2013 (UNCTADStat 2015).

Total exports were multiplied by 2.4x from 2007 to 2013, however agricultural exports grew 1.8x. Minerals fuels and machinery and transport equipment have primarily driven growth in exports, and were multiplied by 3.3x and 3.5x respectively.



Source: UNCTADStat (2015).

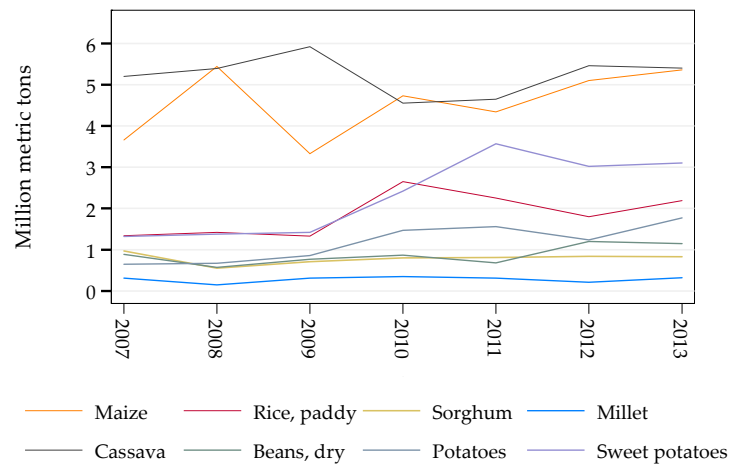
**Figure 4. Major Tanzanian Exports**  
selected product groups

Despite considerable growth in mineral fuels exports, its share of total exports increased from a modest 2.0% in 2007 to 2.7% in 2013. Machinery and transport equipment accounted for 4.8% of total exports in 2013, up from 3.3% in 2007. Crude materials and inedibles accounted for 21.7% of total exports in 2007, rising to 28.9% in 2011 and thereafter dampening to 22.3%. Crude materials grew by 2.4x over the period. Manufactured goods exports were multiplied by 2.3x from 2007 to 2013, and accounted for 13% of total exports in 2013.

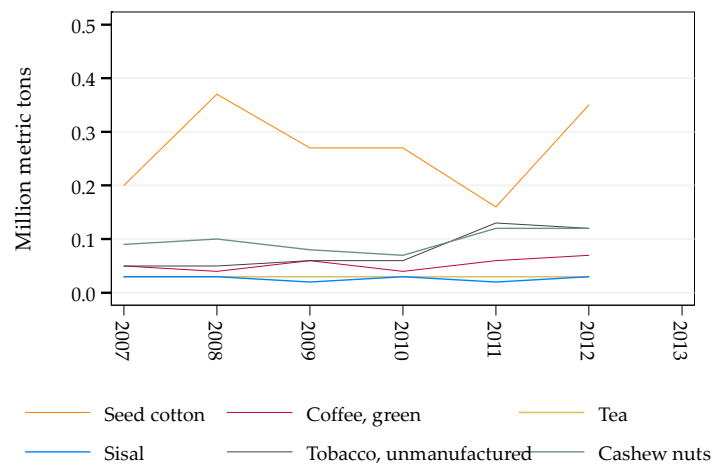
Food crops include maize, rice, sorghum, millet, cassava, beans, potatoes, and sweet potatoes; and cash crops include: cotton, coffee, tea, sisal, tobacco, and cashew nuts.

Based on FAOSTAT data presented in Figure 5, maize and cassava represent the largest shares of gross food crop production<sup>5</sup> in Tanzania with production of 5.36 and 5.40 million metric tons, respectively (FAOSTAT 2015b). The share of maize production marginally increased from 25.5% in 2007 to 26.6% in 2013, however the share of cassava production declined from 36.3% to 26.8% over the same period. Growth in potato, millet and rice production were the major contributors to annual average food production growth from 2007 to 2013, at 18.4%, 14.7%, and 13.8% respectively. Maize production grew at an average annual growth rate of 10.5% over the period, while cassava production grew at -1.0%.

<sup>5</sup> Gross food crop production is calculated as the aggregation of available production data for maize, rice, sorghum, millet, cassava, beans, potatoes, and sweet potatoes.



**Figure 5. Food crop production**



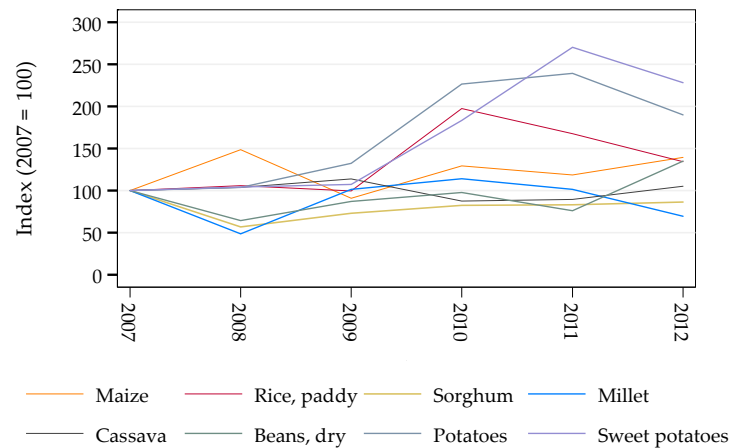
**Figure 6. Cash crop production**

Source: FAOSTAT (2015b)

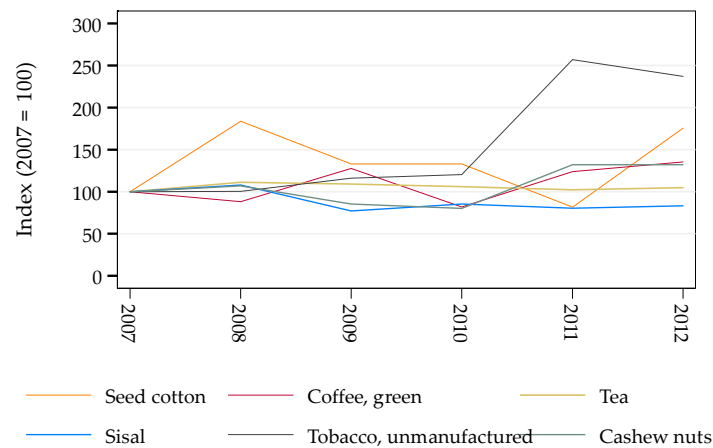
Cotton accounts for the largest share of gross cash crop production<sup>6</sup> in Tanzania with 352,162 metric tons, followed by the production of cashew nuts and tobacco with 122,274 and 120,000 metric tons respectively (FAOSTAT 2015b). Figure 6 presents cash crop production from 2007 to 2012. The share of cotton production has exhibited persistent variability over the period, ranging from 30.7% to 58.5%, in 2012 cotton accounted for 49% of gross cash crop production. The share of cashew nut production experienced volatility, ultimately declining from 20.4% in 2007 to 17% in 2012, while the share of tobacco production increased from 11.1% in 2007 to 24.4% in 2011, thereafter dampening to 16.7% in 2012.

<sup>6</sup> Gross cash crop production is calculated as the aggregation of available production data for production of cotton, coffee, tea, sisal, tobacco, and cashew nuts

Food crop production increased almost 1.4x between 2007 and 2013, growing at an average annual rate of 13.8%. Potato production was a major contributor and was multiplied by 2.7x over the period, as shown in Figure 7; followed by sweet potato, rice and maize production which were multiplied by 2.3x, 1.6x, and 1.5x, respectively. Cash crop production increased 1.6x between 2007 and 2012, driven mainly by growth in Tobacco and Cotton (*see* Figure 8). Production of tobacco was multiplied by 2.4x, while cotton production increased by 1.8x.



**Figure 7. Growth in food crop production**



**Figure 8. Growth in cash crop production**

Source: Author's calculations based on FAOSTAT (2015b)

Note: Details on production indices available in Appendix Table 6.

Table 2 below presents a summary of production quantities, area under harvest, and yield for selected food and cash crops. By 2013, the harvested area under maize production was 4.1 million hectares, up 1.6x from 2.6 million hectares in 2007, as shown in Figure 9 (FAOSTAT 2015a). The harvested area under bean production increase 1.4x over the period from approximately 918,742 hectares to 1.3 million hectares; followed by cassava harvested area which grew 1.2x to 950,000 and rice harvest area, which grew 1.7x to 928,273 hectares.

**Table 2. Production summary**

Year	Area ('000s ha)	Yield (Kg/Ha)	Production ('000s metric tons)
<u>Food crops</u>			
Cereals <sup>A</sup>			
2007	4,376	1,435	6,280
2013	6,095	1,428	8,706
Average	5,411	1,384	7,490
Roots and tubers <sup>B</sup>			
2007	1,300	5,515	7,171
2013	1,828	5,616	10,268
Average	1,613	5,403	8,716
Pulses <sup>C</sup>			
2007	919	968	889
2013	1,300	885	1,150
Average	1,016	861	875
<u>Cash crops</u>			
Cotton			
2007	450	446	201
2013	490	724	355
Average	453	623	282
Beverage crops <sup>D</sup>			
2007	234	342	80
2012	131	755	99
Average	205	423	87
Cashew nuts			
2007	93	996	93
2012	411	298	122
Average	222	442	98
Tobacco			
2007	44	1,150	51
2012	156	772	120
Average	92	858	79
Sisal			
2007	42	738	31
2012	58	443	26
Average	52	525	27

Source: FAOSTAT (2015a, 2015b)

Note: Averages calculated over the period 2007 to 2013; where 2013 data is unavailable average is reflected for the period between 2007 and 2012.

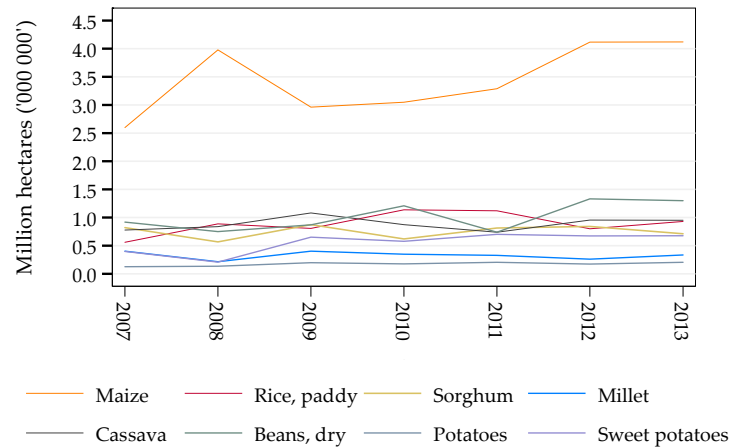
A. Cereals: maize, rice, sorghum, and millet

B. Roots and tubers: cassava, potatoes, sweet potatoes

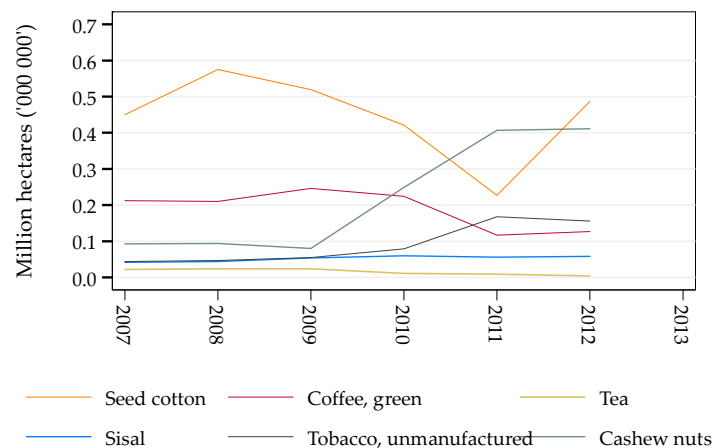
C. Pulses: beans

D. Beverage crops: tea, coffee

According to FAOSTAT (2015a) cotton production accounted for 490,000 hectares under production in 2013, up from 450,000 hectares in 2007 as can be seen by Figure 10. Cashew nuts and tobacco represented the largest growth in area harvested between 2007 and 2013, growing 4.4x and 3.5x respectively. Over the period, the former grew from 93,000 to 410,641 hectares under cultivation, while the latter grew from 44,000 hectares to 155,527 hectares.



**Figure 9. Food crop area harvested**



**Figure 10. Cash crop area harvested**

Source: FAOSTAT (2015a)

Note: Details on area harvested available in Appendix Table 7.

Between 2007 and 2013, cassava and potatoes recorded the highest annual average yields amongst food crops, at 6,680 and 5,926 kg/ha respectively. Tea represented the highest cash crop yield growing approximately 6.3x between 2007 and 2012 from 1,398 to 8,759 kg/ha.

### **3.3 The evolution of agricultural policy in Tanzania**

#### *Post-independence*

Agriculture has played a perennial role in the policy landscape of Tanzania since independence, in 1961. Despite the market for export crops maintaining its historically established control mechanisms, the market for grains was deregulated in the wake of independence (World Bank et al 2000, p.5). Smallholder farmers that were primarily engaged in semi-subsistence activities vastly dominated the sector; and the liberation government recognized cooperative<sup>7</sup> societies as the primary vehicles for the realization of national development.

#### *Arusha declaration*

The 1967 Arusha Declaration was the major impetus for transforming Tanzania into a socialist state. The ideology of socialism was advocated as the basis for development, in conjunction with self-reliance and egalitarianism (TANU 1967). The Declaration prohibited the exploitation of one person by another. Hence, the major means of production were brought under the control and ownership of the public, through a democratically elected government and cooperative representatives. A massive nationalization programme drove rapid growth in the number and size of state owned enterprises and parastatal organizations. Limbu and Mashindano (2002, p.48) assert that the expansion of the public sector resulted in numerous employment opportunities for Tanzanians and increased the government's capability for social service provision.

The Declaration recognized agriculture as the basis for development and placed emphasis on the need to increase food and cash crop production in Tanzania (TANU 1967, p.14). It was envisioned that the priority objectives of poverty eradication and the improvement of living standards would be pursued by targeting the rural sector. The village replaced the cooperative as the primary vehicle in pursuit of rural development and would henceforth serve as a means to share basic resources amongst a group of smallholder farmers. Furthermore, the village structure was expected to enable cooperative agricultural production and enhance accessibility for social services.

The policy environment, and the increased roles and responsibilities of the government, promoted the public sector while discouraging and effectively crowding out private sector activity. Limbu and Mashindano (2002, pp.45-50) argue that the implementation of the Arusha Declaration was undermined by a shortage of skilled labour in the public sector, inadequate incentives, the pursuit of political agendas ahead of economic interests, and the bureaucracy inherent in decision-making. Edwards (2012, p.21) suggests that the villagization agenda was hampered by the unwillingness of peasant farmers to move from their more fertile farmlands into planned villages where they would be assigned new land.

The socialist movement culminated in periods of crisis and stagnation. The economy contracted and exhibited rampant inflation, exacerbated by a widening fiscal deficit, restrictive import policies, and exchange rate controls (World Bank et al 2000, p.6). The public sector was plagued with financial mismanagement, and misappropriation of funds, while agricultural markets were adversely affected by the ailing economy.

### *The reform era*

According to Edwards (2012, p.28), domestic policy was unsuccessfully introduced in the early 1980s in an effort to reform and stabilise the economy. From 1986, economic reform programmes supported by the International Monetary Fund and the World Bank were adopted. With the intention of addressing the numerous economic problems, the reforms promoted a shift in the economy from socialism and central planning towards market orientation. The agricultural sector was restructured as a result of the privatization of production, distribution, and importation activities. Government authorities' price-setting role was revoked and subsidies were eliminated on key farm inputs. The diminished role of the reform government in agricultural development may have hampered the rural development efforts of the liberation and socialist movements.

The current policy framework acknowledges that agricultural development is constrained by persistent underinvestment in the sector and refreshes the government's long and medium term goals (URT, 2006, p.7). Commercialization and transformation of the sector is advocated for across the value chain, from low to high productivity activities, with a particular emphasis on enhancing food security and improving farm incomes.

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<sup>7</sup> A *cooperative* is defined by the ILO (2002) as “an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise”

### *Long and medium term development agendas*

The Tanzania Development Vision 2025 aims to guide the efforts and resources of the nation towards the sustainable eradication of poverty and the improvement of living standards over the long term (URT 1999, p.2). The National Strategy for Growth and Reduction of Poverty (NSGRP)<sup>8</sup> represents the medium term framework for the implementation of the vision, and is underpinned by the pursuit of inclusive growth, supported by good economic governance and enhanced accountability MoFEA (2010, p.35). The Planning Commission proclaims the extension of the pre-reform basis for development beyond the rural agricultural sector (URT 1999, p.22). Semi-industrialization and the diversification of economic activity have been advanced as the primary means to improve productivity and competitiveness across all sectors of the economy.

### *Sector specific policy landscape*

The Agricultural Sector Development Strategy (ASDS) aims to support the development endeavours of Tanzania by creating an enabling and conducive policy environment for enhanced activity in the sector, while the Agricultural Sector Development Programme (ASDP) operationalizes and supports the strategy (URT 2001, p.12; URT 2006, p.8). The ASDS and ASDP position the sector as the primary vehicle for tackling rural poverty, recognizing the ongoing and significant role that agriculture is expected to play in the pursuit of economic development. The Kilimo Kwanza<sup>9</sup> resolution aims to coordinate private and public stakeholders to accelerate the efforts of the ASDP, through various policies and strategic interventions in the agricultural sector (TNBC 2009; Shamte 2009, p.5).

The aim of the National Agricultural Policy (NAP) is to advance the agricultural sector towards being a modern, commercial driver of the economy that is efficient, productive, profitable, and competitive (MoAFSC 2013, pp.8-9). The NAP supplements the ASDS vision, with a particular emphasis on empowering the farmer. Furthermore, the policy advocates for the government to improve the capacity and coordination efforts of financial institutions and intermediaries to improve awareness, access, and accessibility of finance to farmers in order to better tackle agricultural development.

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<sup>8</sup> In Kiswahili, Mpango wa Kukuza Uchumi na Kuondoa Umaskini Tanzania (MKUKUTA)

<sup>9</sup> In English, Agriculture first

### 3.4 Characteristics of credit markets in Tanzania

**Table 3. Providers of financial intermediation services**

<i>Formal sector</i>	<i>Semi-formal sector</i>	<i>Informal sector</i>
Central bank	Savings and credit cooperatives	Savings associations
Banks	Multiple cooperatives	Combined savings and credit associations – rotating savings and credit associations and variants
Commercial banks		
Merchant banks	Credit unions	
Savings banks		
Rural banks	Cooperative quasi-banks	Village community banks (VICOBAs)
Postal savings banks		
Labour banks	Employee savings funds	
Cooperative banks		Informal financial firms
	Village banks	Indigenous bankers
Development banks		Finance companies
State-owned	Development projects	Investment companies
Private		
	Registered self-help groups and savings clubs	Nonregistered self-help groups
Other nonbank institutions		
Finance companies		Individual moneylenders
Term-lending institutions	Non-governmental organizations (NGOs)	Commercial
		Noncommercial
Building societies and credit unions	Microfinance Institutions	(friends, neighbours, relative)
		Traders and shopkeeper
Contractual savings institutions		
Pension funds		NGO
Insurance companies		
Markets		
Stocks		
Bonds		

Source: FAO (1995, 5), Bee (2009, p.144)

A country's financial sector can be classified into formal, semi-formal, and informal institutions, according to the legal frameworks governing lender and borrower behaviour (FAO 1995, pp.2-10). Table 3 presents a summary of the various financial institutions; notwithstanding, financial activity may permeate across these classifications. Formal institutions in Tanzania are licensed by the government and subject to regulation and supervision, whereas informal institutions are outside the scope of government oversight. While the former are subject to stringent operating and risk management practices, the latter typically operate on the basis of familiarity and close proximity between lenders and borrowers. Semi formal institutions are beyond the scope of direct government regulation, however they may be subject to indirect oversight through various public agencies or entities (Ledgerwood 1999, pp.12-13).

Since the adoption of financial sector reforms in 1991, the Tanzanian financial sector has experienced considerable growth (TNCFI 2013, p.2). The number of banks has grown from 4 to 52 and the insurance sector has expanded its coverage from 1 public institution to 27 private insurers. As of June 2013, there were approximately 5,559 Savings and Credit Cooperative Societies (SACCOS) and 170 Non-Government Organizations and companies providing credit.

Commercial banks, public finance institutions, and insurance companies represent the formal financial institutions in Tanzania. According to MoAFSC (2013, p.4) commercial banks disburse over 90% of the institutional credit allocated to the agricultural sector, with the balance primarily accommodated by community banks and cooperatives. Despite this significant relative contribution, formal institutional lending to the sector remains low, absolutely.

**Table 4. Percentage distribution of commercial banks domestic lending by economic activity (%)**

Economic Activity	2010	2011	2012	2013	2014
Agriculture, Hunting, Forestry, and Fishing	9.7	11.8	11.1	10.7	9.4
Agriculture, Hunting, and Forestry	8.8	10.7	10.6	10.4	9.1
Fishing	0.9	1.1	0.5	0.4	0.3
Industry and construction	22.7	22.6	22.8	24.1	23.6
Mining and Quarrying	0.6	0.6	0.7	1.0	1.5
Manufacturing	13.9	12.8	11.7	11.7	11.6
Electricity, gas and water	5.0	4.7	5.6	6.2	5.1
Building and Construction	3.2	4.4	4.8	5.2	5.3
Services	67.6	65.6	66.1	65.1	67.0
Commerce	23.3	26.8	26.8	26.7	26.3
Transport, storage and communications	9.4	7.8	7.5	7.5	8.0
Financial intermediation, real estate and business services	4.5	6.3	6.8	6.7	7.5
Governments, community, social and personal services	30.3	24.8	25.1	24.2	25.1
Total	100	100	100	100	100

Source: BoT (2015)

Note: Details on commercial banks domestic lending by economic activity available in Appendix Tables 9 - 10

The percentage distribution of commercial bank lending in the economy is presented in Table 4. In 2014, agriculture, hunting, forestry, and fishing accounted for only 9.4% of total commercial banks domestic lending, declining from 11.8% in 2011. This low contribution of formal credit to the agricultural sector is complemented by substantial allocations to other areas of the economy. The largest contribution of commercial lending went to trade (25%), followed by social and personal services (21.0%) and manufacturing (11.6%).

Credit to the agricultural sector grew at an annual average rate of 21.7% from 2010 to 2013, buoyed by outstanding growth of 56.0% from 2010 to 2011. In comparison, the real estate and leasing sector grew at an average annual rate of 59.3% from 2010 to 2013, followed by mining and quarrying (55.6%), and tourism (43.7%).

The government has established various public institutions to facilitate the provision of agricultural credit (OECD 2013, p.188-190). The Tanzania Investment Bank (TIB) and Tanzania Agricultural Development Bank (TADB) are state-owned banks mandated with the provision of development finance. Amongst other things, the TIB is involved in the provision of concessionary short to medium term agricultural loans. The TADB is specifically aligned to Kilimo Kwanza and aims to coordinate and mobilize financial resources from private and public sector stakeholders towards various suppliers of credit in the agricultural sector. In addition, the agricultural input trust fund (AITF) provides an alternative avenue for short-term input financing.

Informal financial institutions in Tanzania are represented by various savings and credit groups, namely: village savings and loans associations (VSLAs), village community banks (VICOBAs), rotating savings and credit associations (ROSCAs), customers, and family and friends, amongst others.

VSLAs and VICOBAs are informal village-based microcredit providers that service the liquidity needs of the communities in which they operate. ROSCAs are contributory schemes wherein members' periodic contributions are distributed on a rotational basis. These informal institutions do not rely on formal agreements and enforcement mechanisms. Instead, the borrowers' reputations, the expected reciprocation of fellow members, and the incentive for community-based enforcement are some mechanisms used to enhance the likelihood of repayment (OECD 2013, p.184-186; FAO 1995, p.8).

Semi-formal institutions include savings and credit cooperative societies (SACCOS) and other cooperatives, which typically condition borrowers' access to credit on the savings contributed. SACCOS play a significant role in the provision of financial intermediation services to the rural sector due to their extensive reach and proximity to community members (Wangwe 2004, pp.6-9). These entities rely on social capital and community pressure to ensure the repayment of loans and enforcement of agreements.

In this regard, SACCOS may serve as conduits for formal financial institutions looking to leverage off their local presence and extensive knowledge of the rural sector. While the government regulates formal institutions, the regulatory exemption of SACCOS provides scope for lending malpractice and mismanagement.

Semi-formal institutions also include financial non-governmental organisations and government-mandated institutions (Bee 2009, pp.159-163). In Tanzania, The Promotion of Rural Initiatives and Development Enterprise (PRIDE), the Foundation for International Community Assistance (FINCA), and the Small Industries Development Organization (SIDO) aim to address the financing gap and developmental challenges experienced by the rural poor and small and medium enterprises.

Typically, these entities are legally precluded from taking deposits, hence their primary activities are usually confined to the provision and promotion of externally sourced micro-credit; however, their activities have evolved towards the mobilization of savings through village and community banking models.

The Tanzania National Council for Financial Inclusion suggests that the aversion for investment in the agricultural sector is reinforced by uncertainty about the macroeconomic environment and the perceived associated risks (TNCFI 2013, pp.11-12). In Tanzania, the legal and regulatory framework is characterized by convoluted client on-boarding requirements and inadequate contract enforcement mechanisms. There is limited reach of the current financial market infrastructure, in addition to asymmetric information between lenders and borrowers concerning the potential risks of default and the complexity of financial products, respectively. Despite the rapid expansion of the financial sector, the agricultural sector is characterized by the proliferation of short-term credit facilities with limited offerings of longer-term financing (MoAFSC 2013, pp.21-22). Rural sector demand for formal financing solutions is considered to be inadequate to justify the costs of service provision; while transaction costs and collateral requirements are high where services are provided.

### **3.5 Summary and conclusions**

This chapter provided a comprehensive overview of the agricultural sector in Tanzania. The performance of the sector was evaluated across various dimensions and an exposition of financial institutions was undertaken, with a particular emphasis on the credit market. The policy environment governing agricultural development was explored, highlighting the evolution of agricultural policy in pursuit of long-term agricultural development.

The agricultural sector contributes substantially to the economy of Tanzania, accounting for significant proportions of the gross domestic product and economically active population; however, the significance of the sector has been steadily declining. Food crops represent a significantly larger contribution to production output and area harvested relative to cash crops, with the former historically recording higher yields. Further, agricultural goods account for a large proportion of total exports; however the contribution has been moderated over time.

Commercial banks characterize the formal financial institutions and serve as the primary financial intermediaries in Tanzania. The mission to promote savings and rural development characterizes semi-formal financial institutions, while informal institutions operate at the village or community level. The allocation of finance to the agricultural sector is hampered by instability in the macroeconomic outlook, perceived risks surrounding rural activity, and risk aversion towards the provision of finance beyond the short term. Complex regulation and inadequate enforcement mechanisms, in addition to the inappropriate provision of financing products and services, present barriers to the development of the agricultural sector.

Tanzania evolved from a socialist state to a modern, liberalized regime wherein the focus shifted from the preservation of small-scale agricultural production at the village or community level to the modernization and commercialization of the sector. The policy landscape governing economic development has continually been intent on promoting agricultural development and realizing the economic development goals of poverty alleviation and the improvement of living standards.

## **Chapter 4. Research methodology**

### **4.1 Introduction**

This chapter presents the research methodology that operationalizes the empirical approach undertaken by this study; and is organized into six distinct, yet unified main sections. The second section describes the data used in this study and the survey design that underlies the sampling approach. The third section presents the research approach; outlining the two distinct stages of the empirical strategy, which include the elicitation of credit constraint status and the subsequent investigation of its impact on agricultural productivity. The fourth section describes the estimation strategy and section five details the specification of the estimating equations. The sixth and seventh sections address the reliability, validity, and limitations presented by this study.

### **4.2 Data and survey design**

#### *Data*

This study uses secondary data from the 2011 Agriculture Finance Market Scoping Survey (AgFims). On behalf of the Financial Sector Deepening Trust™ (FSDT) and other stakeholders<sup>10</sup>, Synovate Tanzania™ conducted the survey between April and September 2011. The survey provides a nationally representative cross-sectional dataset of agricultural businesses in Tanzania; this study concerns itself with the sub-sample of agricultural producers.

The full sample consists of 4,094 agricultural households, representing 519,358 agricultural businesses along the value chain; including 489,898 producers, 9,425 processors, and 20,035 service providers. The National Agricultural Policy defines the agricultural sector to include crops, livestock, fisheries, and hunting (MoAFSC 2013, p.2) and the AgFims survey includes agricultural businesses engaged in the crop or livestock sub-sectors. These classifications describe the primary activity that an agricultural business would be engaged in, however this does not preclude involvement in more than one sub-sector across various parts of the value chain.

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<sup>10</sup> The Gatsby Charitable Foundation and the Rockefeller Foundation.

For the purpose of this study the scope of the agricultural sector will be confined to the crop sub-sector; which includes 3,374 agricultural households representing 446,873 agricultural businesses. Hence, the subset under investigation does not include any processors or service providers. A large proportion of the agricultural businesses is captured when focusing on the crop sub-sector, thus a significant loss of representativeness is not expected.

The AgFims survey includes detailed information on the nature, size, and sophistication of each agricultural business, resource endowments and accessibility, demographic characteristics, business activity and income, access to information, risk management practices, and obstacles to growth. Information about financial literacy and behaviour related to saving, borrowing, and investment activity is enumerated, in addition to perceptions about the corresponding financial markets. Furthermore, the survey captures information about loan applications and loan participation over the past 12 months; which may be used to classify agricultural businesses as constrained or unconstrained.

### *Sampling frame*

Considerations of practical and economic feasibility constrain the collection of information on the whole population. A representative sample is a subset of a population of interest, which enables inferences to be made about the target population within resource, operational, and cost constraints. The sampling frame of a survey defines its potential coverage; and it is typically based on the most recent population census, which aims to collect information about all the households and individual household members of the population (Deaton 1997, p.10).

The sampling frame adopted by the AgFims is based on the 2002 Tanzania Population and Housing Census (NBS 2011, p.3), which was the latest population census<sup>11</sup> at the time the survey was conducted. During the nine-year time lapse between the Census and the AgFims survey, changes to the enumeration areas can be plausibly expected as a result of attrition, arising from births and deaths, migration, or redevelopment of particular geographic areas.

Sampling error may arise as a sample is used instead of the whole population. The historical enumeration areas do not account for changes over time, which may result in sampling errors and unrepresentative samples being selected. In addition, the survey may be subject to selection bias, due to the sample frame not adequately capturing some part of the target population.

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<sup>11</sup> A population and housing consensus was conducted in 2012.

Survey designs that use the equal probability of selection method (EPSEM) maintain that each element of the target population has the same probability of being selected into the sample; consequently, every element has the same weight (Kish 1965, p20-21). If each population element does not have the same probability of being selected, sampling weights are necessary to adjust for the sample design and improve the accuracy and representativeness of sample estimates. Unequal selection probabilities imply that households in the selected sample represent different numbers of households in the population. Hence, observations in the sample are adjusted to represent the target population, using design weights based on the sample design (Deaton 1997, p.15). In addition to addressing the disproportionate probability of selection, sampling weights are necessary to address non-response, and post-stratification.

The Agricultural Financial Market Scoping survey employs a three stage stratified sample design, with disproportionate selection (NBS 2011, p.7-8). Assurance that the sample data is representative of the entire population of agricultural businesses in Tanzania is sought by accounting for the probability of inclusion at each stage of the sample design. In particular, the survey takes account of inclusion probabilities for: i) enumerator area selection, ii) the selection of households from selected enumerator areas and, iii) the inclusion of qualifying agricultural businesses from eligible households (NBS 2011, pp.10-11; YDC 2012, p.18).

The *primary sampling units* (PSUs) selected at the first stage are the urban and rural enumeration areas. Enumeration areas represent the smallest operational units of land that a geographical area can be feasibly divided into for conducting a survey or census; in this case the enumeration areas are defined<sup>12</sup> by the 2002 Census. This is to ensure that the sample selection is geographically representative of the country.

The sampling frame is divided into homogenous subgroups, called strata, in preparation for the independent selection of enumeration areas within each stratum; in this case, the strata are defined to be consistent with the geographic domains of the sampling frame. Stratification may increase the precision of estimates and improve the representativeness of the sample by mitigating any potential sampling error inherent in the sample design. The sampler controls strata sizes, and disproportionate allocation may be used to ensure minimum sample sizes for subpopulations of interest. Furthermore, disproportionate stratification may be convenient and serve to minimize cost.

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<sup>12</sup> Operational units were defined “for each administrative region in the Mainland; Unguja and Pemba Islands in Zanzibar.” (NBS, p.3)

Systematic sampling is used to select enumeration areas within strata with probability proportional to size (PPS); the measure of size being the number of households. Synovate(2011b, p.5) defines a household as “a group of people who normally eat from the same pot.” In addition, implicit stratification is employed. Urban and rural geographical domains, region, district, and ward order enumeration areas within each stratum. This technique ensures adequate coverage of representative enumeration areas, as different criteria are expected to predominate across the various geographic domains and sub-domains.

The total number of households in the  $i^{th}$  enumeration area that is found in the  $h^{th}$  stratum may be represented by  $M_{hi}$ , while the total number of households in the  $h^{th}$  stratum is represented by  $M_h$ . The probability of selection of an enumeration area  $p_i$  is reflected by the probability of selecting all the households in an enumeration area, in a particular stratum, from all the households in that stratum:

$$p_i = \frac{M_{hi}}{M_h} \quad (17)$$

A larger sample of enumeration areas in a stratum increases the probability that an enumeration area will be selected. Hence, the reported inclusion probability of enumeration is adjusted for the sample number of enumeration areas  $n_h$  in the  $h^{th}$  stratum:

$$p'_i = n_h \times \frac{M_{hi}}{M_h} \quad (18)$$

At the second stage, households from the selected enumeration areas were systematically selected as the *secondary sampling units* (SSUs). Within each stratum, the listing of all households was done in a “serpentine” way to avoid clustering (Synovate 2011, pp.5-7). Households had to meet certain qualifying criteria to ensure that a sampling frame was defined for agricultural businesses with commercial potential.

Agricultural businesses were defined to include agricultural producers, processors, and service providers; these could either be individuals or business entities. Producers had to be involved in semi-commercial activities, i.e. producing more for sale than consumption; hence, subsistence farmers were precluded from selection. Processors were responsible for the transformation of agricultural products sourced from producers, and service providers were responsible for the provision of services<sup>13</sup> to producers and processors.

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<sup>13</sup> Services may include, but are not limited to, “input providers, information services, agricultural manufacturers, providers of agricultural equipment, professional service providers such as veterinarians, as well as traders such as wholesalers, retailers and middlemen.” (YDC 2012, p.12)

In particular, the income inclusion criteria for producers was that they earned US\$600<sup>14</sup> or more income per year, whereas the income of processors and service providers was benchmarked at US\$1500 or more. For producers, the income threshold defined for inclusion as an agricultural business was described as the estimated amount required to service a micro-finance loan of average size, without difficulty. The threshold for processors and service providers is expected to exceed average income earned by businesses of this nature in Tanzania. The basis of these estimations was not elaborated on further in the metadata

In the event that a producer does not meet the income criteria they may still be selected based on farm size. In particular, farm households that made use of a minimum of 5 acres of land were included in the sample. The size criteria is concerned with access to land for operational use as opposed to mere land ownership; this implies an emphasis on productivity as opposed to mere control.

The different income criteria suggest that the average processor or service provider created more value than the average producer. The wider income range, in conjunction with the additional qualifying criteria based on size, provides a broader scope for the selection of agricultural producers relative to other agricultural businesses. It is on this basis that this study confines its scope to the sub-sample of agricultural producers, in order to enable a certain degree of homogeneity within the population of interest.

After systematically selecting qualifying households, the total number of households in the  $i^{th}$  enumeration area in the  $h^{th}$  stratum may be represented by  $M'_{hi}$ . Let  $m_{hi}$  be the number of households selected from this updated list of qualifying households. Eight households are targeted from each enumeration area. The probability of selecting a qualifying household ( $p_j$ ) from the updated sample of households in the  $i^{th}$  enumeration area is:

$$p_j = \frac{m_{hi}}{M'_{hi}} = \frac{8}{M'_{hi}} \quad (19)$$

At the third stage, household members were randomly selected as the *ultimate sampling units* (USUs). In order to qualify the household member had to be involved in agricultural business and be at least 18 years old. In the event that there was only one qualifying household member they were selected by default. However, if there was more than one qualifying household member then participants were randomly selected<sup>15</sup>.

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<sup>14</sup> The 2011 per capita gross domestic product at current prices was reported at US\$759.75 (IMF WEO, 2015).

<sup>15</sup> Selection was randomized using a Kish Grid (NBS 2011, p.8), which makes use of a random number table as a selection tool.

Let  $k_{ij}$  represent the number of eligible individuals in the  $j^{th}$  household, selected from the  $i^{th}$  enumeration area in the  $h^{th}$  stratum. Given that a single agricultural business is selected from the household members present, the probability of selecting an agricultural business ( $p_k$ ) is:

$$p_k = \frac{1}{k_{ij}} \quad (20)$$

The total inclusion probability  $p_{hij}$  for an individual agricultural business accounts for the probability inclusion at each stage of the sample selection process and is equal to:

$$p_{hij} = \frac{n_h \times M_{hi}}{M_h} \times \frac{m_{hi}}{M'_{hi}} \times \frac{1}{k_{ij}} \quad (21)$$

The sampling weight of the survey  $W_{hij}$  is the inverse of the probability of selection:

$$\begin{aligned} W_{hij} &= \frac{1}{p_{hij}} \\ &= \frac{M_h}{n_h \times M_{hi}} \times \frac{M'_{hi}}{m_{hi}} \times k_{ij} \end{aligned} \quad (22)$$

Non-response could impact the probability of inclusion; hence ex post adjustments may need to be made to the initial weights. After the initial weights have been adopted, post stratification adjustments may also be employed to update the sample distribution in line with the target population distribution. These adjustments can address under-coverage of key population indicators and/or non-response. The selection of USUs ensures that the enumerator interviewed a random sample of qualifying agricultural businesses. Given the selection of eight households in stage two, it is expected that eight interviews would be conducted in each enumerator area; however, this was not always the case. If the selected household member was unavailable for the interview, they were replaced by a random selection from the qualifiers not previously selected, within the enumeration area. If the selected enumerator area yielded no interviews, it was replaced by a random selection from the remaining enumerator areas.

The number of qualifying households in the  $i^{th}$  enumeration area in the  $h^{th}$  stratum may be represented by  $m'_{hi}$ , while the number of agricultural businesses from this sample with completed questionnaires is  $m''_{hi}$ . The initial weights are adjusted for non-response using the

inverse of the probability of securing a completed questionnaire from the updated sample of qualifying households selected in an enumeration area. Thus, the adjusted sampling weights  $W'_{hij}$  are:

$$W'_{hij} = W_{hij} \times \frac{m'_{hi}}{m''_{hi}} \quad (23)$$

This study concerns itself with agricultural producers, particularly within the crop sub-sector. Ex-post weight adjustments would be required in order to reflect this non-random sampling. The total sample of agricultural businesses selected may be represented by  $N_h$ , while the total number of crop producers may be represented by  $n_h$ . The adjusted weights (8) are further adjusted using the inverse of the probability of being selected from the crop sub-sector; these adjusted sampling weights  $W''_{hij}$  are:

$$W''_{hij} = W'_{hij} \times \frac{N_h}{n_h} \quad (24)$$

In summary, the first stage was expected to result in a sample of 626 enumeration areas being drawn, with 8 households being selected at the second stage, and 8 agricultural businesses being selected at the third stage. Thus, the sample design targeted a sample size of 5008 agricultural businesses. The survey ultimately resulted in 639 enumeration areas being drawn, which were geographically representative at the national and urban-rural level, and 4094 interviews being conducted. The most frequently interviewed agricultural businesses were those involved in production, 3,734, followed by service providers and processors, with 256 and 104 respectively (YDC 2011, p.16).

### 4.3 Research approach and strategy

Empirical literature addressing the impact of credit constraints on the consumption and production decisions of agricultural households has used survey data to estimate the likelihood of being credit constrained and its impact on various economic outcomes (Petrick 2005, pp.196-198). Studies have typically estimated these impacts using two-step procedures; which are inefficient and may result in standard errors that are not consistent. A one-step procedure overcomes these challenges, and accounts for the potential simultaneity of consumption and production decisions in the context of a binding credit constraint.

Two distinct steps describe the empirical strategy undertaken by this study. The *first stage* involves making use of qualitative information obtained from a representative household survey to ascertain the credit constraint status of agricultural businesses in Tanzania. The classification of credit constraint status, across borrowers and non-borrowers, may be delineated by whether constraints are induced from the supply-side or the demand-side (Boucher et al 2009 pp.612-615; Guirkinger and Boucher 2008, p.297). This study follows a structured procedure to identify the credit constraint status of agricultural households and is aptly described in the literature as the *Direct Elicitation Method (DEM)*.

Sample selection bias (or *selectivity bias*) may arise when a sample is not randomly chosen from a target population, such that the sample is not representative of the whole population. In order to analyze the productivity of crop producers in Tanzania, a large part of the agricultural business population is omitted from the initial sample, since livestock producers, processors, and service providers are not included in the sample. Heckman (1979, p.153) postulated that sample selection bias may result either from self-selection by sampling units or selection decisions during data processing or data analysis. Hence, the reasons why agricultural business owners are involved in crop production, amongst other activities, are not random.

An inverse probability weight is applied to address the non-random sampling of agricultural households involved in crop production from the total sample of agricultural businesses representative of the whole population in Tanzania.

The Heckman selection model is applied only when one regime is observed and conclusions are inferred from observations of that regime, whereas switching regression models are applied when both regimes are observed (Dutoit 2007, pp.28-30).

Hence, the primary difference arises from the dependent variable being observed in either only one or two regimes, respectively. However, in the Heckman framework, the unobserved regime needs to be taken into account in the estimation strategy. While the Heckman framework is only appropriate when the switch is endogenous, the switching regression may be applied if the switch is either endogenous or exogenous.

In this study, the sample separation is known and has been ascertained using the direct elicitation method that indicates the constraint status (or regime) that each crop producer belongs to. Output value per hectare is observed for both constrained and unconstrained agricultural businesses, while the sample under investigation is representative of all crop producers. Hence, regressing the output value per hectare on crop producers' firm and household characteristics would lead to estimates for the sample of all crop producers and therefore allow conclusions to be inferred for the whole population.

The switching model is endogenous as credit constraint status presumably depends on the output value per hectare in the two regimes. It is expected that crop producers' extent of access to credit, and consequently their opportunity for participation in credit, may be enhanced by their improved productivity. Conversely, it is assumed that crop producers are rational and will seek to relax credit constraints under the premise that productivity is better for unconstrained agricultural businesses.

Accordingly, the *second stage* of this study makes use of the output from the first stage and an endogenous switching regression model is adopted in order to investigate the impact of credit constraint status on agricultural productivity in Tanzania.

The switching regression model will enable the simultaneous estimation of the likelihood of being credit constrained and the consequential impact on gross farm income; taking into account both endogeneity and sample selection (Lokshin and Sajaia 2004, p.282).

Differences in agricultural production value between constrained and unconstrained households may provide motivation for programmes that enhance the provision of finance. However, evidence that suggests constrained households misallocate capital away from productive activities may undermine any efforts to increase the supply of funding in credit markets.

## *First Stage*

The first stage of the study makes use of the DEM and will draw on the borrowing module within the financial behaviour section of the AgFims survey for relevant information about the characteristics of borrowing behaviour and perceptions about credit constraint status. Firstly, we would like to separate households by whether they applied to borrow funds or not. The survey asks a question about each agricultural household's attempts to borrow from particular sources of funds. Various formal and informal sources of funding are presented as options.

From which of the following have you attempted to borrow money from in the past 12 months? <sup>16</sup>

Thereafter, loan applicants are classified as either borrowers or non-borrowers based on whether they obtained a loan in the past or not. If they did obtain a loan, the survey goes one step further in eliciting information about the particular source(s) of funds.

Have you borrowed money in the past 12 months for business purposes? <sup>17</sup>

If Yes, where did you borrow from? <sup>18</sup>

Supply-side constraints arise when the suppliers of credit do not provide a sufficient supply to meet demand; thus, this excess demand is a consequence of *quantity rationing*. Using the Direct Elicitation Method, Boucher et al (2009, p.618) identified three distinct groups of supply-constrained households, namely: unsatisfied borrowers, rejected applicants, and “certainly rejected” non-applicants.

Unsatisfied borrowers are able to borrow, albeit the supply of funds available does not meet their demand. This group may be identified either by eliciting qualitative information about a borrower's desire for more funds at the prevailing interest rate or by collecting quantitative information pertaining to the amount of credit requested and the credit limit granted. In the absence of such information, we are unable to delineate borrowers by whether they are satisfied or not.

Rejected applicants are unable to borrow, despite having a positive demand for credit. These households may be identified presuming that they made an unsuccessful attempt to borrow.

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<sup>16</sup> Survey Question M2. Responses [Yes/No]: Bank, MFI, Sacco, VICOBA, VSLA, ROSCA, Savings group, Money Lender, Customers, Friends and Family, SIDO, FINCA, Farmers Association, PRIDE, DASPU, Cooperative, Pastoralists, SPG, Tribal association.

<sup>17</sup> Survey Question M3.a. Responses: Yes/No

An unsuccessful attempt is necessary, but not sufficient, to strictly classify a household as a rejected applicant. “Certainly rejected” non-applicants did not attempt to borrow as they anticipated their applications would be rejected based on previous experiences or their perceptions about the suppliers of funding. The former classification is a factual observation resulting from a “positive” outcome, whereas the latter classification is a hypothetical construct derived from a normative expectation of credit suppliers’ behaviour.

The information provided by the survey in question does not explicitly address whether applicants were successful in their application for borrowed funds or not. However, by comparing the attempts to borrow from particular sources of funds with the actual borrowing undertaken by each respective household we may make some inferences about access to credit and credit constraint status.

An attempt to borrow funds from a particular source is interpreted as a loan application. A borrower is entitled to submit more than one application for funds; as such numerous attempts may have been made to borrow from the same source or various sources. Further, the survey does not provide any insights into the sequencing and timing differences of borrowing attempts, particularly for those agricultural households that submitted more than one loan application over the previous twelve months.

The observed borrowing event may be unambiguously interpreted as participation in credit from a particular source; conversely, a household that attempted to borrow from a particular source of funds, yet does not actually borrow, is interpreted as having been rejected from that particular source. In much the same way that loan applicants are not confined to a single source of funds, participation in multiple sources of funds is permitted.

In the context of a single source of funding, rejected applicants may be unequivocally classified as supply-side constrained. The survey in question provides scope for households to attempt to borrow from numerous sources of credit. Thus, a household is classified as rejected if, and only if, it does not participate in any sources of credit, despite attempting to borrow from them.

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<sup>18</sup> Survey Question M3.b. Responses [Yes/No]: Bank, MFI, Sacco, VICOBA, VSLA, ROSCA, Savings group, Money Lender, Customers, Friends and Family, SIDO, FINCA, Farmers Association, PRIDE, Auctioneers, Presidential trust fund, Shareholders group.

An unsuccessful attempt to borrow from one source may be followed up with a successful application to borrow from a different source of funds. Hence, the aggregate supply of funds available to a household may be sufficient to meet its demand even if not all loan applications are successful.

Households that participated in at least one source of funding are treated as borrowers, however at least one unsuccessful attempt at borrowing from any source is sufficient to classify these borrowers as quantity rationed. We premise this assumption on the basis that more credit is preferred to less; and a household that is able to obtain funding, from all the sources that it applied to, is better off than a household that did not. Despite having been rejected, these borrowers have been able to secure credit out of the numerous attempts and are hence considered to be unsatisfied borrowers.

Rejected applicants and “certainly rejected” non-applicants are classified as non-borrowers. Based on the reasonable assumption that loan participation is preceded by a loan application, households that did not attempt to borrow may be viewed as a subset of non-borrowing households. Further information is required to identify households’ reasons for not borrowing; the survey asks a question to elicit this information.

Why have you not borrowed money for the business? <sup>19</sup>

The responses to this question (*see* Table 5) provide key insights into each non-borrowing household’s credit market experiences and perceptions. Response A, “Tried but was unsuccessful”, provides the only indicator of households that were unambiguously rejected from any sources of credit. Responses B - E highlight responses that would be expected from households that were “certainly rejected” based on previous experiences and/or their perception of credit suppliers’ behaviour and lending rules. The most common response amongst the supply-constrained households addresses the perception that “there is nobody/institution that will lend the business money”, while the least common response being that they “don’t meet the requirements.”

Unconstrained households are loan applicants and non-applicants whose demand for credit is fully met. As was the case in identifying unsatisfied borrowers, satisfied borrowers may only strictly be identified either by eliciting a lack of desire for more funds or using detailed information that allows us to compare the amount of credit requested against the credit granted. The information at hand presents limitations to such a detailed exposition.

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<sup>19</sup> Survey Question M9. See Table 5 for responses.

Nevertheless, we are able to infer satisfaction by observing that all the sources of funds that a household attempted to borrow from correspond with the all sources of actual borrowing. A successful loan application is assumed to be synonymous with a satisfied borrower; consequently, the number of households that are supply-side constrained may be understated.

**Table 5. Reasons enumerated for non-borrowing**

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<i>Quantity constrained (constrained)</i>
A. Tried, but was unsuccessful
B. There is nobody/institution that will lend the business money
C. Poor credit record
D. Did not have collateral/security
E. Don't meet the requirements
<i>Price rationed (unconstrained)</i>
F. Business did not need to borrow
G. Interest rate is too high
<i>Transaction-costs rationed (constrained)</i>
H. Don't know where to borrow from, how to go about it
I. I have not done preparation to get a loan
J. Takes too long to get the money
<i>Risk rationed (constrained)</i>
K. Business has too much debt already
L. I do not like to borrow money, fear of defaulting
M. Repayment terms are too tight
N. Religious reasons, no interest.

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Source: Synovate Tanzania (2011a, p.45)

Non-applicant households were further classified as unconstrained if they reported that the business did not need to borrow or that interest rates were too high. These price-rationed households are not inhibited by asymmetric information in their access to credit, however they are able to voluntarily withdraw from participation in credit until such a time when conditions are favourable.

Demand-side constraints arise when households, with potentially profitable investment opportunities, voluntarily limit their participation in credit. Both borrowers and non-borrowers are subject to these constraints. Although credit rationing has been described as an equilibrium phenomenon in credit markets, there may be individual households that are presented with adequate access to credit. The nature of the demand-side constraints may be ascertained by investigating the motivations for households' non-borrowing, as highlighted in Table 5 above.

An excess supply of funds may arise as a result of frictions in credit markets. *Transaction costs rationing* and *risk rationing* are limitations on borrowing, imposed by both loan applicants and non-applicants, resulting from an avoidance of high transaction costs and an aversion to the uncertainty associated with higher return activities, respectively. Responses H - J provide indications of households that limited their borrowing activity as a result of

transaction and search costs associated with borrowing. Households falling under this classification commonly stated that they don't know where to borrow from or how to go about it; this was the most common response among the sample of non-borrowers. Responses K - L provide insight into risk rationed households, with the most common response being that the household does not like to borrow money, which is aggravated by the fear of not being able to settle the obligations as they fall due.

**Table 6. Credit constraints and short term borrowing in the sample of crop producers**

	Borrowers (short term)	Non-borrowers	Total
Unconstrained	535 (15.86)	805 (23.86)	1340 (39.72)
Constrained	1940 (57.50)	94 (2.79)	2034 (60.28)
Price constrained	614 (18.20)	0 (0.00)	614 (18.20)
Quantity constrained	1132 (33.55)	94 (2.79)	1226 (36.34)
Transaction cost constrained	623 (18.46)	0 (0.00)	623 (18.46)
Risk constrained	292 (8.65)	0 (0.00)	292 (8.65)
Total	2475 (73.36)	899 (26.64)	3374 (100)

Note: Each cell provides the absolute number of agricultural businesses; proportion of total sample in brackets

In summary, we classified agricultural businesses as constrained, in the formal or semi-formal sector, or unconstrained; in addition to classifying them as borrowers or non-borrowers. Approximately 73.36% of the agricultural producers in the study are reported to have borrowed money for business purposes in the past 12 months. Among those who participated in short-term borrowing, 78.38% were classified as credit constrained in the formal or semi-formal sectors, whereas amongst non-borrowers only 10.46% were classified as being constrained in credit. In this case, quantity constrained agricultural businesses represent the full subsample of non-borrowers, whereas they represent 45.74% of all borrowing agricultural producers. Transaction costs rationed represents a substantial portion of borrowers in the sample, at 25.17%, followed by agricultural businesses that are price rationed or unconstrained. Risk rationed agricultural businesses represent the smallest percentage of constrained borrowers. In the total sample of borrowers and non-borrower, we classified approximately 60.28% as constrained in the formal or semi-formal sector.

## Second Stage

The second stage of this study investigates the likelihood of being credit constrained and its impact on economic output. To ensure that our investigation is theoretically consistent, the classification of credit constraint status may be defined within the context of the agricultural household model developed earlier. We rearrange the budget constraint (3) as follows:

$$K \geq \left[ \sum_i w_i x_i + M(z_h) - (E + S) \right] \quad (25)$$

Let the demand of and supply for credit be defined as follows:

$$Supply_{Credit} \equiv K \equiv K_S \quad (26)$$

$$Demand_{Credit} \equiv K_D \equiv \left[ \sum_i w_i x_i + M(z_h) - (E + S) \right] \quad (27)$$

We define a variable  $k_i^*$  as the difference between the demand for and supply of credit; i.e. a representation of the excess demand for credit:

$$k_i^* = K_D - K_S \quad (28)$$

The interaction of credit supply and demand is not directly observable; as such we assume that excess credit demand is denoted by a latent variable. Hence, the selection equation of credit constraint status is represented as follows:

$$k_i^* = \gamma \mathcal{Z}_i + u_i \quad (29)$$

$$k_i = \begin{cases} 1 & \text{if } k_i^* > 0 \\ 0 & \text{if } k_i^* \leq 0 \end{cases} \quad (30)$$

The vector  $\mathcal{Z}_i$  represents explanatory variables, such as household and production characteristics, which affect the probability of an agricultural business being credit constrained,  $\gamma$  is a vector of parameters to be estimated, and  $u_i$  is a random error term.

Suppose we observe a binary indicator variable  $k_i$  that equals one if an agricultural business is supply-side credit constrained and zero otherwise. Frictions arising from transaction costs or risks may result in the agricultural business voluntarily participating in less credit than it has access to. Thus, demand-side constraints would be represented by an indicator variable  $k_i$  that may equal one despite an excess supply of credit.

## 4.4 Econometric model

### *Endogenous Switching Regression model*

Following Feder et al (1990), Foltz (2004), Winter-Nelson and Temu (2004) and Ali et al (2014) we estimate an endogenous switching regression model of agricultural productivity, which describes the outcomes of agricultural businesses that are sorted into two groups based on their credit constraint status. The outcome equations are represented as:

$$y_{i= \begin{cases} y_{1i} = \gamma_1 X_{1i} + \varepsilon_{1i} & \text{if } k_i = 1 \\ y_{0i} = \gamma_0 X_{0i} + \varepsilon_{0i} & \text{if } k_i = 0 \end{cases} \quad (31)$$

Here, the dependent variables  $y_i$  are the observed outcomes for agricultural businesses that are constrained ( $y_{1i}$ ) and unconstrained ( $y_{0i}$ ), respectively.  $X_{1i}$  and  $X_{0i}$  represent explanatory variables that would influence both  $y_i$  and  $k_i^*$ ; as such there is overlap between  $X_i$  and  $Z_i$ .  $\gamma_1$  and  $\gamma_0$  are vectors of parameters to be estimated, and  $\varepsilon_{1i}$  and  $\varepsilon_{0i}$  are random error terms.

The error terms  $u_i$ ,  $\varepsilon_{1i}$  and  $\varepsilon_{0i}$  are assumed to be jointly normally distributed, with zero mean and covariance matrix:

$$Cov(u_i, \varepsilon_{1i}, \varepsilon_{0i}) = \Sigma = \begin{bmatrix} \sigma_u^2 & \sigma_{1u} & \sigma_{0u} \\ \sigma_{1u} & \sigma_1^2 & \cdot \\ \sigma_{0u} & \cdot & \sigma_0^2 \end{bmatrix} \quad (32)$$

$\sigma_u^2$  is the variance of the error term in the selection equation; it is assumed to be equal to 1 as  $\gamma$  is only estimable up to a scale factor (Maddala 1983, 223; p.1986, p.1635).  $\sigma_1^2$  and  $\sigma_0^2$  are the variances of the error terms in the outcome equations.  $\sigma_{1u}$  is the covariance of  $u_i$  and  $\varepsilon_{1i}$ , while  $\sigma_{0u}$  is the covariance of  $u_i$  and  $\varepsilon_{0i}$ . The covariance  $\sigma_{12}$ , between  $\varepsilon_{1i}$  and  $\varepsilon_{0i}$ , cannot be defined as  $y_{1i}$  and  $y_{0i}$  can never be observed simultaneously (Maddala 1983, p.224).

Unobserved characteristics that simultaneously affect the probability of being credit constrained and the economic outcome may result in the error term of the selection equation being correlated to the error terms of the outcome equations. Hence, the expected values of  $\varepsilon_{1i}$  and  $\varepsilon_{0i}$ , conditional on the sample selection, are nonzero:

$$E[\varepsilon_{1i} | k_i = 1] = \sigma_{1u} \lambda_{1i} \quad \text{where} \quad \lambda_{1i} = \frac{\phi(\beta z_i)}{\Phi(\beta z_i)} \quad (33)$$

$$E[\varepsilon_{0i} | k_i = 0] = \sigma_{0u} \lambda_{0i} \quad \text{where} \quad \lambda_{0i} = -\frac{\phi(\beta z_i)}{1 - \Phi(\beta z_i)} \quad (34)$$

$\phi(\cdot)$  is the standard normal probability density function and  $\Phi(\cdot)$  is the standard normal cumulative density function. If the estimated covariances  $\sigma_{1u}$  and  $\sigma_{0u}$  are statistically significant, then credit constraint status and the output value per hectare are correlated. This provides evidence of endogenous switching and serves as motivation for the appropriateness of the estimation strategy.

The Full Information Maximum Likelihood (FIML) method is an efficient approach for estimating endogenous switching regression models.<sup>20</sup> The FIML simultaneously estimates the selection and outcome equations in order to obtain consistent standard errors; while the simultaneous maximum likelihood estimation corrects for selectivity bias across constraint-status output estimates (Lokshin and Sajaia 2004, pp.282-284; Di Falco et al 2011 pp.835-840; Asfaw et al 2012, p.286). Given the assumptions about the distribution of the error terms, the logarithmic likelihood function for the system of equations (29) and (31) is:

$$\begin{aligned} \ln L_i = & \sum_{i=1}^N z_i \left[ \ln \phi \left( \frac{\varepsilon_{1i}}{\sigma_{1u}} \right) - \ln \sigma_{1u} + \ln \Phi(\varphi_{1i}) \right] \\ & + (1 - z_i) \left[ \ln \phi \left( \frac{\varepsilon_{0i}}{\sigma_{0u}} \right) - \ln \sigma_{0u} + \ln (1 - \Phi(\varphi_{0i})) \right] \end{aligned} \quad (35)$$

Where,

$$\varphi_{ji} = \frac{\beta z_i + \rho_j \varepsilon_{ji} / \sigma_j}{\sqrt{1 - \rho_j^2}} \quad j = 0, 1 \quad (36)$$

$\rho_j$  represents the correlation coefficient between the selection equation error  $u_i$  and outcome equations respective errors  $\varepsilon_{ji}$ .

<sup>20</sup> The “movestay” command of STATA was used to estimate the endogenous switching regression model (Lokshin and Sajaia 2004, p.284)

### Conditional expectations, treatment and heterogeneity effects

Following Di Falco et al (2011, pp.836-837) and Asfaw et al (2012, pp. 287-288), the endogenous switching regression model can be used to compare the expected value of output per hectare of the agricultural businesses that are credit constrained (a) with respect to the agricultural businesses that are not constrained (b). Further, the model may be used to investigate expected economic outcomes in the counterfactual hypothetical cases that constrained households were not constrained (c), and unconstrained households were constrained (d). The conditional expectations can be evaluated as follows:

$$E(y_{0i} | k_i = 0) = \gamma_0 X_{0i} + \sigma_{0u} \lambda_{0i} \quad (37a)$$

$$E(y_{1i} | k_i = 1) = \gamma_1 X_{1i} + \sigma_{1u} \lambda_{1i} \quad (37b)$$

$$E(y_{1i} | k_i = 0) = \gamma_1 X_{0i} + \sigma_{1u} \lambda_{0i} \quad (37c)$$

$$E(y_{0i} | k_i = 1) = \gamma_0 X_{1i} + \sigma_{0u} \lambda_{1i} \quad (37d)$$

In order to investigate the impact of credit constraints on agricultural productivity we calculate the relevant treatment effects. Table 7 summarizes the conditional expectations, treatment and heterogeneity effects.

**Table 7. Conditional expectations, treatment, and heterogeneity effects**

Sub-samples (constraint status)	Observed outcome		Treatment effects
	Unconstrained ( $y_{0i}$ )	Constrained ( $y_{1i}$ )	
Unconstrained ( $k_i=0$ )	(a) $E(y_{0i} k_i=0)$	(c) $E(y_{1i} k_i=0)$	$TT$
Constrained ( $k_i=1$ )	(d) $E(y_{0i} k_i=1)$	(b) $E(y_{1i} k_i=1)$	$TU$
Heterogeneity effects	$BH_0$	$BH_1$	$TH$

Source: Adapted from Di Falco et al (2011, p.837), Asfaw et al (2012, p.287)

Notes:

(a) and (b) represent observed expected crop output value per hectare;

(c) and (d) represent counterfactual expected crop output value per hectare.

$k_i = 0$  if agricultural business is unconstrained;

$k_i = 1$  if agricultural business is credit constrained;

$y_{0i}$  : crop output value if agricultural business is unconstrained;

$y_{1i}$  : crop output value if agricultural business is unconstrained;

$TT$ : the effect of the treatment (i.e., credit constraint relaxation) on the treated (i.e., agricultural businesses that were unconstrained);

$TU$ : the effect of the treatment (i.e., credit constraint relaxation) on the untreated (i.e., agricultural businesses that were constrained);

$BH_i$  : the effect of base heterogeneity for agricultural businesses that were unconstrained ( $i = 0$ ), and constrained ( $i = 1$ );

$TH = (TT - TU)$ , i.e., transitional heterogeneity.

We begin by evaluating the effect of the treatment on the treated ( $TT$ ) to determine the impact of credit constraint relaxation (i.e. the treatment in this instance) on the agricultural productivity of agricultural businesses that are unconstrained. Intuitively, this represents the difference between the actual expectations observed in the sample of agricultural businesses that were unconstrained (a) and the counterfactual expected outcomes of relaxing the credit constraints of constrained businesses (c):

$$\begin{aligned} TT &= E(y_{0i} | k_i = 0) - E(y_{1i} | k_i = 0) \\ &= (\gamma_0 - \gamma_1)X_{0i} + (\sigma_{0u} - \sigma_{1u})\lambda_{0i} \end{aligned} \quad (38)$$

We evaluate the effect of the treatment on the untreated ( $TU$ ) to determine the impact of the credit constraints on the agricultural productivity of agricultural businesses that are constrained. This represents the difference in outcome between the counterfactual case where unconstrained agricultural businesses experience credit constraints (d) and the actual expectations observed for constrained businesses (b):

$$\begin{aligned} TU &= E(y_{0i} | k_i = 1) - E(y_{1i} | k_i = 1) \\ &= (\gamma_0 - \gamma_1)X_{1i} + (\sigma_{0u} - \sigma_{1u})\lambda_{1i} \end{aligned} \quad (39)$$

The base heterogeneity effect  $BH_0$  is calculated to determine the difference between the actual expected outcomes observed in the sample of agricultural businesses that were unconstrained (a) relative to the counterfactual case where credit constraints are imposed on unconstrained agricultural businesses (d):

$$\begin{aligned} BH_0 &= E(y_{0i} | k_i = 0) - E(y_{0i} | k_i = 1) \\ &= \gamma_0(X_{0i} - X_{1i}) + \sigma_{0u}(\lambda_{0i} - \lambda_{1i}) \end{aligned} \quad (40)$$

Similarly, the base heterogeneity for constrained agricultural businesses  $BH_1$  is the difference between (c) and (b):

$$\begin{aligned} BH_1 &= E(y_{1i} | k_i = 0) - E(y_{1i} | k_i = 1) \\ &= \gamma_1(X_{0i} - X_{1i}) + \sigma_{1u}(\lambda_{0i} - \lambda_{1i}) \end{aligned} \quad (41)$$

The transitional heterogeneity effect  $TH$  is calculated to determine whether the impact of relaxing credit constraints is larger or smaller for agricultural businesses that were actually unconstrained or for constrained agricultural businesses in the counterfactual case that their constraints were relaxed; this is represented by the difference between  $TT$  and  $TU$ :

$$\begin{aligned} TH &= TT - TU \\ &= (\gamma_0 - \gamma_1)(X_{0i} - X_{1i}) + (\sigma_{0u} - \sigma_{1u})(\lambda_{0i} - \lambda_{1i}) \end{aligned} \quad (42)$$

## 4.5 Specification of the estimating equations

### *Selection and outcome dependent variables*

In the selection equation, the latent variable representing credit constraint status or excess credit demand is defined as a dummy variable that takes on the value one ( $k_i = 1$ ) when an agricultural business is constrained in the formal<sup>21</sup> or semi-formal<sup>22</sup> credit sector and zero otherwise ( $k_i = 0$ ). In the outcome equation, the measure of productivity adopted by this study is the crop output value per hectare (Feder et al 1990, p.1155; Guirkingner and Boucher 2008, p.302); which reflects the approximate income of the agricultural business per hectare of land used for the purpose of production. We define the outcome variable using land used by the agricultural business as it is reflective of the production potential of the business. The definitions of the variables used in this study are reported in Appendix Table 11.

### *Farm characteristics*

Land owned is used as a measure of fixed capital and an indicator of collateralizable wealth. In Tanzania, the Land (Amendment) Act, 2004 permits owned and registered land to be mortgaged and used as collateral (URT 2004, p.6-11), as such an increase in the land endowment is expected to have a direct, positive impact on the supply of credit (Foltz 2004, pp.232; Petrick 2004, p.89). Further, we include a dummy variable that takes on the value one when the business owner has a title deed and zero otherwise.

Guirkingner and Boucher (2008, pp.299-303) explore the possibility of reverse causality relationship between holding title and productivity; such that in anticipation of a greater credit need, “farmers with a greater intrinsic productivity” would have a higher likelihood of obtaining title for their land holdings. *Ceteris paribus*, we expect to observe a negative relationship between the land endowment of an agricultural business and crop output value per hectare, as the variable inputs available to the business may be constrained and thus inefficiently utilized over larger areas of land. Hence, the agricultural businesses in the sample are expected to experience diminishing returns to scale.

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<sup>21</sup> Formal Financial Institutions include: commercial banks

<sup>22</sup> Semi-Formal Financial Institutions include: microfinance institutions, savings and credit cooperative societies, cooperatives, non-governmental organisations (i.e. FINCA, SIDO, PRIDE), and government-mandated institutions (Presidential Trust Fund, and the DASPU project).

Ownership of a storage facility or warehouse represents fixed capital, and further reinforces the collateral position of the agricultural business. The quality of fixed capital and collateralizable wealth is captured by whether an agricultural business owner has an irrigation system or not; which is expected to enhance the productivity potential of the business.

Involvement in a cooperative or farmer's association provides an avenue to gain access to social networks and information and was measured using a dummy variable that took on the value one if the agricultural business owner received advice from the relevant association and zero otherwise (Ali et al 2014, p.659). Given that the distribution of loans from semi-formal institutions is oftentimes channeled through local institutions, potential borrowers association membership may enhance their reputational capital, as activity in associations may signal to potential lenders that an agricultural business is well known locally.

Hence, associational activity is expected to improve communication and enhance the flow of information to farmers; reducing transaction costs, particularly related to the loan application process and the understanding of contractual terms. Thus, we expect association membership to reduce the likelihood of an agricultural business being credit constrained. Further, the flow of information and communication is expected to relate to agricultural practice that may positively impact the productivity of the farm.

We include the number of full time and part time family members who work for the business, in addition to the agricultural business owner, to serve as a measure of a household's endowment of family labour (Winter-Nelson 2005, p.878). Guirkinger and Boucher (2009, p.303) highlight the importance of family labour and the positive impact it is expected to have on credit constrained farm households, further positing that the substitutability of hired and family labour will determine the extent to which the family labour endowment affects the productivity of unconstrained farm households.

### *Farmer and farm household characteristics*

The savings commanded by an agricultural business represents the initial liquidity endowment. Savings in financial institutions are captured using a dummy variable that takes on the value 1 if the agricultural business has savings in formal financial institutions (i.e. registered bank or shares). It is expected that the availability of savings would contribute to the relaxation of credit constraints experienced by the business, while enhancing crop output value per hectare if funds are directed towards productive activities.

Petrick (2004, p.88) raised issues with the operationalization of total liquidity as a stock variable, at a point in time. In particular, the relative ease of transformation into cash, for various asset classes, would require assumptions that may be difficult to evaluate; and cash stocks may exhibit variability across production structures and seasons, making it difficult to compare across agricultural businesses or households. As such, the availability of savings serves as an indicator of liquidity as it addresses the concerns of convertibility and comparability.

The number of dependents serves as an indicator of household size, in conjunction with the endowment of family labour (Feder et al 1990, p.1154). The consumption needs of the household, and the associated liquidity needs, are expected to increase with the addition of each non-productive household member (Petrick 2004, p.90). Hence, each additional dependent is expected to increase the likelihood of an agricultural business being credit constrained. Further, the number of dependents is expected to be inversely related to labour capacity, which may adversely impact farm productivity.

The age of the farmer and the number of years of involvement in farming-related activities may serve to indicate labour capacity and experience. Age is represented by continuous data. Due to the absence of continuous data for years of experience it was measured using a dummy variable that takes on the value one when the agricultural business owner has been involved in agriculture for more than five years and zero otherwise. It is expected that more years of experience would enhance the labour capacity available to the business and hence its productivity, while an increase in the age of the farmer is expected to marginally diminish labour capacity. Further, the former is expected to lower the likelihood of being credit constrained and the latter is expected to have an adverse impact on credit constraint status.

The education level of the business owner is captured by dummy variables that take on the value one to indicate either: i. no education; ii, incomplete primary education; iii; completed primary education; iv, completed secondary education, or otherwise. It is expected that higher levels of education will have a larger, positive impact on gross farm income resulting from the intrinsic capabilities and skills of the producer; while reducing the likelihood that the farm household is credit constrained (Winter-Nelson 2005, p.876).

We include a dummy variable that takes on the value one when the agricultural business owner is male and zero otherwise. Fletschener (2008, pp.626-628) uses a sample of 210 couples in rural Paraguay to identify the respective credit constraint status of each spouse. It was found that women are more likely to be credit constrained, and their constraint status may be impacted by different factors to those that influence men's constraint status. Furthermore, husbands that were able to intermediate credit to their spouses were shown to choose otherwise. Hence, it is expected that female owned agricultural businesses will exhibit a higher likelihood of being credit constrained. Following from this, we would anticipate that male owned agricultural businesses with increased access to credit would have enhanced productivity potential than female owned businesses.

In the absence of input and output price data, we assume that price variability amongst observations in the Agricultural Financial Marketing Scoping Survey is low and somewhat negligible. Any variation in prices is assumed to be based on geographic differences and crop choice. Hence, we include eight dummy variables for the zones<sup>23</sup> in which each respective agricultural business operates (Feder et al 1990, p.1154); and four dummy variables that take on the value one if the agricultural business is involved in the production of any of the following crops: maize, cassava, cotton or cashew, and zero otherwise. The aforementioned crops were included due their influence on the performance of food and cash crops in Tanzania.

For identification purposes, it is important to introduce exclusion restrictions and include variables that influence the selection variable without having an impact on the outcome variable. In addition to the explanatory variables from the outcome equation, the selection equation includes a set of instrumental variables that will affect the agricultural business's credit constraint status, but not the crop output value per hectare. In particular, we use indicators of information and net government transfers that would indirectly support production and consumption activity by directly contributing to the relaxation of the credit constraints experienced by an agricultural household. The measure of information is an extension services dummy variable that takes on the value one if the agricultural business owner received advice from the government and zero otherwise; the measure of government transfers is a dummy variable taking the value one if the agricultural business made use of any inputs or services that were subsidized or provided by the government.

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<sup>23</sup> Northern, Western, Central, Southern Highlands, Lake, Eastern, Southern, and Zanzibar zones.

## 4.6 Research reliability and validity

*Reliability* describes the consistency and reproducibility of the output produced by a measurement instrument under varying circumstances, *ceteris paribus*; while *validity* relates to the strength and accuracy of our inferences, i.e. alignment between what we intend to measure and what we actually measure (Roberts P et al 2006, p.1; Adams et al 2007, pp.235-240). Internal validity investigates the causality relationship between our treatment and outcome, whereas external validity relates to the generalizability of our results. Reliability is necessary, but not sufficient for validity. By testing alternative specifications we are able to stress test the generalizability and sensitivity of our output.

Following Di Falco (2011) and Asfaw et al (2012), the acceptability of the proposed instruments is evaluated by conducting a rejection test; which tests the suitability and validity of instruments by determining whether they will affect the credit constraint status, but not the crop output value per hectare among households that are unconstrained. The results presented in Appendix Table 12 suggest that the two proposed variables are indeed suitable and valid in their use as instrumental variables; together, they have a jointly statistically significant impact on credit constraint status (selection equation,  $\chi^2 = 19.86$ ;  $p = 0.00$ ), but not on the crop output value per hectare of agricultural businesses that are unconstrained (outcome equation, F -stat. = 0.33,  $p = 0.72$ ).

The design effect (*deff*) and root design effect (*deft*) are concepts that aide in assessing the effect of complex survey design on precision; by comparing the variance of an estimate under the complex design and the variance that we would have hypothetically obtained from simple random sampling without replacement (Deaton 1997, p.15). The *deft* and *deff* ratios are as follows:

$$deft = \frac{s_{CS}}{s_{SRS}} \quad (43)$$

$$deff = \frac{s_{CS}^2}{s_{SRS}^2} \quad (44)$$

where  $s_{CS}$  is the design-based standard error and  $s_{SRS}$  is an estimate of what the standard would be under simple random sampling; with the variances being captured by  $s_{CS}^2$  and  $s_{SRS}^2$ , respectively.

Design effects were obtained using the outcome equation dependent variable, output value per hectare. The effect of the three stage stratified sample design, with disproportionate selection, adopted by the Agricultural Financial Market Scoping reflects a marginal decrease in the standard error to 42,425 , relative to simple random sample 44,266. The deff indicates that the complex survey sample variance is approximately 1.09 times more than if the survey were based on a SRS, using the same sample size. The root design effects (DEFT) measure implies that the confidence intervals would have to be approximately 1.04 times as large as they would under SRS, as DEFT measures how much the sample errors increase by. These findings imply that the output value per hectare is relatively homogeneous within strata. In summary, the simple equivalent sample (SES) is approximately  $n = 3086$ , which is smaller than the actual sample size of 3,734 agricultural producers.

To examine the reliability of our results we repeat our estimation under two alternative specifications. Following Ali et al (2014, p.659-661) the dependent variable in the endogenous switching regression framework is the natural logarithm of agricultural business output value per hectare; hence the outcome equation takes on a *log-linear* or *log-level* form. In the *log-log* specification, the agricultural business's endowment of land and labour per hectare are defined in log form (Guirkinger and Boucher 2008, p.304; Winter-Nelson and Temu 2005, p.878). Examining and controlling for outliers may further evaluate reliability. Based on a visual inspection of histograms, box-plots, and scatterplots of the key continuous variables used in this study (*see* Appendix Figures 1 and 2), we find any outliers are managed effectively through the natural log transformation of our data. Hence, we do not eliminate any observations, as the thresholds would be arbitrary at best; and proceed with our study by estimating the aforementioned alternative specifications. In order to evaluate the robustness and construct validity of our output we estimate alternative specifications whereby we define and operationalize credit constrained agricultural businesses under quantity constraints and all constraints (i.e. quantity, transaction costs, and risk constraints), respectively.

## 4.7 Research limitations

Due to the limited data availability on agricultural activities in Tanzania, this study faces potential measurement issues. The operationalization of credit constraint status was directly elicited from the AgFims survey, however a more purposeful conceptualization of credit constraints may be obtained with a more intent measurement instrument.

In a survey field report, Synovate Tanzania (2011, p.17) reported numerous challenges relating to the survey instrument used during data collection. Respondents were required to report income from the previous year related to the agribusiness, however total income from all sources was typically provided. As a resolution, enumerators were required to emphasize that only income from the targeted agricultural business for the previous year was pertinent. Despite the insistence of the interviewer, the challenge of obtaining an appropriate approximation of income may result in an overestimation of output value per hectare; which may further be exacerbated by recall bias experienced by respondents. Further, the AgFims survey did not capture information on output quantities, input and output prices. As such we are unable to explicitly account for differences in pricing across regions or type of crop.

The cross-sectional nature of the survey instrument adopted by this study precludes the evaluation of the reliability of the findings over time; and limitations to the generalizability of the results may arise due to the census sampling frame being outdated. The historical enumeration areas do not account for changes over time, which may result in sampling errors and unrepresentative samples being selected.

The non-random sampling approach of the survey, and the subsequent sampling of agricultural producers performed by this study, may result in findings that are biased and not representative or generalizable to the Tanzanian agricultural sector. Sampling error may arise as a sample is used instead of the whole population. The survey may be subject to selection bias, due to the sample frame not adequately capturing some part of the target population. In estimating output value per hectare we must be cognizant that the unobserved factors influencing credit constraint status may be systematically related to the expected effects of credit on various economic outcomes. Ex-post weight adjustments are introduced to the design weights to account for the disproportionate probability of selection of households involved in agricultural production. Further, the simultaneous maximum likelihood estimation mitigates selection bias in constraint status output estimates.

## **4.8 Summary and conclusions**

This chapter provided a comprehensive review of the empirical methodology to be undertaken by this study. We discussed the secondary data obtained for this study from the Agricultural Financial Market Scoping survey and described its complex three-stage survey design. The research approach taken by this study may be summarized in two steps. Firstly, we make use of qualitative information in order to determine the credit constraint status of agricultural businesses in Tanzania; and secondly, we use the credit constraint status to investigate its impact on agricultural businesses' crop output value per hectare.

We use secondary data captured by the Agricultural Financial Market Scoping survey between April and September 2011, due to its representativeness of the agricultural landscape in Tanzania. The particular focus of this study is on subsample of crop producers, which account for the largest contribution to economic output and enables the mitigation of any sub-sector variation that may result from self-selection.

The survey employs a three stage stratified sample design to assure that the sample is representative of the target population. The sampling design takes into account inclusion probabilities at the first stage where enumerator areas are selected within strata using systematic sampling, subsequently households are selected using systematic sampling based on inclusion criteria and, finally, qualifying agribusinesses are included based on random selections from eligible households.

A structured exposition was undertaken in order to operationalize and directly elicit the credit constraint status of each agribusinesses, based on the information relating to their financial behaviour provided in the survey. We classified agribusinesses as constrained, in the formal or semi-formal sector, or unconstrained.

We adopt the endogenous switching regression model in order to enhance the efficiency of our estimates, ensure consistency of our standard errors, and mitigate against sample selection bias that may ordinarily arise from implementing two-step procedures. We make use of the Full Information Maximum Likelihood method in order to simultaneously estimate the selection and outcome equations. The output from the endogenous switching regression will be used to calculate relevant treatment effects and investigate the relationship between credit constraint status and crop output value per hectare.

The dependent variable in the selection equation is the credit constraint status of the agribusiness, while the dependent variable in the outcome equation is crop output value per hectare. The explanatory variables capture the characteristics of the farm, the farmer, and the agricultural household that would provide insights into how credit constraint status relates to agricultural productivity.

The farm characteristics are represented by measures of fixed capital and collateral (land, buildings, storage), access to social networks and information (association), and inputs (employees per hectare). The particular farmer and farm household characteristics outline the availability of liquidity (savings in formal financial institutions), depends on the income from the business, owner's age, education, experience, and gender. We also include regional and crop choice dummy variables in order to account for any variation in input and output prices that are not explicitly captured by the specification of the model.

The research strategy provides an opportunity to evaluate the reliability and validity of the estimation parameters. An evaluation of the design effects obtained, using the outcome equation dependent variable, provides evidence that the sample size is adequate relative to a hypothetical sample of agribusinesses selected randomly from the total population rather than a complex survey design.

The econometric model will be estimated with a log-linear form and log-log form, respectively. In particular, the labour and land endowments will be redefined as their natural logarithm equivalents in order to investigate the consistency of the estimation output. The validity of the study will be evaluated by estimating the model under two alternative definitions of credit constraint status, which capture quantity constraints only, and all constraints, respectively.

We acknowledge relevant research limitations, placing particular emphasis on measurement, identification, and generalizability issues. Potential issues related to the reliability of the direct elicitation method and enumeration challenges with regards to gross income are acknowledged. Further, sampling error may arise as a result of the sub-sampling of the crop producers captured by the survey.

## **Chapter 5. Research findings and analysis**

### **5.1 Introduction**

This following chapter reports the significant research findings of the empirical investigation of credit rationing in Tanzania; and is presented in two main sections. The first section presents the descriptive statistics, and in particular, the section describes the sources and uses of borrowed funds for use in the business over the past 12 months, the income distribution of crop producers in the sample by credit constraint status, and lastly the means and standard errors of relevant variables used in the study.

The second section presents the econometric results. The section initially presents the determinants of credit constraints experienced by agricultural businesses in the sample, followed by a presentation of the avenues and extent to which credit constraint status may impact agricultural productivity; concluding with a discussion on the relevant treatment effects experienced by constrained and unconstrained agricultural businesses in the sample.

### **5.2 Descriptive statistics**

The distribution of loan purposes by type of lender is presented in Table 8. Based on the responses captured by the Agricultural Financial Market Scoping survey, informal financial institutions provided 69% of the total number of loans to crop producers in the sample. The primary suppliers of funds were family and friends, which represented 38.7% of loans, followed by loans from customers and moneylenders. The savings and credit groups (i.e. VICOBA<sub>s</sub>, VSLA<sub>s</sub>, ROSCA<sub>s</sub>, and savings groups) accounted for 15% of the total number of loans distributed. Semi-formal financial institutions represented 21.4% of all loans, with SACCOS accounting for the largest share, followed by microfinance institutions. The formal sector accounted for 9.6% of the total number of loans.

Across all sources of funds, the primary motivations for borrowing money were the expansion of the business and the settlement of operational expenses, 51.8% and 35.6% of the total number of loans in the sample, respectively. In addition, 10.7% of the loans were obtained for risk management purposes. None of the loans reported for personal use were sourced from semi-formal institutions, while formal and informal institutions provided 1.8% and 0.4% of personal loans, respectively.

**Table 8. Distribution of loan purposes (uses) by type of lender (sources)**

Source of loans	Total number of loans	% of total loans	Purpose of loan (% distribution across loan type)				
			Expansion	Operational expenses	Risk management	Personal use	Other
<i>Formal</i>							
Bank	110	9.6	59.1	25.5	12.7	1.8	0.9
<i>Semi-formal</i>							
MFI	84	7.3	66.7	25.0	7.1	-	1.2
SACCOS	153	13.4	46.4	39.2	11.1	-	3.3
FINCA	2	0.2	100	-	-	-	-
PRIDE	2	0.2	100	-	-	-	-
Presidential trust fund	1	0.1	-	100	-	-	-
SIDO	3	0.3	66.7	-	-	-	33.3
Subtotal	245	21.4	54.3	33.5	9.4	-	2.9
<i>Informal</i>							
VICOBA	44	3.8	54.5	29.5	11.4	2.3	2.3
VSLA	57	5.0	54.4	31.6	12.3	-	1.8
ROSCA	23	2.0	39.1	43.5	4.3	4.3	8.7
Savings group	48	4.2	54.2	31.3	12.5	-	2.1
Money-lenders	76	6.6	48.7	36.8	14.5	-	-
Customers	87	7.6	52.9	37.9	9.2	-	-
Friends and Family	444	38.7	48.4	40.1	10.6	0.2	0.7
Auctioneers	1	0.1	100	-	-	-	-
Farmers association	8	0.7	62.5	25.0	12.5	-	-
Shareholders group	3	0.3	66.7	33.3	-	-	-
Subtotal	791	69.0	50.1	37.7	10.9	0.4	1.0
Total	1146	100	51.8	35.6	10.7	0.4	1.4

**Table 9. Mean crop output value/ha distribution by credit constraint status**

	Mean	Quintile					n
		1st	2nd	3rd	4th	5th	
Full sample	735,472	91,405	225,547	405,522	757,061	2,764,784	3316
Non-borrower	691,066	90,373	225,848	406,032	757,622	2,913,141	2429
Borrower	865,121	96,024	224,392	404,012	755,796	2,498,232	887
Constrained	667,930	89,128	224,491	406,077	753,969	2,689,602	1994
Unconstrained	840,360	96,083	227,598	404,659	760,576	2,855,734	1322
Price rationed	843,445	94,381	228,262	409,182	781,956	3,261,424	605
Quantity constrained	677,495	89,213	224,408	405,148	752,967	2,586,899	1204
Transaction cost constrained	640,415	86,735	222,088	413,999	762,973	2,931,631	609
Risk constrained	663,618	91,915	227,864	393,830	722,592	2,661,622	286

Note: The September 2011 period ending exchange rate was reported at Tsh 1640 per US dollar (IMF IFS 2015).

The distribution of crop output value per hectare is reported by credit constraint status in Table 9. The full sample of crop producers earns an average income of approximately TZS 735,472 per hectare. Average crop output value per hectare for unconstrained businesses was approximately 25.82% higher than that of constrained businesses, with the former earning 14.26% more than the average agricultural business and the latter earning 9.18% less. Borrowers in the sample reported average income that was 25.19% higher than that of non-borrowers.

Price rationed agricultural businesses are reported as earning a marginally higher average income than their unconstrained counterparts, providing evidence that price constraints are reflective of non-binding liquidity constraints. Agricultural businesses that experience transaction cost constraints report the largest deviation from the mean output value per hectare. Unconstrained producers generally earn more output value per hectare, except for those in the 3<sup>rd</sup> quintile, albeit reflecting a marginal difference between constrained and unconstrained agricultural businesses.

For non-borrowing producers 68% of respondents can be found in quartiles one to three, whereas for borrowing businesses 67% of respondents were captured in quartiles four to six; which provides evidence as to why, on average, non-borrowing agricultural businesses earned less than those that borrowed money over the past 12 months for business purposes, despite the distribution of output value per hectare across quintiles suggesting otherwise.

The largest reported variation from unconstrained producers was reported in the fifth quintile, across the various types of supply and demand-side constraints. Agricultural businesses that were price constrained recorded higher output values per hectare in the uppermost quintile than those that were unconstrained, reinforcing the absence of any binding constraints. On the contrary, businesses that were quantity and risk constrained reported lower average crop output values per hectare in the first and fifth quartiles; providing support for the binding constraints experienced by agricultural businesses and households.

**Table 10. Descriptive statistics**

Variables	Full sample (N = 3316)		Unconstrained (N = 1322)		Constrained (N = 1994)		t-stat ( $\chi^2$ )
	Mean	Standard error	Mean	Standard error	Mean	Standard error	
<i>Outcome variables</i>							
Output value per ha	735,472	(44,429)	840,360	(59,267)	667,930	(53,267)	2.433 **
Log(output value per ha)	12.8047	(0.052)	12.957	(0.054)	12.707	(0.059)	4.545***
<i>Selection variable</i>							
Constrained	0.608	(0.014)					
<i>Farm characteristics</i>							
Owned land (ha)	4.851	(0.179)	5.181	(0.353)	4.640	(0.167)	1.436
Owned storage or warehouse	0.638	(0.017)	0.617	(0.022)	0.653	(0.020)	0.628
Title	0.068	(0.007)	0.086	(0.010)	0.056	(0.007)	6.949**
Irrigation system	0.211	(0.016)	0.233	(0.017)	0.196	(0.019)	4.529
Farmers association/cooperative	0.139	(0.014)	0.188	(0.018)	0.108	(0.014)	32.289***
Full or part-time employees per ha	0.669	(0.044)	0.712	(0.051)	0.642	(0.047)	1.515
<i>Farmer and farm household characteristics</i>							
Savings in financial institutions	0.232	(0.018)	0.252	(0.019)	0.219	(0.022)	4.595
Number of dependents	7.339	(0.124)	7.568	(0.185)	7.192	(0.142)	1.806*
Age of agribusiness head	44.523	(0.369)	43.815	(0.484)	44.978	(0.440)	-2.101**
No education	0.088	(0.008)	0.053	(0.008)	0.110	(0.011)	32.801***
Primary education incomplete	0.060	(0.006)	0.064	(0.012)	0.058	(0.008)	0.361
Primary education completed	0.774	(0.011)	0.777	(0.016)	0.771	(0.013)	0.428
Secondary education completed	0.079	(0.006)	0.106	(0.010)	0.061	(0.007)	19.916***
Experience of agribusiness owner	0.863	(0.009)	0.856	(0.014)	0.867	(0.011)	0.084
Gender of agribusiness head	0.886	(0.008)	0.889	(0.011)	0.884	(0.011)	0.512
<i>Crop choice</i>							
Agribusiness cultivates maize	0.188	(0.021)	0.210	(0.025)	0.173	(0.021)	3.24
Agribusiness cultivates cassava	0.020	(0.004)	0.018	(0.004)	0.020	(0.005)	1.351
Agribusiness cultivates cotton	0.088	(0.024)	0.067	(0.015)	0.101	(0.031)	6.451
Agribusiness cultivates cashew nuts	0.083	(0.017)	0.070	(0.015)	0.091	(0.019)	5.125
<i>Regional differences</i>							
Northern region	0.144	(0.025)	0.155	(0.024)	0.137	(0.028)	2.124
Western region	0.236	(0.039)	0.195	(0.034)	0.262	(0.044)	10.827*
Central region	0.054	(0.010)	0.054	(0.011)	0.053	(0.011)	0.039
Southern highlands	0.212	(0.030)	0.240	(0.034)	0.194	(0.030)	17.342***
Lake zone	0.108	(0.016)	0.072	(0.012)	0.131	(0.021)	32.031***
Eastern Region	0.095	(0.016)	0.107	(0.019)	0.087	(0.016)	2.337
Southern region	0.137	(0.025)	0.153	(0.033)	0.127	(0.024)	0.642
Zanzibar region	0.015	(0.003)	0.023	(0.006)	0.010	(0.002)	4.148*
Urban EA	0.140	(0.017)	0.163	(0.021)	0.125	(0.017)	15.724***
<i>Instrumental variables</i>							
Government subsidy	0.303	(0.022)	0.377	(0.027)	0.256	(0.023)	36.135***
Government extension services	0.232	(0.015)	0.288	(0.020)	0.197	(0.016)	30.381***

Note: \*, \*\* and \*\*\* indicate that the mean values of subgroups are significantly different at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) significance levels

Descriptive statistics that report the means and standard errors of the outcome, selection, and explanatory variables used in the study are presented in Table 10. We also present statistical significance tests that investigate the equality of means or proportions across credit constraint status for the continuous and binary variables, respectively. Around 60% of the full sample of agricultural businesses is constrained in the semi-formal sector. The differences in average crop output value per hectare, discussed earlier, are found to be statistically significant across unconstrained and unconstrained businesses; proving motivation for an investigation into the relaxation of credit constraints in Tanzania.

The summary statistics report that the average agricultural businesses in the full sample owns 4.85 hectares of land and approximately 63.8% of all crop producers in the sample own a storage or a warehouse facility. The results show that unconstrained agricultural businesses own more land, have marginally more employees per hectare, and a higher proportion owns storage space or an irrigation system than their constrained counterparts; however these findings are not statistically significant.

It was reported that 6.8% of the agricultural businesses in the total sample of crop producers hold title over registered land; and we observed a marginally higher proportion that hold title deeds amongst the unconstrained businesses, relative to those that are credit constrained. Approximately 13.9% of producers are reported as being part of a cooperative or farmers association and a significantly larger proportion of unconstrained businesses were reported to be involved in associational activity relative to their constrained counterparts.

The unconstrained agricultural businesses in the sample are significantly distinguishable from those that are constrained, with regards to characteristics of the farmer and farm household. It was reported that 23.2% of business owners across the full sample keep savings in formal financial institutions, while having an average of 7 dependents that are supported by the income of the business. The difference in the average number of dependents supported by constrained and unconstrained agricultural businesses is reported to be statistically significant at the 10% level.

Agricultural business owners in the full sample are typically around 44 years old, with more than three quarters having completed secondary school. Owners of unconstrained businesses appear to be younger than their constrained counterparts; further, the former is represented by a significantly larger proportion of individuals that have completed their secondary education, while the latter reports a larger proportion of individuals with no education.

The results suggest that crop producers in the representative sample are predominately male and have more than five years experience in agricultural activity. Agricultural businesses that are unconstrained have a marginally higher proportion of female representation, while those that are constrained report a larger proportion of owners with experience; however, these differences are not statistically or economically significant.

In the full sample of crop producers, approximately 18.8% are involved in maize production, while 2% are engaged in the production of cassava. Cotton and cashew nut producers account for 8.8% and 8.3% of the crop producers in the sample, respectively. For the aforementioned crops, the proportion of agricultural businesses that are unconstrained is larger than the proportion of those who are constrained, with the exception of the maize producers. These findings would suggest that producers of cash crops are less likely to be credit constrained, however the reported differences in relative proportions are not statistically significant.

Approximately 14% of the crop producers were reported as being found in an urban enumeration area; hence, the majority of the agricultural businesses under study form part of the rural sector. A larger proportion of unconstrained agricultural businesses were observed in urban areas, when compared to the share of urban representatives amongst the constrained businesses.

The findings reveal that 23.6% of the crop producers in the sample were observed in the Western region, followed by the Southern Highlands; together accounting for about 45% of the agricultural businesses' locations. The unconstrained agricultural businesses in the sample are significantly distinguishable from constrained agricultural businesses across various regions. A significantly larger proportion of unconstrained businesses were reported as being in the Southern Highlands and the Zanzibar region when compared to the share of constrained businesses, and a smaller proportion is represented in the Western Region and Lake Zone.

The receipt of a government subsidy to finance farm inputs was reported by 30.3% of the total sample, whereas 23.2% of all crop producers merely received extension services and advice from the government. Relative to constrained agricultural businesses, significantly larger proportions of unconstrained businesses are observed to have received an input subsidy or extension services from the government. This finding suggests that government support may aide in the relaxation of liquidity constraints.

In the section that follows, we estimate a rigorous econometric model to further investigate the differences in crop output value per hectare, after controlling for all extraneous variables. The impact of credit constraints on agricultural production in Tanzania can only be measured by taking into account any systemic differences between constrained and unconstrained agricultural businesses, while accounting for the possibility that individuals who are unconstrained might have earned a higher level of income even if their liquidity constraints were not relaxed.

### **5.3 Econometric results**

#### *Determinants of credit constraints*

The estimation results, reported in Table 11, show that an agricultural business owner who receives a government subsidy to finance agricultural inputs or who is in possession of a title deed is less likely to be quantity constrained in the formal or semi formal financial sector by 16.5% and 18.7%, respectively. These findings are in line with our expectations and suggest that government support, in the form of net transfers, provides relief of the liquidity constraints experienced by agricultural businesses, while owned and registered land would enable crop producers to gain access to credit.

Savings in formal financial institutions are reported to increase the likelihood of being quantity constrained by 20.5%. This finding is contrary to our expectations as access to alternative sources of liquidity is expected to reduce the external liquidity requirements of the business. However, the fungibility of savings and lack of mechanisms to monitor and control the use of funds may result in savings being channeled towards addressing the liquidity requirements of the farm household as opposed to farm production needs. Further, savings may be used as a mechanism to channel liquid resources away from productive activity.

Ownership of fixed assets is expected to enhance the collateral position of an agricultural business, hence reducing the likelihood of being credit constrained. However, the results show that businesses owning a storage or warehouse facility are more likely to be quantity constrained by 14.1%; and by 13.5% when taking into account all constraints. This finding dismisses the argument positing the enhancement of collateral and suggests that fixed assets related to storage and warehouse facilities may not be as easily enforceable as pledges on owned and registered land.

**Table 11. Determinants of credit constraints and their impact on productivity**

Log-linear specification (Quantity constrained only)						
	Constraint status		Unconstrained		Constrained	
	(0/1)		Log (output value per ha)			
Owned land (ha)	-0.002	(0.003)	-0.016***	(0.006)	-0.025***	(0.007)
Employees per ha	0.003	(0.025)	0.141***	(0.039)	0.189***	(0.034)
Owned storage or warehouse	0.141**	(0.065)	-0.040	(0.066)	-0.064	(0.072)
Title	-	(0.109)	-0.103	(0.109)	0.067	(0.186)
Irrigation system	0.022	(0.079)	0.515***	(0.076)	0.462***	(0.089)
Farmers association/cooperative	-0.025	(0.095)	0.174**	(0.082)	0.224**	(0.105)
Savings in financial institutions	0.205***	(0.078)	0.417***	(0.083)	0.686***	(0.094)
Number of dependents	-0.007	(0.007)	-0.003	(0.006)	-0.007	(0.008)
Age	0.000	(0.003)	-0.011***	(0.002)	-0.002	(0.003)
Primary education completed	-0.014	(0.089)	0.180**	(0.081)	0.142	(0.089)
Secondary education completed	-0.168	(0.141)	0.329**	(0.154)	0.220	(0.167)
Experience	0.100	(0.086)	0.000	(0.092)	-0.283**	(0.112)
Gender (male = 1)	0.125	(0.092)	0.161*	(0.097)	-0.061	(0.105)
Maize == 1	0.055	(0.082)	-0.079	(0.081)	-0.057	(0.105)
Cassava ==1	0.193	(0.178)	-0.379**	(0.186)	-0.348	(0.242)
Cotton == 1	0.054	(0.130)	-0.311***	(0.103)	-0.185	(0.117)
Cashew nuts == 1	0.241*	(0.140)	-0.488***	(0.139)	-0.156	(0.179)
Western region	0.541***	(0.129)	0.089	(0.151)	0.092	(0.166)
Central region	0.182	(0.133)	-0.829***	(0.155)	-0.866***	(0.187)
Southern highlands	0.174	(0.116)	-0.121	(0.116)	-0.181	(0.139)
Lake zone	0.278**	(0.117)	-0.375***	(0.137)	-0.265*	(0.160)
Eastern Region	0.003	(0.129)	0.060	(0.127)	-0.156	(0.182)
Southern region	0.141	(0.146)	0.029	(0.137)	-0.321*	(0.186)
Zanzibar region	0.089	(0.179)	0.951***	(0.158)	0.775***	(0.233)
Urban EA	-0.058	(0.087)	0.338***	(0.086)	-0.012	(0.103)
Government subsidy	-	(0.068)				
Government extension services	-0.085	(0.071)				
Constant	-	(0.212)	13.311***	(0.253)	12.742***	(0.405)
$\sigma_i$			1.082***	(0.095)	0.944***	(0.058)
$\rho_j$			0.588**	(0.243)	0.249	(0.291)
Log-likelihood			-1072975.8			
chi2			4.27**			
<i>n</i>			3316			

Note: Estimation by Full Information Maximum Likelihood at the agricultural business level. Dependent variable of the outcome variable is the log of crop output value per hectare. The dependent variable of the selection equation is a binary variable indicating whether or not the household is quantity constrained. Robust standard errors are in parentheses.  $\sigma_i$  denotes the square-root of the variance of the error terms  $\varepsilon_{ji}$  in the outcome equations captured by equation (7);  $\rho_j$  denotes the correlation coefficient between the error term  $u_i$  of the selection equation (5) and the error term  $\varepsilon_{ji}$  of the outcome equations (7). Significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) significance levels. Dummy base variables omitted: No education or primary education incomplete; northern region.

**Table 12. Determinants of credit constraints and their impact on productivity**

Log-linear specification (All constraints)						
	Constraint status		Unconstrained		Constrained	
	(0/1)		Log (output value per ha)			
Owned land (ha)	-0.002	(0.003)	-0.011**	(0.005)	-0.033***	(0.006)
Employees per ha	-0.014	(0.022)	0.149***	(0.033)	0.148***	(0.042)
Owned storage or warehouse	0.135**	(0.065)	0.016	(0.088)	-0.109*	(0.057)
Title	-0.100	(0.106)	-0.141	(0.127)	0.090	(0.127)
Irrigation system	-0.041	(0.076)	0.342***	(0.085)	0.561***	(0.074)
Farmers association/cooperative	-0.275***	(0.090)	0.071	(0.176)	0.173*	(0.096)
Savings in financial institutions	0.075	(0.079)	0.340***	(0.092)	0.589***	(0.069)
Number of dependents	-	(0.006)	-0.006	(0.011)	-0.002	(0.006)
Age	0.007**	(0.003)	-0.010**	(0.004)	-0.004	(0.002)
Primary education completed	-0.078	(0.092)	0.178	(0.121)	0.143**	(0.067)
Secondary education completed	-0.377***	(0.146)	0.175	(0.233)	0.310**	(0.136)
Experience	-0.101	(0.083)	-0.214**	(0.103)	-0.106	(0.095)
Gender (male = 1)	-0.025	(0.088)	-0.057	(0.110)	0.091	(0.087)
Maize == 1	0.002	(0.080)	-0.009	(0.098)	-0.142*	(0.083)
Cassava ==1	0.253	(0.161)	-0.199	(0.225)	-0.474**	(0.189)
Cotton == 1	0.058	(0.132)	-0.440***	(0.145)	-0.178**	(0.088)
Cashew nuts == 1	0.425***	(0.146)	-0.191	(0.255)	-0.413***	(0.152)
Western region	0.208*	(0.126)	-0.202	(0.180)	0.089	(0.114)
Central region	0.024	(0.126)	-1.140***	(0.188)	-0.710***	(0.143)
Southern highlands	0.058	(0.105)	-0.358***	(0.137)	-0.049	(0.111)
Lake zone	0.320***	(0.115)	-0.308	(0.244)	-0.319***	(0.116)
Eastern Region	-0.107	(0.119)	-0.304**	(0.150)	0.187	(0.137)
Southern region	-0.206	(0.145)	-0.337*	(0.195)	-0.071	(0.163)
Zanzibar region	-0.251	(0.170)	0.756***	(0.212)	0.806***	(0.187)
Urban EA	-0.154***	(0.086)	0.261**	(0.111)	0.120	(0.083)
Government subsidy	-0.232***	(0.076)				
Government extension services	-0.181***	(0.069)				
Constant	0.306	(0.203)	14.138***	(0.672)	12.720***	(0.214)
$\sigma_i$			1.067***	(0.237)	0.954***	(0.023)
Rho			0.558	(0.493)	0.078	(0.192)
Log-likelihood			-1071109.7			
chi2			1.03			
<i>n</i>			3316			

Note: Estimation by Full Information Maximum Likelihood at the agricultural business level. Dependent variable of the outcome variable is the log of crop output value per hectare. The dependent variable of the selection equation is a binary variable indicating whether or not the household is constrained (all constraints considered). Robust standard errors are in parentheses.  $\sigma_i$  denotes the square-root of the variance of the error terms  $\varepsilon_{ji}$  in the outcome equations captured by equation (7);  $\rho_j$  denotes the correlation coefficient between the error term  $u_i$  of the selection equation (5) and the error term  $\varepsilon_{ji}$  of the outcome equations (7). Significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) significance levels. Dummy base variables omitted: No education or primary education incomplete; northern region.

When taking into account all types of constraints, as reported in Table 12, access to information from government extension services and membership in a farmers' association or cooperative are expected to reduce the likelihood of an agricultural business being constrained in the semi-formal sector by 18.1% and 27.5%, respectively; while businesses that receive a government subsidy are less likely to be constrained by 23.2%. These findings are consistent with our expectations that associational activity would enable a producer's access to social networks and information, which would in turn enhance its reputation and profile in the community. Further, a government subsidy serves as supplementary liquidity for an agricultural business.

We find that agricultural business owners that have completed secondary education are less likely to be credit constrained by 37.7%, considering all constraints; however, older business owners are more likely to experience credit constraints. Contrary to our expectations, the likelihood of being credit constrained is reduced by 1.5% for each additional dependent that relies on the income of the business. This finding may suggest that each additional dependent brings with them a contribution to the liquidity requirement of the household.

Across all types of constraints, agricultural businesses that are found in urban areas are less likely to be constrained than those found in rural areas. Relative to the Northern region, liquidity constraints are more likely to be experienced by crop producers in the Western region or Lake Zone. Furthermore, cashew nut producers have an increased likelihood of being credit constrained.

### *Impact of credit constraints*

When taking into account all constraints, both estimated parameters of the correlation coefficient  $\rho_j$  are not statistically different from zero, suggesting that we cannot reject the null hypothesis of no sample selectivity bias. However, the estimated covariances  $\sigma_{1u}$  and  $\sigma_{0u}$  provide evidence of endogenous switching and support the appropriateness of the estimation strategy. Moreover, the differences in the parameter estimates of the productivity model between agricultural businesses that are unconstrained and those that are credit constrained provide evidence of heterogeneity in the sample.

The estimates show that each additional hectare of land owned negatively impacts the crop output value per hectare of the constrained and unconstrained by 3.3% and 1.1% respectively, when taking into account all types of credit constraints; these findings are consistent with our expectations and are robust when only taking into account quantity constraints.

The results show that savings in formal financial institutions, increases in family labour endowments, and ownership of an irrigation system significantly enhance the productivity of constrained and unconstrained crop producers in the sample, in the context of either quantity constraints only or all constraint types. The estimated coefficients would suggest that constrained agricultural businesses experience a larger positive impact from having access to savings than their unconstrained counterparts. When considering all types of credit constraints, savings enhance the productivity of constrained businesses by 58.9%, while unconstrained businesses' productivity is increased by 34%. This finding suggests that there is a larger impact in relaxing liquidity constraints for those who are constrained than unconstrained businesses.

In line with our expectations, an increase in the number of employees per hectare would increase the output value per hectare of quantity constrained agricultural businesses by 18.9%, while businesses that do not experience quantity constraints would have relatively lower improvements in productivity by 14.1%. In consideration of all constraints, the relative enhancements from increased labour units are similar for constrained and unconstrained households at 14.8% and 14.9% respectively.

When taking into account all constraints, constrained agricultural businesses that own irrigation systems are expected to increase their productivity by 56.1%, while the productivity of unconstrained businesses is improved by 34.2%. This finding provides evidence that improvements in the quality of fixed assets enhances the productivity of constrained agricultural businesses to a greater extent than the impact on unconstrained businesses; however, when taking into account quantity constraints only, the impact on the former is larger than the effects experienced by the latter.

A male-headed agricultural business is expected to earn a higher output value per hectare than a female headed business; although this finding is significant at the 10%, it is subject to bias as a result of the underrepresentation of females in the sample of crop producers. When taking into account all types of credit constraints, the results suggest that the gender of the owner does not affect the economic output of the business.

In considering all types of constraints, ownership of a storage or warehouse facility diminishes the productivity of constrained agricultural businesses by approximately 10.9%, however there is no effect on productivity when considering quantity constraints only. This finding is contrary to our expectations, however it is consistent with the diminishing returns to scale expected from increases in the land endowment. Despite having the capability to acquire fixed capital, an agricultural business may have challenges in scaling up their variable inputs in order to capture any efficiency that may arise from the availability of increased capacity.

As expected, constrained business owners across all types of constraints, are shown to enhance crop output value per hectare by an average of 17.3% when gaining membership of a farmers' association or cooperative. Quantity constrained businesses experience a greater positive impact from associational activity than their unconstrained counterparts.

For agricultural businesses that are constrained, in the context of all constraints, an owner who had completed primary school is expected to increase farm productivity by 14.3% and completion of secondary school is expected to enhance productivity by 31%, relative to an owner that had neither completed primary school nor attended school entirely. For quantity constrained agricultural businesses, there are no significant enhancements to production as a result of higher levels of education; however for those businesses that are unconstrained, the completion of primary and secondary school increases crop output value per hectare by 18% and 32.9% respectively.

The age of the owner is expected to diminish the productivity of unconstrained agricultural businesses, with each additional year reducing the output value per hectare by around 1%. Constrained businesses are not significantly affected by the age of the owner, however the results show that the experience of an owner in farming-related activities adversely impacts productivity when considering all types of constraints and quantity constraints respectively. While experience is expected to enhance the labour capacity available to the business owner, the results may suggest that involvement of a producer in farming-related activities for five years or more does not necessarily address considerations of the quality of labour or experience.

Consistently across regions and credit constraint definitions it appears that unconstrained agricultural businesses found in urban areas have a higher productivity. Relative to the Northern region, businesses in the Central region have lower output value per hectare, however those in the Zanzibar region have a higher productivity. Taking into account all types of constraints, constrained agricultural businesses in the Lake Zone and unconstrained businesses in the Southern Highlands, Eastern Region, and Southern Region have a lower expected crop output value per hectare.

In consideration of all types of credit constraints, selection of crop type does not have a significant effect on crop output value per hectare except for a negative impact on cotton producers. For constrained agricultural businesses, the choice to produce cassava, cashew nuts, cotton, or maize would adversely impact productivity relative to alternative crop choices; with cassava and cashew nuts having the largest impact, reducing output value per hectare by 47.4% and 41.3%. Quantity constrained producers are not significantly affected by crop choice, however their unconstrained counterparts are adversely affected by the choice of all stipulated crops except maize. These findings would suggest that transaction cost and risk constraints play a more critical role when it comes to crop choice and its impact on productivity than quantity constraints.

In order to examine the reliability and robustness of the results we estimate an alternative model, which redefines the labour and land endowments as their natural logarithm equivalents. The alternative specification will be estimated using the alternative definitions of credit constraints, taking into account quantity constraints only and all credit constraints, respectively.

The results of the robustness tests presented in Appendix Table 13 and 14 are mostly consistent with the findings presented earlier in terms of estimation strategy. There is consistency across most of the avenues through which crop output value per hectare is impacted by credit constraint status, however some differences are observed in the results. In particular, the farmer and farm household characteristics such as education and experience no longer have an impact on the productivity of constrained agricultural businesses, when taking into account all constraints; further, ownership of a storage or warehouse facility is no longer significant as a measure of fixed capital and membership in a farmers association or cooperative ceases to be significant across all definitions of credit constraints.

Table 13 presents the average expected crop output value per hectare<sup>24</sup> under actual and counterfactual credit constraint status conditions for agricultural businesses in Tanzania. The predicted outcomes of crop output value per hectare are obtained from the endogenous switching regression model and used to examine differences between those who were observed to be unconstrained and constrained by semi-formal financial institutions, respectively. The evaluation of treatment effects is done using the broader operationalization of credit constraint status that takes into account quantity, transaction costs, and risk constraints.

**Table 13. Average expected output value per hectare; treatment and heterogeneity effects**

Sub-samples (constraint status)	Observed outcome		Treatment effects
	Unconstrained ( $y_{0i}$ )	Constrained ( $y_{1i}$ )	
Unconstrained ( $k_i=0$ )	(a) 567,422 (17,250)	(c) 462,226 (19,973)	TT = 105,196 *** (26,391)
Constrained ( $k_i=1$ )	(d) 1,206,117 (26,224)	(b) 412,750 (9,148)	TU = 793,367 *** (27,774)
Heterogeneity effects	BH <sub>1</sub> = -638,695 *** (31,389)	BH <sub>2</sub> = 49,475 ** (21,968)	TH = -688,171 *** (19,550)

Note: All constraint types (i.e. quantity, transaction costs, and risk constraints). See note of table 7. Standard errors in parentheses. Significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) significance levels.

Cells (a) and (b) of Table 13 represent the expected crop output value per hectare observed in the sample, while cells (c) and (d) represent the counterfactual cases. The expected crop output value per hectare earned by agricultural businesses that were unconstrained was approximately TZS 567,422 per hectare, while agricultural businesses that were constrained in the semi-formal sector were expected to earn TZS 412,750. Although the expected crop output value of agricultural businesses that were observed to be unconstrained was 37.47% more than credit constrained agricultural businesses, it should be noted that this simple comparison may be misleading, and is insufficient to infer a causal relationship between credit constraint status and economic outcome.

The last column Table 13 presents the treatment effects of credit constraint status on crop productivity. In the counterfactual case (c), agricultural businesses that were actually unconstrained would have earned approximately TZS 105,196 per hectare or 18.45% less if they became credit constrained.

<sup>24</sup> The average expected crop output value per hectare is calculated by taking the exponential transformation of the estimated natural logarithm form.

In the counterfactual case (d), agricultural businesses that were actually constrained would have earned approximately TZS 793,367 per hectare or 192.21% more if their credit constraints were relaxed. These results suggest that the relaxation of credit constraints significantly increases agricultural productivity. The negative and significant transitional heterogeneity of TZS 688,171 suggests that the impact of credit constraint relaxation is larger for agricultural businesses that are constrained relative to the impact on those that were unconstrained.

The last row of Table 13 adjusts for any base heterogeneity in the sample. Agricultural businesses that were actually unconstrained would have earned TZS 49,475 per hectare or 12% more than the agricultural businesses that were constrained in the counterfactual case (c). This finding suggests that unconstrained agricultural businesses are marginally better crop producers than constrained businesses regardless of credit constraint status. In the counterfactual case (d), constrained agricultural businesses whose credit constraints had been relaxed would have earned TZS 639,695 or 112.56% more than agricultural businesses that were actually unconstrained. These results further reinforce that the relaxation of credit constraints increases agricultural productivity as measured by crop output value per hectare; and that the impact is more significant for those agricultural businesses that are observed to be constrained.

In order to test the consistency of our impact evaluation results we further estimate treatment effects using the narrower definition of credit constraint status that only takes into account quantity constraints; presented in Appendix Table 15. In addition to testing the robustness of our results, the comparison is expected to provide insights into the different impacts of the relaxation of credit constraints when supply-side and demand-side constraints are addressed.

When only considering quantity constraints, the expected crop output value of unconstrained agricultural businesses is reported to decline by 14.74% or TZS 72,888 per hectare relative to the expected value under all types of considerations, while the expected productivity value of constrained businesses is reported to increase by 6.19% or TZS 27,217 per hectare. The counterfactual case where an unconstrained agricultural business becomes constrained reported a 36.20% decrease to TZS 339,361 per hectare, whereas the case where the quantity constraints of a constrained business are relaxed results in a 5.01% increase in crop output value per hectare relative to the broader definition of credit constraints.

In considering all types of constraints, the treatment on the treated is approximately TZS 49,977 per hectare or 32.21% less when considering quantity constraints only; the treatment on the untreated is marginally less by TZS 36,451 per hectare or 4.39%. The marginal decline in the transitional heterogeneity by TZS 13,525 per hectare of 2% suggests that the relative impact of relaxing credit constraints is consistent between constrained and unconstrained agricultural businesses regardless of the definition of credit constraint status.

Despite the consideration of all types of constraints presenting a result suggesting that unconstrained agricultural businesses may be better crop producers than their constrained counterparts, it is notable to highlight that this result is reversed when only taking into account quantity constraints. The base heterogeneity of quantity constrained agricultural businesses reflects a higher crop output value per hectare for those businesses that are actually constrained relative to the counterfactual case experienced by unconstrained agricultural businesses; while the base heterogeneity of unconstrained businesses provides further evidence for the disproportionate impact experienced by constrained businesses upon the relaxation of credit constraints.

#### **5.4 Summary and conclusions**

This chapter described characteristics of the key variables used in this study and presented the significant empirical findings. An investigation into the sources and uses of funds was presented, in addition to highlights of the income distribution of crop producers by credit constraint status. The determinants of credit constraint status were explored and the impacts of constraints evaluated. The impact evaluation was further enhanced by the estimation of treatment effects experienced by constrained and unconstrained agricultural businesses.

It was found that unconstrained agricultural businesses earn more than constrained businesses, with the former experiencing a disproportionately larger deviation from the mean crop output value per hectare. Borrowing businesses fared better than non-borrowers as funds primarily sourced from friends and family, savings and credit groups, and microfinance institutions were channeled into business activities.

Larger proportions of unconstrained agricultural businesses held a registered title and savings in formal financial institutions, and were involved in associational activity; further, they tended to be found in rural areas, produced cash crops, and received government support. A

large proportion of owners in unconstrained businesses were found to have completed secondary education, and have more dependents.

The likelihood of being credit constrained was reduced for agricultural businesses that were found in urban areas, received a government subsidy to finance inputs, or were in possession of a title deed. Furthermore, owners that completed secondary education and had more dependents were less likely to be constrained. Agricultural businesses run by relatively older owners that held savings, owned storage facilities, participated in associational activity or obtained information from government extension services had an increased likelihood of being credit constrained.

The treatment of credit constraint relaxation is disproportionately larger for constrained agricultural businesses than for the treated businesses observed as unconstrained. As evidenced by a marginal difference in transitional heterogeneity, the relative impact of relaxing credit constraints is consistent irrespective of definition of constraint status. Furthermore, there is insufficient evidence to irrefutably suggest that unconstrained agricultural businesses are better producers than their constrained counterparts. Adopting the narrower definition of constraint status, that only takes quantity constraints into account, narrows the expected earnings range between unconstrained and constrained agricultural businesses. Hence, the full impact of credit constraints on agricultural productivity may be underestimated when transaction cost and risk constraints are overlooked.

## **Chapter 6. Discussion of results**

### **6.1 Overview of the key findings of the study**

The agricultural sector contributes substantially to the economic output and labour force of Tanzania, however the former has been steadily declining. The sector accounts for around three quarters of the total labour force and despite the aggregate economy having grown at an average real growth rate of 6.3% between 2007 and 2013, the agricultural sector lags behind at 3.9%. The crop sub-sector accounts for the largest contribution to agricultural GDP, which has grown more rapidly than the economically active population in agriculture. In 2013, agricultural exports accounted for 25.1% of total exports, however fuel products, machinery, and transport equipment are driving growth in exports.

The largest food crops produced in Tanzania are maize and cassava, while the largest cash crops are cotton, cashew nuts and tobacco. Food crops account for the largest contribution to production output and areas harvested, and generally recorded higher yields over the period under study than cash crops; however we observe more substantial growth in the cash crop area under harvest. Further, gross food crop production has grown at a more accelerated annual average rate relative to the growth of the population.

The research approach undertaken by this study covered two steps, namely: 1) the direct elicitation of the credit constraint status of agricultural businesses, and 2) an investigation into its impact on crop output value per hectare. The former was captured in a selection equation and the latter in an outcome equation; and an endogenous switching regression model captured the simultaneous estimation of these equations. The characteristics of the agricultural business, the owner, and the farm household were explored in order to explain the avenues by which agricultural businesses may have been credit constrained and how this would impact their performance. Subsequently, treatment effects were estimated to analyze the relationship between credit constraint status and agricultural productivity.

An evaluation of the robustness of the results was undertaken by estimating a log-log specification of the econometric model, in addition to the initial log-linear model; and the validity of the study was tested by comparing the estimation results when defining credit constraint status using quantity constraints only and all constraints, respectively.

Agricultural businesses earned an average crop output value of TZS 735,472 per hectare, with unconstrained businesses earning 14.26% more and constrained businesses earning 9.18% less. Approximately 60.28% of the full sample of agricultural producers was constrained in the semi-formal sector, with quantity constraints accounting for 36.34%.

The primary sources of credit to the agricultural sector were family and friends, savings and credit groups and microfinance institutions, and the primary motivations for borrowing were business expansion and the settlement of operational expenses. Agricultural businesses that borrowed earned more than non-borrowing businesses, while quantity, risk, and transaction costs constraints adversely impacted the earnings potential of agricultural producers. On the contrary, price constrained agricultural businesses earned marginally more than their unconstrained counterparts.

We observed statistically larger proportions of agricultural businesses with a registered title deed or membership to a cooperative or farmers' association when comparing unconstrained agricultural businesses to constrained businesses. There were no significant differences found across credit constraint status with regards to land ownership size, storage or warehouse ownership, adoption of irrigation technology, or number of employees per hectare. Unconstrained agricultural businesses exhibited significantly different farmer and farm household characteristics relative to those who were constrained, with the former having a larger proportion that holds savings in formal financial institutions and more dependents than the latter.

A substantial proportion of agricultural business owners had completed primary education and a statistically significant proportion of unconstrained business owners had completed secondary school. However, a significant proportion of constrained agricultural business owners had not completed any schooling. Producers in the sample tended to be male, with a large proportion having more than five years of experience in agricultural activity.

A higher proportion of unconstrained agricultural businesses received government support, in the form of net transfers and advice, relative to their constrained counterparts. Further, the results report that producers of cash crops were less likely to be credit constrained. A large proportion of agricultural businesses were found in rural areas, with the Western and Southern regions accounting for the largest proportions of businesses in the sample.

Agricultural businesses were less likely to be credit constrained if they were found in urban areas, and in particular crop producers in the Zanzibar region were expected to be less constrained than those in the Northern region. Crop producers were less likely to be constrained if they had completed secondary school, and for each additional dependent on the income of the business; and were less likely to be quantity constrained if they were in possession of a title deed. The receipt of a government subsidy to finance agricultural inputs further reduced the likelihood of being credit constrained.

Producers of cashew nuts and those found in the Western region or Lake zone were more likely to be credit constrained. Savings in formal financial institutions increased the likelihood of being quantity constrained, while storage or warehouse facility ownership, participation in associational activity, and information from government extension services increased the likelihood of an agricultural businesses being credit constrained when taking into account all constraints. Further, older businesses were more likely to be constrained.

Agricultural productivity was enhanced by savings in formal financial institution, increases in the available labour endowment and the adoption of irrigation technology; however it was diminished by increases in the land endowment available to an agricultural business.

Although male-headed agricultural businesses that are not quantity constrained were found to positively and significantly impact agricultural productivity, female-headed agricultural businesses were grossly underrepresented in the sample. Further, the stance that the impact of the business owner's gender was not significant was reinforced in the context of all constraints.

Storage or warehouse facility ownership was shown to reduce farm productivity when all constraints were taken into account, however regardless of the constraint definition, farmers' association or cooperative membership resulted in enhanced crop productivity.

A significant positive relationship was reported between the level of education and farm productivity, for constrained agricultural businesses in the context of all constraints and unconstrained businesses with regards to quantity constraints. However, there is a significant negative relationship between an agricultural business owner's age and their productivity; further, experience of five years or more is expected to adversely affect crop output value per hectare.

Agricultural businesses in urban areas exhibited higher productivity than those in rural areas. The results reveal significant heterogeneity based on geographic location of crop producers, with businesses in the Central region commanding lower earnings and those in Zanzibar earning higher income relative to the Northern region.

Selection of crop type did not appear to have a significant impact on the earnings outcome of agricultural businesses, with the exception of the negative impact experienced by cotton producers. Constrained businesses were consistently and adversely affected across the selections of crop type. The results provide evidence of transaction cost and risk constraints being the channel by which crop choice impacts agricultural productivity.

When taking into account all types of constraints, the results of the treatment effects reveal that constrained businesses were expected to increase their earnings by 192.2% if their credit constraints were relaxed, whereas unconstrained agricultural businesses would have earned 18.5% less if they became constrained. When relaxing constraints on the agricultural businesses observed as constrained, our findings suggest that their earnings would have been enhanced beyond that of their observed unconstrained counterparts by 112.7%. However, when imposing constraints on unconstrained agricultural businesses they still fared better than their counterparts actually observed as being constrained, possibly due to innate unobservable characteristics that make them better producers.

An examination of the expected observations, under a narrower definition of credit constraint status, finds crop output values per hectare that are 14.7% lower for unconstrained agricultural businesses and 6.2% higher for constrained businesses, relative to the broader definition of credit constraints. These deviations capture the effect of transaction cost and risk constraints on expected earnings.

The treatment on the treated is 32.2% larger under the broader definition, whereas the treatment on the untreated is 4.4% larger. The marginal increase in transitional heterogeneity of 2% provides evidence to suggest that the relative impact of relaxing credit constraints for the treated and untreated is consistent irrespective of the definition of credit constraint status. Further, the result under consideration of all constraints that suggests unconstrained agricultural businesses may be better producers is refuted under the narrow definition, which finds that businesses observed to be constrained fair better relative to unconstrained businesses under counterfactual considerations of quantity constraints.

## **6.2 Synthesis of findings with empirical literature and theory**

Credit rationing describes an excess demand for credit, while credit constraints represent the ensuing experiences of unsatisfied borrowers and non-borrowers who lack access. A substantial proportion of agricultural businesses in this study participated in credit, however a significant share of the respondents was classified as credit constrained. Broadly speaking, access to credit addresses the ability and extent of a loan applicant to borrow, whereas participation in credit is marked by a borrowing event.

The credit market in Tanzania has expanded significantly since the reformation of the financial sector, and is characterized by formal, semi-formal, and informal financial institutions. Formal financial institutions are the primary suppliers of finance and financial intermediation services in Tanzania, with commercial banks accounting for the majority of loans disbursed to the economy. However, the allocation and growth of commercial credit to agriculture has been relatively low when compared to other sectors. Despite the proliferation of suppliers of credit, agricultural businesses are persistently subject to credit rationing.

The standard argument of classical economic analysis suggests that the equilibrium price of credit should clear the market and ensure an efficient allocation of resources; however in the presence of information asymmetries, the standard argument is undermined. Information in credit markets is imperfect and costly, and the resultant problems of adverse selection, moral hazard, and enforcement difficulties provide a theoretical basis for credit rationing.

Direct mechanisms to overcome asymmetric information rely on lenders' resources and capabilities in screening applicants, monitoring their behavior, and enforcing loan agreements, while the design of contracts is an inextricable aspect of indirect mechanisms. Indirect mechanisms may be undermined by the nature of the activities being funded and/or the endowments available to borrowers. Due to the costly nature of direct mechanisms, lenders may be more inclined to avoid violations of stipulated loan contract terms by withdrawing credit. The proximity of the stakeholders in semi-formal and informal arrangements bridges the information gap in a cost effective manner and enables enforceability through more effective monitoring and control of borrower operating and financial behaviour. In the sample, family and friends are the primary suppliers of credit, in terms of the number of loans distributed; followed by savings and credit groups and

microfinance institutions. As such, the primary motivation of borrowing to address business related activities was upheld.

Semi-formal member-based organisations are the most dominant and arguably the most important financial institutions in Tanzania; and they are typically characterized by non-governmental organisations that promote rural development and cooperatives linking loan applicants' access to credit to their savings behaviour. Savings and credit groups that operate at the village or community level characterize informal financial institutions. Semi-formal institutions oftentimes serve as a liaison between formal institutions looking to expand their market reach in the informal sector and communities with demand for financial resources.

In addition to its function as the price of credit, the interest rate may play a role in determining the risk composition of a lender's loan portfolio while inducing certain behaviours in loan applicants. Under ideal conditions, an increase in interest rates would enable a lender to accommodate excess demand in credit markets, however this may be undermined by an increase in the probability of default associated with the loan portfolio. Hence, credit rationing would ensue, as a lender's expected return is not necessarily commensurate with any increases in the interest rate.

The simultaneity of decision-making for a credit constrained agricultural household may lead to a misallocation of resources as the consumption and production sides of the household compete for liquidity. In the context of a static agricultural household model we focus on the production side of the household to explore the determinants of credit constraints and its impact on productivity. Significant determinants influencing the likelihood of being credit constrained and differences in the parameter estimates of the output model provide evidence of heterogeneity between unconstrained and constrained agricultural businesses.

In the current study, the possession of a title deed and the receipt of a government subsidy to finance inputs reduce the likelihood of being constrained. In particular, holding title for registered land enhances the quality and enforceability of a loan contract; hence, providing an alternative mechanism to quantity rationing. In Polish rural credit markets, interest rate subsidies did not enhance the allocation of credit, suggesting that policy interventions targeting agricultural development may be more effective by addressing the pervasive information asymmetries in agricultural finance. Irrespective of the type of constraint experienced by crop producers in our study, a government subsidy is expected to contribute to the initial liquid endowment of an agricultural business and provide relief for credit

constraints. The input subsidy directly addresses an agricultural business's need for enhanced farm inputs.

As production decisions are typically dependent on the level of credit available, a constrained choice set of farm inputs is expected to arise from constrained access to credit. Consequently, the presence of a binding credit constraint can lead to underinvestment in agricultural production, with resultant adverse impacts on gross agricultural output and income.

Access to information and social networks may provide opportunities for agricultural businesses to improve their access to credit, in addition to taking advantage of other financial intermediation and advisory services. Participation in associational activity and information received from government extension services are expected to address information asymmetries, however it was found that they increased the likelihood of being credit constrained. These findings suggest that having access to information and networks is necessary, but not sufficient, to relieve credit constraints; the quality of information is of paramount importance. Further, the sources and relevance of information need to be further evaluated.

In Tunisia, the short-term operational needs of farmers were undermined by credit constraints, whereas their long-term investment needs were not; addressing the constraints on production could have enhanced the livelihoods of these farmers. However, improvements in participation in microcredit were shown to be insignificant or detrimental to welfare in Malawi, particularly in the absence of institutions that seek to enhance human capital and create a conducive environment for seamless, uninterrupted, agricultural operations.

Access to liquidity positively impacted the productivity of coffee producers in Tanzania and contributed favourably to addressing poverty and inequality in the highland areas of the Northern region. A significant conclusion drawn from the study was that the intentions underlying the provision of credit may be misguided if intervention strategies do not take into consideration differences between a household's access to credit and the experience of liquidity constraints, particularly in a context where constraint status is self-reported.

We find that constrained crop producers in our sample of Tanzanian agricultural businesses earn substantially less than unconstrained businesses. Further, we observe that the relaxation of credit constraints disproportionately enhances the productivity of businesses observed as constrained, relative to the treatment effects experienced by businesses observed as unconstrained.

As expected, crop output value per hectare is enhanced through increases in the labour endowment and ownership of irrigation technology. The improved quality and availability of inputs contributes directly to agricultural productivity, while indirectly improving the welfare of the agricultural household. However, the negative relationship between land endowment and productivity suggests that the average agricultural business in the sample is subject to diminishing returns to scale.

In this study, a positive significant relationship was observed between savings in formal financial institutions and productivity; however agricultural businesses with savings are more likely to be credit constrained. By making use of their own available initial liquidity endowments, businesses are able to support production and consumption activity.

In China, the fungibility of formal credit resulted in the allocation of credit away from agricultural production and towards consumption and investment activities; suggesting that increased access to credit would only marginally improve productivity. The positive relationship between holding savings and being credit constrained provides evidence in support of the fungibility argument and presents a possible explanation for credit rationing in Tanzania. However, in contrast to the Chinese case that reports the allocation of fungible funds away from productive activity, the Tanzanian case suggests that fungible funds may be allocated toward business activities.

In Peru, it was found that the elimination of credit constraints would be expected to enhance agricultural productivity, particularly when taking into account all constraints, namely, quantity, transaction cost, and risk constraints. In Rwanda, findings suggested that transaction costs and small loan amounts were responsible for the persistent credit rationing in credit markets.

Despite making use of random samples, the representativeness of the results documented by previous empirical studies is constrained to the areas under study. While the impact of credit constraints may have been reliably estimated, the results presented may not be readily generalizable beyond the samples being investigated. Furthermore, the credit rationing literature reviewed is dominated by an emphasis on supply-side constraints.

The impact of credit constraints in our study is more pronounced for agricultural businesses that are observed as credit constrained than unconstrained businesses under counterfactual considerations, when considering either quantity constraints only or all types of constraints. A further examination of the expected observations, under a narrower definition of credit constraint status that only takes into account quantity constraints, reports a narrower crop output value per hectare range between unconstrained and constrained agricultural businesses, relative to the broader definition of credit constraints. Empirically and practically, a broader definition of credit constraint status and an acknowledgement of its impacts would lend a hand to broader policy considerations in addressing credit rationing in developing markets.

### **6.3 Policy recommendations**

The agricultural sector has undergone vast changes since the dawn of Tanzania's independence. The intention of the liberation movement was to uphold the principles of self-reliance and equality through the enhancement of agricultural production and social service provision at the village level; however, misaligned incentives, misallocated resources, and a macroeconomic environment that was not conducive to the expansion of the public sector continually hampered expected economic outcomes.

The economy has transgressed its socialistic foundations wherein the public sector was the main driver of economic activity. Reform programmes, driven by the global development community, served as a catalyst for the transformation of the economy towards a more liberalized and market oriented paradigm. Nevertheless, agricultural development continues to be a mainstay of economic development in Tanzania. The National Strategy for Growth and Reduction of Poverty and the National Agricultural Policy aim to drive the modernization of the sector into a commercial vehicle with the potential to boost productivity and competitiveness.

The agricultural policy framework should be designed to create a conducive, enabling, and stable environment for the realization of the development goals of Tanzania, while attracting investment from the private sector based. In spite of a clear framework for financial institutions there are various challenges related to the allocation of financial resources to the agricultural sector. The transformation of the sector is required in order to provide opportunities for agricultural development beyond the current characterization of smallholder farmers that operate on a semi-subsistence level.

Imperfect and costly information and control mechanisms may induce lenders to ration credit to the agricultural sector. This in turn would lead to underinvestment in the economy, which would undermine the welfare goals of society. We propose various direct and indirect interventions to tackle the market failures highlighted by this study. While the former describes the government's actual participation in the economy, the latter relates to their influence on the economic environment as a means to induce behaviour that addresses the market failures identified. We acknowledge that the roles and responsibilities undertaken by government need to be moderated to guard against a culture of dependency, while ensuring that the private sector is not crowded out of economic activity.

Improved access to credit and information may be instrumental in enabling desirable levels of investment for the realization of increased income, poverty alleviation and improvements in living standards. An input subsidy serves to mitigate the quantity constraints of an agricultural business by directly addressing its liquidity needs. The provision of subsidies to finance agricultural inputs has been shown to be effective in reducing the likelihood of an agricultural business being credit constrained, however the sustainability of this mechanism needs to be evaluated. Additionally, the government should be more proactive in enhancing the savings capacities of agricultural business owners in rural areas.

The government may consider providing subsidies to address the high transaction costs experienced in the provision of formal financing solutions to the rural sector. In particular, the subsidy will address agricultural businesses lack of preparation to get a loan by providing an opportunity to get technical assistance on where to obtain credit and how to go about it. The quality of information is of paramount importance to ensure that, in addition to its role in supporting the production outcome of agricultural businesses, the likelihood of being credit constrained is reduced.

Due to uncertainty in the broader economy and the perceived risks of rural sector activity, credit suppliers do not readily support medium to long-term agricultural projects. While the short-term operational needs of agricultural businesses are important, the modernization and commercialization of the sector is reliant on the commitment of patient capital. In order to assuage the fears of potential investors, the government may directly promote information related to rural activity and corresponding investment opportunities.

The limited reach of the current financial market infrastructure and the allocation of commercial credit to agriculture may be strengthened by coordinating the efforts of various financial institutions. The government should support semi-formal financial institutions in their efforts to serve as channels by which formal institutions enter and expand their reach in informal markets. Moreover, informal institutions may benefit from best practice and technical assistance obtained from formal or semi-formal institutions.

The legal and regulatory framework underlying financial intermediation and the allocation of capital should serve as a mechanism to enhance access to credit by providing for the seamless enforcement of contractual obligations. Additionally, consumer protection policy should emphasize the rights and recourse available to borrowers or potential borrowers in order to guard against their exploitation.

It is important that regulation addresses the asymmetric information between lenders and borrowers; hence, providing a mechanism to mitigate against potential risks of default. However, the complexity of regulation pertaining to the provision of financial services, particularly when it comes to client on-boarding requirements, contributes to the high transaction costs prevalent in the provision of credit and may have the unintended consequences of inhibiting borrowing activity. Information related to relevant regulations should be simply and regularly communicated and the regulatory authorities may consider training the main stakeholders that are primarily impacted. While regulatory requirements should not place unnecessary information and cost burdens on stakeholders, it is critical that the regulatory environment is appropriately sophisticated to curb malpractice and mismanagement in financial institutions.

The complexity, inadequacy and inappropriateness of financing products and services available to rural agricultural businesses tend to protract the semi-subsistence nature of the agricultural sector and inhibit its development. Agricultural policy should support the educational development of agricultural business owners in order to enhance their financial decision making capabilities, while enabling them to cultivate sustainable borrowing behaviour. Further, policy should aid in supporting agricultural businesses to improve their quality of labour and managerial capabilities in order to optimize the use of their initial liquidity endowment, fixed factors of production, and farm inputs.

The goals highlighted by the Tanzania Development Vision 2025 have been core to the developmental agenda of Tanzania since the dawn of independence and are expected to continue to shape her policy landscape into the foreseeable future, with support from the Agricultural Sector Development Strategy and its operationalization in the form of the Agricultural Sector Development Programme.

#### **6.4 Recommendations for future research**

The research approach, findings, and recommendations presented by this study raise a need for further research, to better understand the relationship between an agricultural business's credit constraint status and its agricultural productivity. Further, there is scope for the research limitations identified by this study to be addressed by research efforts going forward.

Agricultural businesses that are credit constrained may have systematically different characteristics to businesses that are unconstrained; hence, unobservable characteristics may affect both a business's constraint status and their productivity. The non-random sampling approach taken by this study may result in inconsistent estimates, which are not representative or generalizable to the Tanzanian agricultural sector. Furthermore, sampling error may arise due to the selection of the crop producer subsample from the entire sample of agricultural businesses. Hence, selection bias may result from unobservable factors that are not adequately captured by the econometric model. A sampling design that deliberately captures agricultural producers may provide an opportunity to improve on the representativeness of the sample.

The endogeneity problem may be addressed by simultaneously estimating the selection and outcome equations, as undertaken by this study; however, a more robust strategy would be to take an experimental approach and randomly assign access to credit to treatment and control agricultural businesses, respectively. Further research may incorporate experimental designs in order to control for any confounding factors that could influence the economic outcomes of agricultural businesses, while enhancing the validity of the control group as a counterfactual in assessing the implications of credit constraint relaxation.

Measurement and identification issues may arise due to the use of secondary data. The operationalization of the credit constraint status of an agricultural business is limited by the reliability of the qualitative information used for direct elicitation, while the gross income

measure captured in the survey may overestimate the crop output value earned by the average agricultural business.

Future research is encouraged to obtain primary responses to tailor-made survey instruments that are purposefully designed to directly elicit the credit constraint status of each respondent. Additionally, more detailed information related to access to and participation in credit should be recorded. In particular, information related to the credit limit available to agricultural businesses and their loans outstanding would provide quantitative measures from which excess demand for credit may be elicited.

The economic outcome of an agricultural business may be better evaluated by ensuring that the performance indicator of interest is appropriately measured. Challenges with the gross income variable used in this study provide scope for more detailed information to be obtained about businesses' sources of income. Moreover, input and output prices may be captured exogenously by future research. Additionally, the survey randomly selects a single agribusiness from the eligible household members available. Hence, there is room for further research to be conducted at the household level, which may provide more insights into the aggregate earnings and welfare of the agricultural household.

The cross-sectional nature of the survey precludes an evaluation of the reliability and generalizability of the results over time. Hence, as an extension to the static framework adopted by this study, future research may explore the dynamic implications of credit constraints on agricultural production. The current study explicitly focuses on the production side of agricultural household decision-making within a static framework. However, a more robust theoretical model may be developed in order to investigate the idiosyncrasies of the consumption side of the agricultural household.

An evaluation of the cost implications of addressing the identified market failures is beyond the scope of this study. It is critical that the feasibility and sustainability of any policy recommendations are evaluated in the context of a cost-benefit analysis, which clearly provides evidence that the benefits of the public sector's interventions will outweigh the costs.

## **Chapter 7. Concluding remarks**

Using a nationally representative sample of agricultural businesses in Tanzania, this paper investigates the determinants of credit constraints and their impact on crop output value per hectare. There is significant evidence to reject the null hypothesis that there is no relationship between credit constraint status and agricultural productivity of Tanzanian crop producers. Credit constraints are found to significantly negatively impact agricultural productivity; hence, unconstrained agricultural businesses earn more than their constrained counterparts.

We directly elicit constraint status and find that a large portion of crop producers was constrained in the formal and semi-formal credit market. Subsequently, we simultaneously estimate the selection and outcome equation using an endogenous switching regression model, and finally evaluate the treatment effects and analyze the significance of the impact that credit constraint status has on agricultural productivity.

The likelihood of being credit constrained is found to be reduced if an agricultural business was located in an urban area, held a title for owned and registered land or received an input subsidy from the government; with more education or dependents improving constraint status even further. Savings in formal institutions, warehouse or storage ownership, or advice from the government or farmers' associations increased the likelihood of constraints.

We found that the treatment effect of the relaxation of credit constraints was significantly positive and larger for agricultural businesses observed as unconstrained, when compared to the unconstrained counterfactual. Further, this paper provides evidence in support of a broader definition of credit constraints in policy discourse, which includes transaction costs and risk constraints, in addition to quantity constraints.

Agricultural policy should aim to tackle credit rationing, by addressing the imperfect and costly information and control mechanisms that perpetuate frictions in credit and agricultural markets. The government should spearhead the coordinated efforts of various financial institutions, public and private stakeholders, and most importantly, the farmer. Further, it is important that a conducive environment is established to enhance confidence in the stability of the economy, while balancing the complexity and comprehensiveness of regulation. Addressing the credit constraints experienced by agricultural businesses is a critical step in achieving the eradication of poverty and the improvement of living standard.

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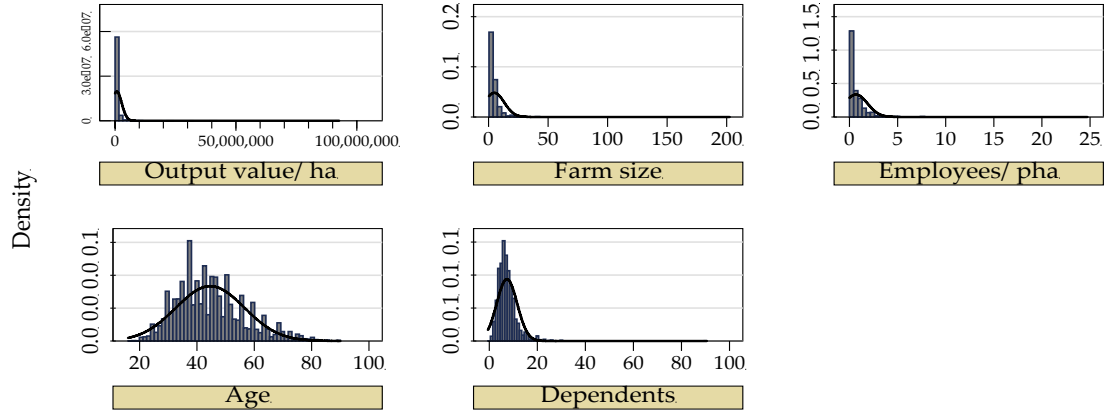
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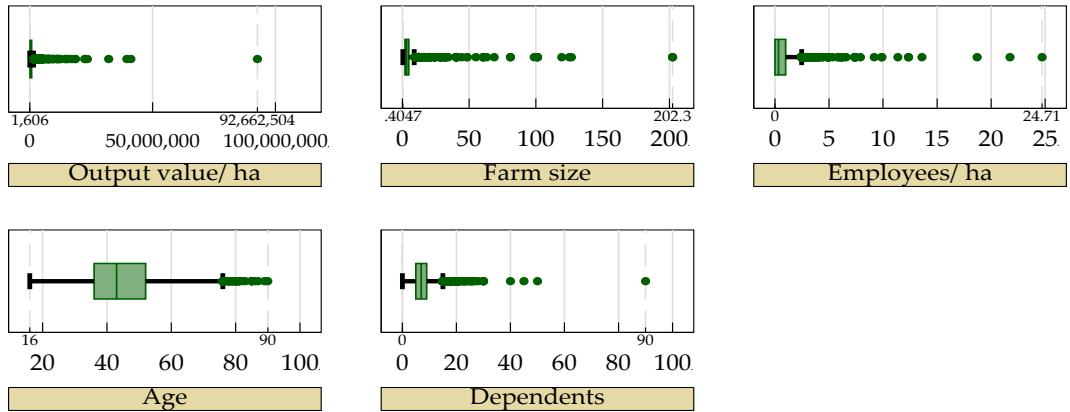
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# Appendices

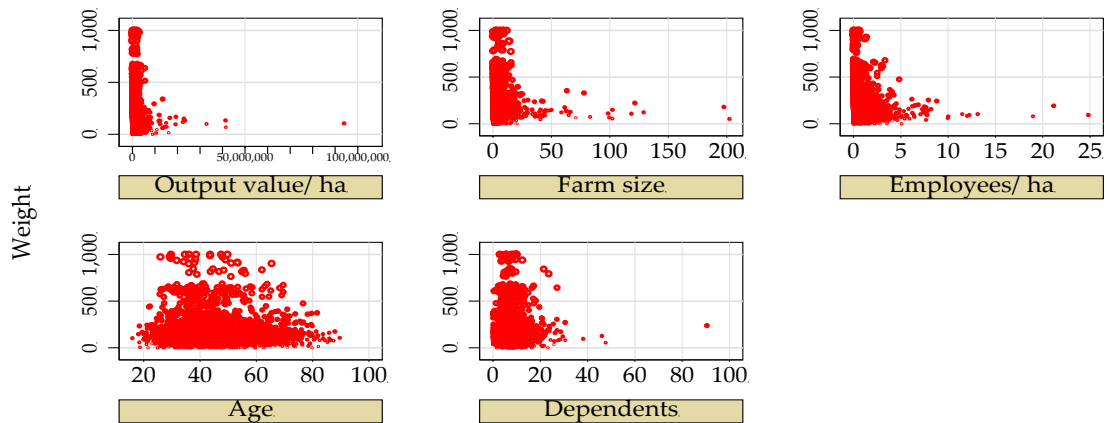
## Appendix 1. Preliminary Diagnostics Linear specification



Histograms



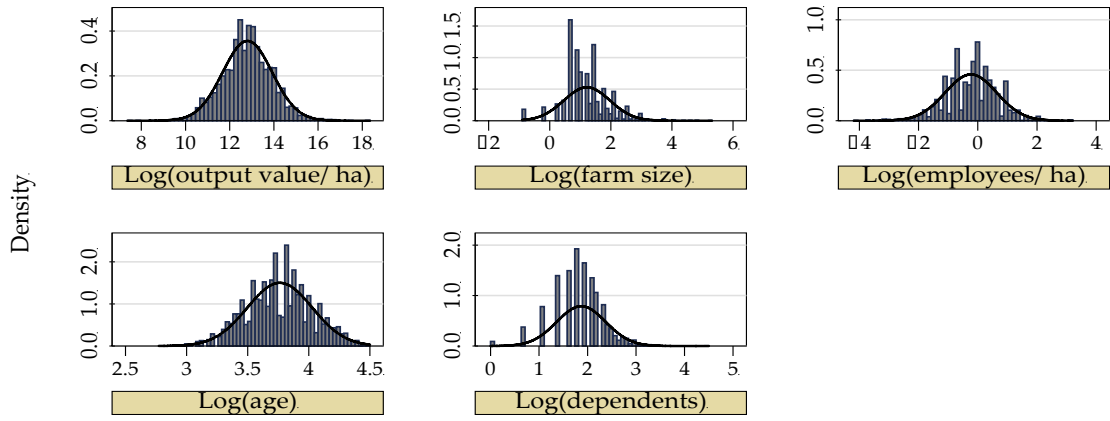
Box plots



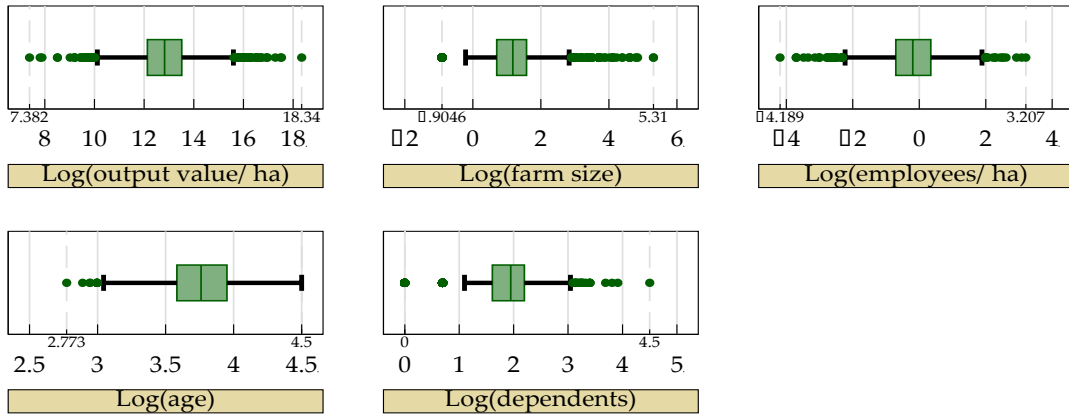
Scatterplots vs Adjusted Sampling Weights.

## Appendix 2. Preliminary Diagnostics

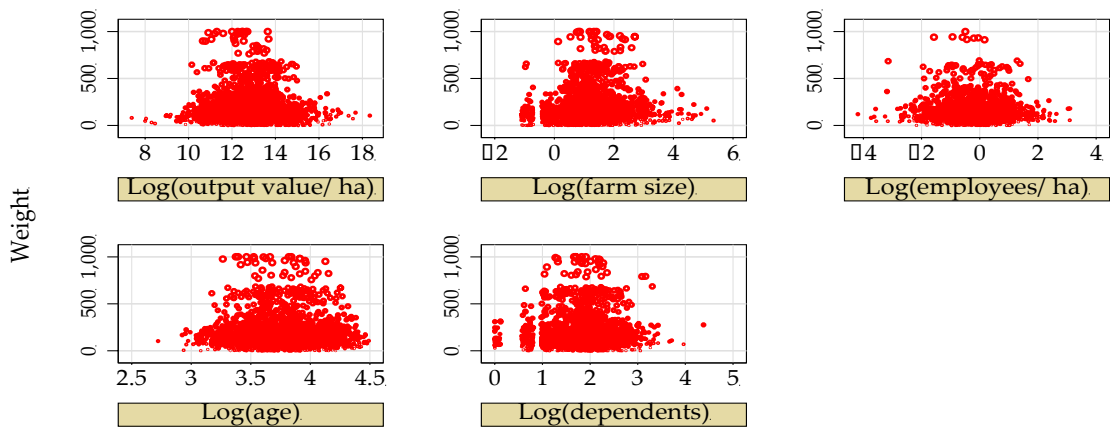
### Non linear specification



**Histograms**



**Box plots**



**Scatterplots vs Adjusted Sampling Weights**

**Appendix Table 1. Selected population and labour statistics ('000)**

	2007	2008	2009	2010	2011	2012	2013	2014
Total Population - Both sexes	41,120	42,354	43,640	44,973	46,355	47,783	49,253	50,757
Total economically active population	20,286	20,921	21,595	22,306	23,055	23,843	24,675	25,555
Total economically active population in Agriculture	15,693	16,084	16,496	16,928	17,379	17,851	18,346	18,865

Source: FAOSTAT (2015c; 2015d; 2015e)

**Appendix Table 2. GDP at 2007 prices by economic activity (TZSbn)**

Economic Activity	2007	2008	2009	2010	2011	2012	2013
Agriculture, Hunting, Forestry, and Fishing	7,182	7,721	8,115	8,333	8,622	8,903	9,186
Industry and construction	5,406	5,759	5,950	6,489	7,271	7,566	8,426
Mining and quarrying	935	844	1,002	1,074	1,142	1,218	1,265
Manufacturing	1,880	2,094	2,192	2,388	2,554	2,659	2,834
Electricity, gas and water supply	474	498	520	560	544	561	607
Construction	2,117	2,323	2,236	2,467	3,031	3,128	3,720
Services	12,691	13,228	13,994	15,081	16,347	17,530	18,627
Commerce	3,127	3,323	3,407	3,715	4,099	4,273	4,488
Transport and communications	2,188	2,289	2,583	2,980	3,157	3,502	3,810
Financial intermediation, real estate and business services	3,469	3,716	3,978	4,352	4,634	4,913	5,158
Governments, community, social and personal services	3,907	3,900	4,026	4,034	4,457	4,842	5,171
Net taxes and FISIM	1,491	1,559	1,734	1,781	1,951	1,954	2,332
GDP at 2007 prices	26,770	28,267	29,793	31,684	34,191	35,953	38,571

Source: NBS and MOF (2015)

**Appendix Table 3. Annual GDP growth at 2007 Prices (%)**

Economic Activity	2007	2008	2009	2010	2011	2012	2013
Agriculture, Hunting, Forestry, and Fishing		7.50	5.10	2.70	3.50	3.30	3.20
Industry and construction		6.50	3.30	9.10	12.10	4.10	11.40
Mining and quarrying		-9.70	18.70	7.20	6.30	6.70	3.90
Manufacturing		11.40	4.70	8.90	7.00	4.10	6.60
Electricity, gas and water supply		5.10	4.40	7.70	-2.90	3.10	8.20
Construction		9.70	-3.70	10.30	22.90	3.20	18.90
Services		4.20	5.80	7.80	8.40	7.20	6.30
Commerce		6.30	2.50	9.00	10.30	4.20	5.00
Transport and communications		4.60	12.80	15.40	5.90	10.90	8.80
Financial intermediation, real estate and business services		7.10	7.10	9.40	6.50	6.00	5.00
Governments, community, social and personal services		-0.20	3.20	0.20	10.50	8.60	6.80
Net taxes and FISIM		4.60	11.20	2.70	9.50	0.20	19.30
GDP at 2007 prices		5.60	5.40	6.30	7.90	5.20	7.30

Source: NBS and MOF (2015)

**Appendix Table 4. Shares of agricultural GDP at 2001 Prices (%)**

Economic activity	2007	2008	2009	2010	2011	2012	2013
Crops	50.2	50.3	50.5	51.0	51.7	52.1	52.3
Livestock	35.0	35.2	35.2	34.8	34.2	33.7	33.3
Forestry and hunting	8.9	8.6	8.6	8.7	8.7	8.7	8.8
Fishing	5.9	5.9	5.6	5.5	5.5	5.5	5.6
Agriculture, Hunting, Forestry, and Fishing	100	100	100	100	100	100	100

Source: NBS and MOF

**Appendix Table 5. Annual GDP growth by agricultural sub-sector at 2001 Prices (%)**

Economic activity	2007	2008	2009	2010	2011	2012	2013
Crops		7.8	5.5	3.6	4.8	4.2	3.5
Livestock		8.1	5.3	1.4	1.6	1.8	2.0
Forestry and hunting		3.8	5.1	3.4	3.3	3.5	4.7
Fishing		7.3	0.4	0.9	2.6	3.0	5.3
Agriculture, Hunting, Forestry, and Fishing		7.5	5.1	2.7	3.5	3.3	3.2

Source: NBS and MOF

**Appendix Table 6. Production indices (2007 = 100)**

	2007	2008	2009	2010	2011	2012	2013
<b>Food crops</b>							
Maize	100	149	91	129	119	139	146
Rice, paddy	100	106	99	197	168	134	164
Sorghum	100	57	73	82	83	86	86
Millet	100	49	101	114	101	69	105
Cassava	100	104	114	87	89	105	104
Beans, dry	100	64	87	98	76	135	129
Potatoes	100	104	132	227	239	190	272
Sweet potatoes	100	104	107	183	270	228	234
Total Food crop production	100	109	102	124	127	132	140
<b>Cash crops</b>							
Seed cotton	100	184	133	133	82	176	
Coffee, green	100	88	128	82	124	135	
Tea	100	111	109	106	102	105	
Sisal	100	108	77	85	80	83	
Tobacco, unmanufactured	100	100	116	120	257	237	
Cashew nuts	100	107	85	80	132	132	
Total cash crop production	100	138	115	110	117	158	

Source: FAOSTAT (2015b)

**Appendix Table 7. Area harvested (Ha)**

	2007	2008	2009	2010	2011	2012	2013
<u>Food crops</u>							
Maize	2,600,340	3,980,970	2,961,330	3,050,710	3,287,850	4,118,120	4,120,270
Rice, paddy	557,981	887,660	805,630	1,136,290	1,119,320	799,361	928,273
Sorghum	817,946	566,760	874,219	618,370	811,164	839,423	711,388
Millet	400,000	213,972	398,506	345,855	328,112	260,417	334,575
Cassava	779,067	837,744	1,081,380	873,000	739,794	954,509	950,000
Beans, dry	918,742	749,540	868,310	1,208,690	737,661	1,330,000	1,300,000
Potatoes	125,000	134,415	195,690	172,970	203,089	170,000	203,165
Sweet potatoes	396,134	204,500	651,940	576,220	699,073	670,000	675,000
<u>Cash crops</u>							
Cotton	450,000	574,840	519,350	421,200	226,506	487,440	490,000
Coffee, green	212,105	210,000	245,890	223,510	116,508	127,335	
Tea	22,382	23,590	23,758	11,410	8,551	3,750	
Sisal	41,882	44,199	53,774	59,915	56,097	58,051	
Tobacco, unmanufactured	44,000	47,000	55,210	78,930	168,488	155,527	
Cashew nuts	93,000	94,000	80,000	249,090	406,597	410,641	

Source: FAOSTAT (2015a)

**Appendix Table 8. Yield (Kg/Ha)**

	2007	2008	2009	2010	2011	2012	2013
<u>Food crops</u>							
Maize	1,407	1,367	1,123	1,551	1,320	1,239	1,300
Rice, paddy	2,405	1,600	1,657	2,332	2,009	2,252	2,364
Sorghum	1,187	973	811	1,291	994	999	1,170
Millet	770	699	784	1,015	951	821	965
Cassava	6,673	6,437	5,471	5,210	6,281	5,723	5,684
Beans, dry	968	761	891	718	916	902	885
Potatoes	5,200	5,021	4,400	8,513	7,659	7,265	8,700
Sweet potatoes	3,337	6,743	2,174	4,207	5,111	4,505	4,593
<u>Cash crops</u>							
Cotton	446	641	514	634	722	722	724
Coffee, green	230	205	254	179	520	520	
Tea	1,398	1,475	1,438	2,906	3,742	8,750	
Sisal	738	753	443	440	443	443	
Tobacco, unmanufactured	1,150	1,081	1,063	772	772	772	
Cashew nuts	996	1,054	989	298	301	298	

**Appendix Table 9. Commercial Banks domestic lending by economic activity (TZSbn)**

Economic Activity	2010	2011	2012	2013	2014
Agriculture, Hunting, Forestry, and Fishing	547.9	854.5	938.8	1 061.90	1 147.50
Agriculture, Hunting, and Forestry	498	773.3	895.9	1 027.20	1 110.60
Fishing	49.9	81.2	42.9	34.7	36.9
Industry and construction	1 285.60	1 629.20	1 929.80	2 388.20	2 887.00
Mining and Quarrying	33.9	42.3	55.2	96.7	185.8
Manufacturing	786.5	928.2	991.8	1 160.60	1 423.80
Electricity, gas and water	283.1	338.5	472.1	616.4	623.6
Building and Construction	182.1	320.1	410.7	514.4	653.7
Services	3 820.50	4 740.60	5 602.20	6 447.00	8 193.80
Commerce	1 314.90	1 933.60	2 266.40	2 646.60	3 219.20
Transport, storage and communications	534.1	560.3	633.4	745.5	980.5
Financial intermediation, real estate and business services	256.1	452.1	577.3	661.8	921.8
Governments, community, social and personal services	1 715.40	1 794.60	2 125.10	2 393.10	3 072.20
<b>Total</b>	<b>5 654.00</b>	<b>7 224.20</b>	<b>8 470.80</b>	<b>9 897.00</b>	<b>12 228.30</b>

Source: BoT (2015)

**Appendix Table 10. Growth of commercial banks domestic lending by economic activity (%)**

Economic Activity	2010	2011	2012	2013	2014
Agriculture, Hunting, Forestry, and Fishing		56.00	9.90	13.10	8.10
Agriculture, Hunting, and Forestry		55.30	15.90	14.70	8.10
Fishing		62.60	-47.10	-19.20	6.30
Industry and construction		26.70	18.50	23.80	20.90
Mining and Quarrying		24.70	30.30	75.40	92.10
Manufacturing		18.00	6.80	17.00	22.70
Electricity, gas and water		19.60	39.50	30.60	1.20
Building and Construction		75.80	28.30	25.20	27.10
Services		24.10	18.20	15.10	27.10
Commerce		47.10	17.20	16.80	21.60
Transport, storage and communications		4.90	13.00	17.70	31.50
Financial intermediation, real estate and business services		76.50	27.70	14.60	39.30
Governments, community, social and personal services		4.60	18.40	12.60	28.40
<b>Total</b>		<b>28</b>	<b>17</b>	<b>17</b>	<b>24</b>

Source: BoT (2015)

**Appendix Table 11. Variables definitions**

Variable name	Definition
<i>Outcome variables</i>	
Output value per ha	Output value/ha
Log(output value per ha)	Log(output value/ha)
<i>Selection variable</i>	
Constrained	dummy = 1 if business is quantity constrained by semiformal or formal institution
Price constrained	dummy = 1 if business is price constrained
Transaction cost constrained	dummy = 1 if business is transaction-cost constrained
Risk constrained	dummy = 1 if business is risk constrained
<i>Farm characteristics</i>	
Owned land (ha)	Farm size (hectares owned)
Owned storage or warehouse	dummy = 1 if the business owns a warehouse/storage
Title	dummy = 1 if business owner has title deed for owned land
Irrigation system	dummy = 1 if business owns an irrigation system, 0 otherwise
Farmers association/cooperative	dummy = 1 if business got advice from cooperative/farmer's association
Full or part-time employees per hectare	Total labour/hectare
<i>Farmer and farm household characteristics</i>	
Savings in financial institutions	dummy = 1 if business has savings in a formal institution, 0 otherwise
Number of dependents	Number of people dependent on the business income
Age of business head	Age of business owner
No education	dummy = 1 if business owner has completed no education, 0 otherwise
Primary education incomplete	dummy = 1 if business owner has completed some primary school, 0 otherwise
Primary education completed	dummy = 1 if business owner has completed primary school, 0 otherwise
Secondary education completed	dummy = 1 if business owner has completed secondary school, 0 otherwise
Experience of business owner	dummy = 1 if business owner has 5 or more years experience, 0 otherwise
Gender of business head	dummy = 1 if business owner is male, 0 otherwise
<i>Crop choice</i>	
Maize	dummy = 1 if primarily involved in maize production
Cassava	dummy = 1 if primarily involved in cassava production
Cotton	dummy = 1 if primarily involved in cotton production
Cashew nuts	dummy = 1 if primarily involved in cashew production
<i>Regional differences</i>	
Northern region	dummy = 1 if business is in the northern region, 0 otherwise
Western region	dummy = 1 if business is in the western region, 0 otherwise
Central region	dummy = 1 if business is in the central region, 0 otherwise
Southern highlands	dummy = 1 if business is in the southern highlands region, 0 otherwise
Lake zone	dummy = 1 if business is in the lake region, 0 otherwise
Eastern Region	dummy = 1 if business is in the eastern region, 0 otherwise
Southern region	dummy = 1 if business is in the southern region, 0 otherwise
Zanzibar region	dummy = 1 if business is in zanzibar, 0 otherwise
Urban EA	dummy = 1 if business is in an urban stratum, 0 otherwise
<i>Instrumental variables</i>	
Government subsidy	dummy = 1 if agricultural business received an input subsidy from the government
Government extension services	dummy = 1 if agricultural business received advice from the government

**Appendix Table 12. Test on the validity of the selection instruments**

	Log-linear specification			
	Model 1		Model 2	
	All constraints			
	Constrained (0/1)	Constrained = 1 Log (output value per ha)		
Owned land (ha)	-0.001	(0.003)	-0.033***	(0.006)
Employees per ha	-0.012	(0.019)	0.149***	(0.042)
Owned storage or warehouse	0.120*	(0.064)	-0.114**	(0.058)
Title	-0.100	(0.104)	0.094	(0.137)
Irrigation system	-0.032	(0.077)	0.560***	(0.092)
Farmers association/cooperative	-0.279***	(0.086)	0.176**	(0.086)
Savings in financial institutions	0.070***	(0.086)	0.579***	(0.079)
Number of dependents	-0.017**	(0.007)	-0.001	(0.006)
Age	0.007***	(0.003)	-0.004*	(0.002)
Primary education completed	-0.083	(0.097)	0.139**	(0.063)
Secondary education completed	-0.349**	(0.146)	0.316**	(0.130)
Experience	-0.097	(0.084)	-0.105	(0.086)
Gender (male = 1)	-0.038	(0.086)	0.091	(0.078)
Maize == 1	0.008	(0.076)	-0.144*	(0.083)
Cassava ==1	0.267	(0.172)	-0.477***	(0.186)
Cotton == 1	0.058	(0.136)	-0.182**	(0.092)
Cashew nuts == 1	0.440***	(0.133)	-0.436**	(0.190)
Western region	0.203*	(0.119)	0.090	(0.214)
Central region	0.032	(0.118)	-0.701***	(0.257)
Southern highlands	0.049	(0.112)	-0.059	(0.220)
Lake zone	0.316***	(0.117)	-0.318	(0.219)
Eastern Region	-0.104	(0.111)	0.197	(0.224)
Southern region	-0.223	(0.146)	-0.057	(0.262)
Zanzibar region	-0.280	(0.195)	0.814***	(0.254)
Urban EA	-0.166*	(0.090)	0.131	(0.104)
Government subsidy	-0.239***	(0.079)	0.043	(0.067)
Government extension services	-0.174**	(0.074)	0.042	(0.102)
Constant	0.333	(0.206)	12.767***	(0.345)
Wald test on instruments	$\chi^2 = 19.859$ ***		F-Stat. = 0.330	
<i>n</i>	3330		1994	

Note: Model 1: Probit model; Model 2: ordinary least squares ( $R^2 = 0.2802$ ).

Estimation at the agricultural business level. Robust standard errors in parentheses.

Significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) significance level. Dummy base variables omitted: No education or primary education incomplete; northern region.

**Appendix Table 13. Determinants of credit constraints and their impact on productivity: robustness tests**

Log-linear specification (Quantity constrained only)						
	Constraint status		Unconstrained		Constrained	
	(0/1)		Log (output value per ha)			
Log (owned land)	0.030	(0.054)	-0.320***	(0.047)	-0.173**	(0.081)
Log (employees per ha)	-0.038	(0.044)	0.252***	(0.042)	0.363***	(0.069)
Owned storage or warehouse	0.013	(0.077)	-0.048	(0.072)	-0.128	(0.102)
Title	-	(0.149)	-0.071	(0.108)	-0.199	(0.384)
Irrigation system	0.339**	(0.149)	0.434***	(0.079)	0.706***	(0.137)
Farmers association/cooperative	0.198**	(0.097)	0.139	(0.085)	0.098	(0.162)
Savings in financial institutions	0.062	(0.113)	0.419***	(0.084)	0.620***	(0.134)
Number of dependents	0.123	(0.101)	0.007	(0.006)	-0.010	(0.015)
Age	-0.009	(0.008)	-0.010***	(0.003)	-0.010**	(0.004)
Primary education completed	-0.001	(0.003)	0.231***	(0.088)	0.082	(0.130)
Secondary education completed	0.006	(0.101)	0.424***	(0.158)	-0.325	(0.276)
Experience	-0.174	(0.166)	-0.007	(0.088)	-0.008	(0.167)
Gender (male = 1)	0.204*	(0.111)	0.101	(0.093)	-0.146	(0.162)
Maize == 1	-0.014	(0.113)	-0.007	(0.079)	0.103	(0.137)
Cassava ==1	0.110	(0.098)	-0.217	(0.199)	-0.033	(0.415)
Cotton == 1	0.478**	(0.213)	-0.213	(0.132)	-0.077	(0.188)
Cashew nuts == 1	0.071	(0.150)	-0.706***	(0.147)	-0.103	(0.238)
Western region	0.300*	(0.156)	-0.070	(0.159)	0.024	(0.339)
Central region	0.415**	(0.175)	-0.828***	(0.154)	-0.785***	(0.221)
Southern highlands	0.066	(0.166)	-0.020	(0.113)	-0.333*	(0.188)
Lake zone	0.103	(0.142)	-0.482***	(0.142)	-0.287	(0.295)
Eastern Region	0.303**	(0.151)	0.061	(0.132)	-0.238	(0.219)
Southern region	-0.076	(0.161)	0.105	(0.147)	-0.391*	(0.232)
Zanzibar region	0.040	(0.168)	0.651***	(0.171)	0.401	(0.318)
Urban EA	-0.040	(0.217)	0.271***	(0.093)	0.005	(0.149)
Government subsidy	-0.053	(0.117)	-		-	
Government extension services	-0.115	(0.070)	0.188**	(0.081)		
Constant	-	(0.253)	13.526***	(0.231)	12.831***	(0.956)
$\sigma_i$			0.914***	(0.039)	1.185***	(0.434)
Rho			0.341*	(0.176)	0.746*	(0.435)
Log-likelihood			-601931.73			
chi2			4.93 **			
<i>n</i>			2116			

Note: Estimation by Full Information Maximum Likelihood at the agricultural business level. Dependent variable of the outcome variable is the log of crop output value per hectare. The dependent variable of the selection equation is a binary variable indicating whether or not the household is quantity constrained. Robust standard errors are in parentheses.  $\sigma_i$  denotes the square-root of the variance of the error terms  $\varepsilon_{ji}$  in the outcome equations captured by equation (7);  $\rho_j$  denotes the correlation coefficient between the error term  $u_i$  of the selection equation (5) and the error term  $\varepsilon_{ji}$  of the outcome equations (7). Significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) significance levels. Dummy base variables omitted: No education or primary education incomplete; northern region.

**Appendix Table 14. Determinants of credit constraints and their impact on productivity: robustness tests**

Log-linear specification (All constraints)						
	Constraint status		Unconstrained		Constrained	
	(0/1)		Log (output value per ha)			
Log (owned land)	0.033	(0.052)	-0.280***	(0.057)	-0.248***	(0.059)
Log (employees per ha)	-0.034	(0.043)	0.235***	(0.053)	0.331***	(0.048)
Owned storage or warehouse	0.098	(0.080)	-0.005	(0.091)	-0.076	(0.088)
Title	-0.200	(0.141)	-0.073	(0.138)	-0.057	(0.180)
Irrigation system	0.118	(0.093)	0.348***	(0.098)	0.626***	(0.104)
Farmers association/cooperative	-0.208*	(0.107)	0.095	(0.113)	-0.101	(0.124)
Savings in financial institutions	0.091	(0.097)	0.400***	(0.101)	0.524***	(0.103)
Number of dependents	-0.015**	(0.007)	0.004	(0.007)	-0.008	(0.010)
Age	0.006*	(0.003)	-0.009**	(0.004)	-0.006*	(0.003)
Primary education completed	-0.082	(0.112)	0.212	(0.132)	0.103	(0.097)
Secondary education completed	-0.426	(0.172)	0.292	(0.218)	-0.150	(0.207)
Experience	0.025	(0.107)	-0.083	(0.102)	-0.047	(0.119)
Gender (male = 1)	-0.010	(0.113)	-0.031	(0.119)	0.028	(0.119)
Maize == 1	0.087	(0.095)	0.131	(0.103)	-0.070	(0.099)
Cassava ==1	0.530***	(0.203)	0.074	(0.237)	-0.264	(0.237)
Cotton == 1	-0.015	(0.156)	-0.361**	(0.178)	-0.113	(0.141)
Cashew nuts == 1	0.470***	(0.165)	-0.471**	(0.219)	-0.338*	(0.188)
Western region	0.033	(0.175)	-0.119	(0.218)	-0.192	(0.173)
Central region	0.107	(0.165)	-0.863***	(0.222)	-0.808***	(0.158)
Southern highlands	0.116	(0.140)	-0.058	(0.158)	-0.197	(0.126)
Lake zone	0.474***	(0.152)	-0.235	(0.247)	-0.374**	(0.175)
Eastern Region	0.022	(0.153)	-0.012	(0.186)	-0.047	(0.155)
Southern region	-0.177	(0.171)	-0.042	(0.191)	-0.291	(0.177)
Zanzibar region	-0.139	(0.216)	0.640***	(0.217)	0.299	(0.231)
Urban EA	-0.168	(0.115)	0.178	(0.124)	0.064	(0.114)
Government subsidy	-0.163**	(0.071)				
Government extension services	-0.266***	(0.080)				
Constant	0.050	(0.261)	13.908***	(0.399)	13.028***	(0.377)
$\sigma_i$			0.922***	(0.104)	1.087***	(0.149)
Rho			0.448	(0.340)	0.689**	(0.269)
Log-likelihood			-604624.9			
chi2			4.22**			
<i>n</i>			2116			

Note: Estimation by Full Information Maximum Likelihood at the agricultural business level. Dependent variable of the outcome variable is the log of crop output value per hectare. The dependent variable of the selection equation is a binary variable indicating whether or not the household is constrained (all constraints considered). Robust standard errors are in parentheses.  $\sigma_i$  denotes the square-root of the variance of the error terms  $\varepsilon_{ji}$  in the outcome equations captured by equation (7);  $\rho_j$  denotes the correlation coefficient between the error term  $u_i$  of the selection equation (5) and the error term  $\varepsilon_{ji}$  of the outcome equations (7). Significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) significance levels. Dummy base variables omitted: No education or primary education incomplete; northern region.

**Appendix table 15. Average expected output value/hectare; treatment and heterogeneity effects**

Sub-samples (constraint status)	Observed outcome		Treatment effects
	Unconstrained ( $y_{0i}$ )	Constrained ( $y_{1i}$ )	
Unconstrained ( $k_i=0$ )	(a) 494,534 (12,035)	(c) 339,361 (19,679)	TT = 155,173 *** (23,068)
Constrained ( $k_i=1$ )	(d) 1,269,785 (35,906)	(b) 439,967 (16,444)	TU = 829,818 *** (39,493)
Heterogeneity effects	BH <sub>1</sub> = -775,251 *** (37,870)	BH <sub>2</sub> = -100,606 *** (25,645)	TH = -674,645 *** (27,709)

Source: Adapted from Di Falco et al (2011, p.837); Asfaw et al (2012, p.287)

Note: Quantity constraints only. See note of table 7. Standard errors in parentheses. Significant at the 1% (\*\*\*) , 5% (\*\*) and 10% (\*) significance levels.