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Three Essays on Consumption Behavior, Credit, and Labor Supply of Farm Households in Sub-Saharan Africa: Evidence from Uganda

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THREE ESSAYS ON CONSUMPTION BEHAVIOR, CREDIT, AND
LABOR SUPPLY OF FARM HOUSEHOLDS IN SUB-SAHARAN
AFRICA: EVIDENCE FROM UGANDA

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Agricultural Economics and Agribusiness

by
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August 2017

I dedicate my dissertation work to my dear and loved wife Dr. Fanta Diamanka and my very sweet girl Marieme Sene. Fanta and Marieme have been very patient, understanding and supportive despite all the difficulties I went through. I dedicate this dissertation to my grand mother who passed away and whom I cannot forget in my life. My Grandmother words of encouragement and push for tenacity still ring in my ears. Grandmother Marieme Diagne May Allah forgives you and welcomes you to Firdaws. I dedicate this dissertation to my mom who is currently sick and could not get a chance to understand the meaning of this piece. I also would like to dedicate this work my dearest friends Habib Mbaye and Sheikh Ibrahima Kebe, as well as my sister Aida Ndour for continuously supporting my mom despite all the Challenges. Special thanks and dedicate to my father who along the way kept me strong while praying for me. I aslo dedicate this piece to my mother and father in law Aissata Sow and Mamadou Diamanka who have been determinant for my choice to pursue higher education. You all have ben my best cheerleaders.

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ABSTRACT

Consumption patterns, credit, and labor supply are determinants of human welfare, and also indicators of a country's economic progress, poverty, and inequalities. In this study, I review many of the stylized facts regarding consumption behaviors, credit, and the decision to engage in off-farm labor supply. I also put the life cycle model into an empirical model and perform testing. This is done in a three-essay format with a focus on the country of Uganda. In the first essay, I test whether farm households' consumption behavior is consistent with an optimization process predicted by economic theory. In chapter II, I evaluate the impact of borrowing constraints on farm households' consumption behavior when consumers or producers do not have access to financial services due to market imperfections. In chapter III, I investigate the determinants of off-farm participation and labor supply (hours) of farm households in Uganda. Farm household off-farm labor is perceived as an important strategy to cope with credit constraints and an instrument to improve livelihoods and food security, especially in Uganda, and generally in Sub-Saharan Africa.

I use data based on the farm household survey conducted in East Africa by the World Bank as part of the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) project. I use three years of survey data from 2009/2010, 2010/2011, and 2011/2012, covering the district of Kampala and 72 (58 rural and 14 urban) Enumeration Areas (EAs) in the five regions of the country.

In chapter 1, I find that the Euler equation of consumption is rejected and that the “life cycle model” of inter-temporal optimization does not characterize consumption behavior in Uganda.

In chapter 2, I estimate the Euler equation when borrowing constraints do not have an impact on consumption behavior using the inter-temporal optimization framework. I found that the life cycle model without borrowing constraint restrictions is “rejected”.

In chapter 3, I look at the decision to engage in off-farm work and labor supply hours using a double hurdle model. I find that heads of households who completed a secondary level of education and above engage more in off-farm work at the prevailing market wage. The reservation wage at which an educated head of a farm household in Uganda is willing to work seems to match ongoing and established market wage in the informal sector. Thus, if the head of household chose to work on the farm and not off-farm, it was because his or her marginal product of labor on-farm is greater than the wage rate prevailing off-farm. However, 39.5 percent of the heads of households with no formal education remained engaged in agriculture compared to those with some education regardless of the level attained. Twenty five percent of heads of households with education above the secondary level remain in the non-agriculture sector; and if they decide to join off-farm wage earners, they are likely to supply more hours of work off the farm regardless of sex.

The major policy implications from the findings of this dissertation are that a suitable model, which characterizes consumption behavior in developing countries, could improve welfare in Uganda. Credit constraints do affect consumption behavior and policies focusing on restructuring land titling will help farm households penetrate financial markets and have access to credit. Moreover, credit and decisions on labor supply are key policy tools that policymakers in Uganda should focus on in poverty analyses and welfare to increase the average lifetime income and the investment in agriculture.

CHAPTER 1: INTRODUCTION

1.1.Introduction

Standard consumption theory posits that rational consumer behavior or choice has a demand function that follows three testable properties: homogeneity, symmetry, and the negative definiteness of demand function. However, the assumption of consumer rationality that produces a demand function with these properties is uncommon. Deaton (1974) demonstrates that the theory of consumer behavior explains individual behavior but does not ipso facto hold at the aggregate level, even if one assumes rationality. Deaton states that the assumed functional form of the linear expenditure system could be too restraining to adequately depict consumer's behavior to address macroeconomic issues using microeconomic data. Therefore, the debate in the literature can be couched in terms of two hypotheses: either consumers are not rational, or the models researchers adopt to depict consumers' behavior or choices are not well suited to explain their behavior, especially in developing countries. In many developed and developing countries, predictions and empirical policy implications derived from these strong assumptions remain unresolved and controversial in the literature (Browning and Crossley 2001; Deaton 2016).

Starting in the late 1980s, policy-makers in Uganda established a series of stabilization policies, including land and pro-market structural reforms to enhance welfare by increasing investment in agriculture. As a result, investment responses from these stabilization policies led to a sustained period of high economic growth from 1987-2010 (World Bank 2016). According to the World Bank, real gross domestic product (GDP) averaged 7 percent growth per year in the 1990s and the 2000s, ranking Uganda among the 15 fastest growing economies in the world.

However, frequent migration and the settlement camps housing those from unstable neighboring countries like the Democratic Republic of Congo (765km), Rwanda (169 km), South Sudan (435 km), Tanzania (396km), and Kenya (933 km), coupled with a population growth rate of 3 percent per annum, decelerated Uganda's income growth from 4.47 percent to about 3.91 percent between 2012 and 2016 (World Bank 2016). Therefore, a large proportion of the

population in mostly farm households is highly vulnerable to falling back into poverty, which would make achieving the millennium development goals a challenge for Uganda. Moreover, half of the population in Uganda is young, between 16 and 39 years of age. The fertility rate is estimated at 5.7 children per woman in 2015, with an additional 700,000 new workers enter the labor market every year (World Bank 2016).

The contribution of this dissertation is to shed light on farm household consumption behavior by putting consumer theories and their predictions to empirical modeling and testing in Uganda. This is very important since achieving a good livelihood in Uganda, in particular, and Sub-Saharan Africa, in general, necessitates “overcoming challenges” such as day-to-day consumption, relaxing credit constraints, and increasing productivity in agriculture. Moreover, the dissertation contributes to economic development literature by highlighting the significant importance of credit constraints and their impact on consumption, given that a farm household's access to credit is very limited in Uganda. This dissertation also identifies determinants of off-farm work and labor participation in the informal sector and offers policy insights to address the unsustainable and rapid urban development that encourages farmers to leave their farms. To achieve these goals, I use microeconomic data and develop testable empirical models to evaluate small farm households' consumption behavior. I frame consumer behavior based on the spirit of the life cycle hypothesis and through the lens of the neoclassical consumption model. In the neoclassical consumption model, individuals choose the time path of their consumption to maximize utility. This leads to a model benchmark solution in which consumption is proportional to an individual's total wealth, including current financial wealth and the present value of current and future labor income, including off-farm labor income. Unlike consumers represented in the existing literature about developed countries, consumers in Uganda face non-insurable risks associated with agriculture production, income uncertainty, credit constraints, price distortions, and off-farm labor supply decisions. Consequently, much policy advice on agricultural and economic development relative to African countries remains based on unrealistic assumptions and analysis. Thus, to counter the

negative effects of bad policy, which could create many problems, I take advantage of unique panel data from (2009/2010, 2010/2011, 2011/2012) and present useful policy insights for agricultural development in Uganda^{1,2}

1.2. Research Objectives

The overall objective of this dissertation is to devise a consumption function and test if farm households' consumption behavior is consistent with some type of optimization process predicted by economic theories. The goal is to evaluate if farm households in Uganda plan in a manner consistent with some inter-temporal optimization process. If so, my objective is to test if the life cycle model under capital market imperfection is an adequate representation of households' decision-making processes.

The goal is also to generate a robust testable hypothesis about life cycle models and consumer behavior, the impact of credit constraints on consumption, and the determinants of off-farm labor supply decisions in Uganda. The three chapters in this dissertation end with three overarching policy implications: The three chapters in this dissertation end with three overarching policy implications:

- i. an evaluation of policy reforms inherent to consumption taxes, welfare, and poverty alleviation;

¹The UNCTAD Investment Policy Reviews aim to help countries improve their investment policies and to help governments and the international private sector with an individual country's investment environment to boost their economies: http://unctad.org/en/docs/iteipcmisc9_en.pdf.

²The Comprehensive Africa Agriculture Development Program (CAADP) is Africa's policy framework for agricultural transformation, wealth creation, food security and nutrition, economic growth, and prosperity for all: <http://www.un.org/en/africa/osaa/peace/caadp.shtml>.

- ii. An evaluation of the impact of credit constraints on consumption behavior and how land titling can help farm households penetrate the financial markets and gain access to credit in Uganda; and
- iii. Addressing the frequent migration of household members seeking off-farm employment in the informal sector with an understanding of the factors that drive farmers to leave the farm. Even though off-farm income helps provide for the day-to-day consumption needs, it can also undermine investment in agriculture in the long run, which is essential for economic development in Uganda. If farmers leave the farm often and the rate of return by participating in off farm work is greater than income from farming, they can value farming less and less.

1.3.Theoretical Framework and Methodology

Farm households in Uganda are studied from the neoclassical economic perspective. A farm household is perceived as a distinct entity that behaves differently from other agents or actors in the economy. From this perspective, the interactions between consumption, saving, production, land tenure, and labor (off-farm labor supply) are considered under the life cycle framework. The first tenet of this is that farm households must decide their required or needed level of consumption, hence simultaneously and inter-temporally determining the level of consumption, credit, and off-farm labor supply required under market imperfections. The market imperfections are characterized by production uncertainty resulting from spatiotemporal variations in rainfall patterns, agricultural price distortions, credit constraints, time-inconsistent preferences, and non-competitive labor markets. Within this framework, a basic life cycle model with production uncertainty is extended. Following Phimister (1993), the link between the marginal utility in two consecutive periods is derived under the constant elasticity of substitution assumption. Throughout the dissertation, I

define a farm household as a group of people who have normally been living and eating their meals together for at least six of the twelve months preceding the interview.

1.4.Data

The data used in all three essays in this dissertation are from the farm household survey conducted in East Africa by the World Bank as part of the Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) project. Over the past two decades, important changes have taken place in farm households, market structures, and community. Surveys used in this dissertation range from the year 2009 to 2012 and cover the district of Kampala plus 72 Enumeration Areas (EAs) (58 rural and 14 urban) out of the 783 EAs in the (i) Central Region with the exception of Kampala District, (ii) Eastern Region, (iii) Western Region, and (iv) Northern Region. Moreover, the surveys include questions related to the household, such as the sex of its members, details about its agriculture and livestock, its community, and its market. The three years of data are collected as follows: Year 1 (2009-2010), n= 3,123 households; Year 2 (2010-2011) n= 2,716 households; and Year 3 (2011-2012) n= 2,716 households.

1.5.Chapter 1

My first essay is presented in Chapter 2. The title of the essay is: *Market Imperfections, Farm Household Consumption Behavior and the Life Cycle Model in Sub-Saharan Africa: Evidence from Uganda*. In this essay, I focus on testing whether small farm household consumption behavior is consistent with life cycle model predictions, which state that consumption is proportional to an individual's total wealth, including current financial wealth and the present value of current and future labor income. As a result, this essay analyzes inter-temporal decisions on how households manage consumption within the credit rationing and market imperfections of Uganda.

1.5.1. Framing of the Problem

Understanding consumption patterns helps determine human welfare, a country's economic progress, and poverty, as well as illuminating inequalities. However, the heterogeneity in consumer behaviors implies different policy prescriptions for investment in agriculture and labor supply decisions in farm households. In both developed and developing economies, aggregate consumption accounts for many business cycle dynamics. Deaton (2016) states that for every level of income consumption determines savings and investment. For instance, in Uganda, farm households represent more than 70 percent of the labor force. Thus, those households' consumption behavior need to be understood to alleviate poverty, combat inequality, and foster agricultural development. Therefore, the study of consumption behavior, credit, and decisions about the labor supply drive major economic policy, while imperfect and incomplete labor markets continue to be a crucial feature of the microeconomics of economic development in many developing countries.

1.5.2. Objectives

The first objective in essay one is to evaluate the life cycle model and its empirical predictions by understanding features of the economic environment of farm households in Uganda under market imperfections. For instance, when looking at the preference or utility side of the equation, I assume that households put less weight or value on future income because of the unpredictable nature of the economic environment (e.g. drought, production uncertainty, price distortions, poverty, and diseases). On the constraint side, I assume that households face market imperfections in the credit market, with fluctuating lending rates and a risk basis profile. On the information side, I assume that households keep updating their beliefs and revising their expectations and decision-making processes, taking into account the interactions between income, consumption, credit, land tenure, household size, age, and financial performance. The second objective in essay one is to overcome the apparent data inadequacy and deficiencies in the modeling

of unitary and collective small farm household consumption behavior. Using the data, I am able to access household specific economic transaction and financial abilities, which have undermined previous results when it comes to the power of the life cycle model empirical predictions. I discuss different behavioral assumptions and models under the standard microeconomic framework to evaluate farm household consumption behavior in Uganda. Finally, I provide an integrated framework for policy recommendations, with a strong focus on income dynamics, consumption, and production at the household level in order to work towards capacity building and poverty alleviation.

1.5.3. Variables and Methods

The variables are C_{t+1} and C_t , which are the consumption levels at time t and $t+1$; Y_{it} income, NW_{it} net worth, LD_{it} long term debt, SD_{it} short term debt, GO_{it}/TD_{it} gross output: total debt ratio, OL_{it}/TL_{it} $GO_{it}: TD_{it}$ owned land: total land ratio, TD_{it}/NW_{it} total debt: net worth ratio, and TA_{it} total assets. I also include some demographic characteristics for the head of the household, such as age, A_{it} and household size, HS_{it} . As in Hall and Mishkin (1982), Shapiro (1984), Altonji and Siow (1987), and Zeldes (1989), the data not only focus on food expenditures, but also on total household consumption, which allows for the direct application of the Euler equation (see appendix, equation [22] if an additional separability assumption is imposed in the model). Previous papers by Hayashi (1985), Langemeier and Patrick (1990), and Phimister (1993) have left the separability issue unresolved.

Farm households are studied under the framework of the neoclassical economic perspective and the perceived farm household is studied as a distinct entity that behaves differently than other agents. I explain consumption behavior by focusing on the head of household's behavior in small farm households in Uganda. This approach to model consumption provides new insight to policy-makers in understanding what works and what factors and constraints alter household consumption behavior in Uganda. I generate testable models under uncertainty, following Phimister (1993),

Shapiro (1984), and Zeldes (1989). I assume an alternative to an existing life cycle hypothesis in the context of small farming household consumption dynamics. The derivation of the model is shown in Appendix A. In summary, I found that the Euler specification is rejected. However, based on the findings, it is not clear whether the failure of the inter-temporal Euler equation is because farm households in Uganda optimize, are currently borrowing constrained, or consumption is based on a simple “heuristics” or “rule of thumb.” One of the arguments put forward in the literature to justify this rejection is that a strong degree of homogeneity across households appears to be the result of credit constraints. Moreover, the failure of the inter-temporal Euler equation is also linked to precautionary saving in anticipation of income shocks and uncertainty. However, households might also save for different reasons; what is prevalent in the data is that most households are saving for bequest reasons in Uganda. As a result, households facing income uncertainty in the future are more likely to display higher saving rates in the presence of a precautionary saving motive, such as securing land, setting up a small business, or investing in financial assets provisions for unexpected events, like paying for debts, taking care of elderly family members, or supporting orphan children who have lost their parents from disease. Consequently, households may incur higher debt given that land is scarce in Uganda; and land provides a relatively good net asset position for households and can boost consumption levels, access to credit, and aggregate income.

1.6. Chapter 2

My second essay is presented in Chapter 3. The title of this essay is *Farm Household Consumption Behavior in the Presence of Uncertainty and Restrictions on Credit in Sub-Saharan Africa: Evidence from Uganda*. In this essay, I frame the analysis of dynamic consumption behavior in farm households in Uganda under liquidity constraints. I analyze the impact of borrowing constraints of farm households when consumers and producers do not have access to financial services or face credit constraints due to market imperfections in Uganda.

1.6.1. Framing of the Problem 2

An understanding of the impact of credit constraints in developing countries is crucial for designing economic policies. Thus, I analyze the multiple definitions surrounding credit constraints. According to Barham et al. (1996), households are fully constrained when they do not have enough assets for collateral or when they apply for but are rejected for credit from formal financial institutions. Households are classified as partially constrained if they are not rejected but receive a loan of less than the amount for which they applied. Diagne, Zeller, and Sharma (2000) argue that households should be considered credit constrained if at least one member of the household at least 17 years of age faces a binding credit limit. Swain (2002) argues that credit constraint is a situation wherein a household member cannot borrow from the formal sector. The informal sector may be available but is clearly a less preferred choice to access credit.

In essay II, I adopt the definition of credit constraints defined by Barham et al. (1996) as it fits some of the stylized facts of saving behavior. Recently, locally owned private banks and non-bank financial institutions (NBFIs) have gained huge market shares, which could provide a significant benefit to the development of the agricultural sector in the Ugandan economy. Timmer and Akkus (2008) posit that no country has sustained a quick transition out of poverty unless it increased agricultural productivity. The agriculture sector in developing countries suffers from credit constraints because of banks in financial distress, the risks associated with the moral hazard, and the challenges in valuing farmers' assets.

Financial institutions naturally avoid high-risk lending strategies and push needy clients out of the loan disbursement pool. For instance, farm households in Uganda get financial support from relatives or friends and micro-credit or microfinance institutions because their loan applications are less likely to be approved by formal financial institutions (Mpuga, 2010). Keya and Rubaihayo (2013) show that private commercial banks are not willing to lend to farmers, and, even if they do, high-interest rates and collateral requirements push farmers to default on these loans. These facts corroborate the hypothesis in the literature that farm households do not invest in agriculture because

of a lack of finances and in many cases landownership or tenure and land registration problems. Thus, this essay focuses on the effect of credit constraints and on consumption behavior in Uganda. More specifically, I focus on how credit constraints affect the decision-making process in farm households' consumption behavior. If it is true that the availability of credit stimulates and enhances farm household productivity and consumption, then policymakers can use the information on farm households' consumption, income, and the importance of land ownership and clear title to devise policies to relax credit constraints in Uganda.

Credit constraints have impacted many farm households around the world. For instance, information obtained from the survey of farm households (n=761) in India indicates that 72 percent of these farm households face credit constraints (Swam 2002). Barham et al. (1996) look at Guatemalan farmers (n=201) and find that 34 percent have faced borrowing constraints from private banks, and 27 percent have faced partial borrowing constraints. Diagne et al. (2000) survey Bangladeshi farm households (n=350) and find that 55 percent to 61 percent of the households experienced borrowing constraints, while in Malawi, Diagne and Zeller (2001) find 84 percent to 92 percent of farm households have faced borrowing constraints. In China, 37 percent of farm households have faced borrowing constraints (Feder et al. 1990), while 19 percent of farm households in the United States have experienced borrowing constraints (Jappelli 1990).

1.6.2. Objectives 2

The objective in essay II is to understand and measure the impact of credit constraints on consumption in farm households in Uganda. Most of the recent papers (Gayle and Khorunzhina 2016; Schreiber and Beblo 2016) using a life cycle rational expectation framework of consumption and liquidity constraint find empirical irregularities and inconsistencies relative to the results. These empirical irregularities can be attributed to consumers' inability to access financial services and data inadequacies in trying to create a microeconomic model capable of reproducing many of the stylized facts that borrowing constraints produce (Rampini and Viswanathan 2016; Cooper 2013).

Liquidity constraints can create systematic differences in farm household savings and consumption behavior. For instance, farm households with large initial assets or high disposable incomes might not be credit constrained compared to farm households with a low initial asset value and liquidity.

Therefore, I first carefully devise parameters that allow me to look into the debt-to-asset ratio, which measures the proportion of a farm household's assets being financed with either long or short-term debt, rather than equity. I use this ratio to determine financial risk or solvency and its effects on farm household behavior on aggregate consumption. Second, I calculate the debt-to-value added ratio and owned land to total land ratio to understand asset ownership, land acquisition, and tenure. Third, given the different systems of land ownership registration in Uganda, I pay particular attention to the impact of these different systems on farm household intertemporal consumption, behavior, and the ability to borrow.

1.6.3. Variables and Methods 2

Explanatory variables used are HS_{it} , the total number of people within a household including the nonresidents, EXP_{it} farmers' years of experience, which asks the respondents the year in which they first acquired a land parcel for cropping and other agricultural activities. DY_{it} Farm disposable income (DY_{it}) is the amount of money that a farm household earns or gains each year after taxes and transfers. NW_{it} Farm net worth (book value or shareholder's equity) is the amount by which a farm household's assets exceed its liabilities. Consequently, a consistent increase or decrease in net worth may indicate good financial health or bad financial conditions as a result of annual operating losses or a significant decrease in asset values relative to farm household liabilities. I calculate farm households' net worth as farm households' total assets minus total outside liabilities. GO_{it}/TB_{it} Farm gross output to farm total debt ratio is an indicator of financial capability to repay debt. (STD_{it}/TA_{it}) Measures what percentage of the farm households' total assets was financed by credit. I also calculate OL_{it}/TL_{it} farm owned land to total land ratio ($OL_{it}:TL_{it}$)

I consider a model in which current farm households in Uganda own, operate, and manage their farms in each period and must choose a certain level of consumption. However, in an imperfect capital market, these choices are constrained by capital stocks, the level of investment, production capacity, and any credit constraints limiting the farm. Moreover, in many developing countries like Uganda, climate change is directly or indirectly affecting crop yield, which impacts the farm's bottom line, such as profits, credit, and the level of debt. Therefore, under these constraints, farm households are assumed to maximize their expected lifetime utility derived from consumption at any period. This framework departs from the traditional approach of consumer behavior as the product of a single decision maker; rather it considers the collective approach to consumer behavior, which takes into account the multi-person household's preference via the head of household decision-making process. Each decision node is perceived as a social state at time t chosen by the head of household to maximize expected lifetime utility derived from consumption. Thus, this essay is based on the general microeconomic theory of consumption under liquidity constraints, which at the aggregate level reflects and captures many of the stylized facts. Following Hall (1979), Hall and Mishkin (1980), Zeldes (1989), and Deaton (1990), the utility maximization problem is characterized and the derivation of the models is shown in appendix A.

The model estimation under the hypothesis of no borrowing constraints is tested against the inter-temporal specifications of the Euler equation, including financial and income variables. I use the Living Standards Measurement Survey (LSMS-ISA) of small farm households in Uganda from 2009-2012. As a result, I find that credit constraints have a significant impact on farm household consumption behaviors (model) in Uganda. The presence of credit constraints in Uganda rejects the Euler specification without the borrowing constraint.

My third essay is presented in Chapter 4. The title of this essay is: *The Determinants of Off-Farm Labor Supply in Sub-Saharan Africa: Evidence from Uganda*. In this essay, I examine the determinants of off-farm labor supply in Uganda, which can be an important strategy to cope with credit constraints and improve consumption and food security in Uganda.

1.7.1. Framing of the Problem 3

Farm households in Uganda rely heavily on subsistence agriculture for income, consumption, and welfare. Consequently, agricultural shocks via income make these households vulnerable by infusing persistent variations and a significant level of uncertainty into their lives. To cope with these challenges, farm households have developed a number of strategies and mechanisms to mitigate credit constraints.

In essay 3, I investigate the determinants of off-farm household labor supply in both rural and urban settings in Uganda. The definition of what a household is potentially has significant implications for the composition and size of the household, labor supply (on and off-farm), food production or consumption, and income. For instance, households in developing countries include extended family members sharing the family unit compounds, eating together or working in the same agricultural plot, and relying heavily on subsistence agriculture. In this essay, a “household” in Uganda is defined as all members of the household living in the same dwelling space who acknowledge a common household head. Therefore, economic realities and financial distresses surrounding households are very different from those in developed countries.

The agrarian setting, uncertain crop yield, and large household size make household income uncertain, as do borrowing constraints from banks, and the inability to meet debt obligations both in the short and long run. Thus, constrained by access to credit, market imperfections, lack of technologies, and productivity, farm households use non-farm labor income to supplement consumption. Mishra and Goodwin (1997) show that if farmers are risk averse, it is likely that

subsequent income variability will lead to a significant increase in off-farm household labor supply. Several researchers (Rosenzweig and Stark 1989; Kochar 1999; Fafchamps and Quisumbing 1999; Holden et al. 2004) show that access to low-wage off-farm income is constrained by a lack of employment opportunities in developing countries. In fact, more than 70 percent of Africa's poor people live in rural areas and depend solely on agriculture, the latter of which is subject to erratic rainfall and poor soil conditions, as well as being crippled by decades of underinvestment -- all of which push rural households deeper into poverty. Bardhan and Udry (1999) showed that the non-existence of complete insurance and credit markets pushes households to engage off-farm income to stabilize the stream of income and to hedge against the risks associated with the dire consequences of substantial income fluctuations (Abdulai and CroleRees 2001). Thus, if households in Uganda had access to credit, it would alleviate some capital constraints and enable them to purchase the means to maximize yield during planting and growth periods and then expect the returns after harvest. Thus, off-farm income could be a source of investment, and this essay elucidates the determinants of off-farm income and labor supply (hours).

1.7.2. Objectives 3

The first objective of essay 3 is to understand the determinants of off-farm activities and labor supply. As long as average income from off-farm in the informal economy is higher than the average income in farming, there is mounting evidence that off-farm income will crowd out any investment in agriculture. If this is true, then households in a similar setting will tend to take a long-term position that favors short-term security rather than focusing on long-term sustainable income earning from farming in Uganda. The second objective is to identify the determinants of off-farm labor supply by the head of household in Uganda. The third objective is to evaluate policy implications to reverse the trends toward increasing off-farm work, the latter of which is detrimental to the development of agriculture in Uganda and generally in all developing countries.

1.7.3. Variables and Methods 3

The variables used in essay III are $Offfarm_{it}$, the decision of farm households to engage in off-farm activities, which is given a value of 1 if the head of household is involved in off-farm activities for a wage and a value of 0 if otherwise. $offwkhrs_{it}$, Represents the time allocated to off-farm activities for wages once the household head decides to participate in off-farm activities. Age_{it} , Stands for the age of the head of household. $Educ_{it}$, Represents the number of years of schooling completed by the head of household surveyed from no formal education to a completed university degree. $Male_{it}$, Is the sex of the head of household (1 if male and 0 otherwise). $Baganda_{it}$ is the ethnic group or tribe to which the head of household belongs (1 if Baganda, and 0 otherwise). Baganda are the majority in Uganda (19 percent), followed by the Langi (9.42 percent), the Banyakole (9.17 percent), the Basoga (8.08 percent), and the Teso (7.7 percent). These variables help capture the individual shadow price of time and reservation wages since the data did not have reliable observations on the ongoing market wage rate. $Adulth_{it}$ and $Childh_{it}$, represent the number of adults and children in the same farm household including the non-residents respectively. $Tassets_{it}$ measures the total estimated value (in Ugandan shielings, or *shs*) of household assets owned during the last 12 months prior to the survey. $Credac_{it}$ measures credit access by asking if the household member received a credit to operate the farm or to expand business in the past 12 months prior to the interview with a 1=Yes and 2=No. $Remittance_{it}$ measures the total estimated amount (*shs*) received in cash by the farm household from relatives or friends in the past 12 months prior to the interview.. $Arealand_{it}$ estimates the total area of land planted for the surveyed crop year in hectares and self reported. $ToTdis_{it}$ determines the district market price which is equal to the mean market price for each district to proxy for Trade Index between farm and off-farm prices of agricultural products (ratio, *shs*) the term of trade index or the opportunity cost between farm and off-farm prices for agricultural products in the marketplace; $Distage_{it}$ measures the distance from the farm household to the nearest marketplace and road in kilometers (km); $Trunkrd_{it}$ measures the roads/bridges or infrastructure's current quality or practicality with a 1 = good; 0 =

poor. The model is built under the framework in which current the head of household (male or female) operates and manages a certain type of agricultural activity. Thus, a farm in each period must choose a certain level of consumption, the hours of work on-farm and the off-farm income and labor supply to each, as well as leisure. I relax the assumption of perfect competition to reflect realities in the context of Uganda and let the labor market be flexible. Consequently, farm household's labor allocation decisions remain in equilibrium, and thus, those people who are not working or engaging in off-farm activities are those who have chosen not to work at the prevailing market wage schedules in the informal sector. Furthermore, the decision of a head of household not to work at the market wage has no effect on the aggregate demand, supply, and price of labor. If the head of household chose to work on the farm and not off-farm, it was because his or her marginal product of labor on-farm is greater than the wage rate prevailing off-farm. Thus, household utility is assumed to be a function of goods, G for consumption at price p_g and leisure L (appendix A).

I use the unrestricted Cragg (1997) double hurdle model to estimate participation versus no participation and the number of hours worked off the farm. I then compare it with the restricted Tobit model. The restricted Tobit specification is rejected and I find that head of households who completed a formal education above the primary level engage less in off-farm work at the prevailing market wage. The reservation wage at which an educated head of farm household in Uganda is willing to work off the farm is above the established market wage in the informal sector. However, 62 percent of the heads of household with no formal education remained engaged in agriculture only compared to those with a secondary level of education regardless of the level attained. Twenty-five percent of household heads with education above the secondary level remained in the non-agriculture sector, and if they decide to earn off-farm wages, they were more likely to supply more hours regardless of sex.

1.8. Organization of the Rest of the Dissertation

In Chapter 2, (Essay 1) I provide a review of existing studies related to modeling farm household consumption and findings to elucidate this dissertation. I then discuss the research

methods and model setup and its environment as well as the variables used. I discuss the results and conclude with some policy recommendations. In Chapter 3, (Essay 2) I provide the literature review while looking at the impact of credit constraints on modeling farm household consumption behavior with and without borrowing constraints and analyze circumstances surrounding credit constraints in Uganda. I then discuss the challenges of incorporating credit constraints in the model and the existing literature surrounding the issue. Next, I discuss the methodological approach, variables used, and the econometric applications and results. I conclude Chapter 3 (Essay 2) with the conclusions and policy recommendations resulting from the findings. In Chapter 4, I investigate the determinants of the off-farm labor supply in Uganda. I discuss the literature, variables used, and the model implementation. I then discuss the issues surrounding the model application and the econometric issues relative to the unrestricted double hurdle model and the restricted Tobit model. Afterward, I interpret the results and conclude with some policy recommendations. Chapter 5 presents the overall conclusions of the dissertation. I provide the supporting materials related to all three essays in the appendix section.

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CHAPTER 2: MARKET IMPERFECTIONS, FARM HOUSEHOLD CONSUMPTION BEHAVIOR, AND THE LIFE CYCLE MODEL IN SUB-SAHARAN AFRICA: EVIDENCE FROM UGANDA

2.1.Introduction

This essay investigates agricultural production dynamics and consumption behavior in small farm households in Uganda within the spirit of the life cycle model. Accordingly, in this essay, I test whether the life cycle model characterizes small farm household consumption behavior in Uganda. In particular, I seek to recognize if farm household consumption behavior is consistent with the life cycle model.

The neoclassical consumption model, in which individuals choose the time path of their consumption to maximize utility, leads to a benchmark solution in which consumption is proportional to an individual's total wealth, including current financial wealth and the present value of current and future labor income. At the macroeconomic level, this simple theory indicates that national saving depends on the rate of growth of national income, rather than its level. Consequently, that level of wealth in the national economy follows a simple relation to the length of the retirement span (Deaton 2005). Thus, an understanding of how consumption responds to income shocks is very important in evaluating the impact of taxes on consumption, labor markets and land policy reforms, and the welfare policies in Uganda (Jappelli and Pistaferri 2010). However, in many developed and developing countries, these apparent predictions and strong empirical policy implications remain unresolved and controversial in the literature (Browning and Crossley 2001; Deaton 2005; Mendola 2007). For instance, as Deaton (2005) argues, active working people in the labor market, by consuming and saving, can decide how much to save for their retirement and, simultaneously, adjust their consumption patterns given their age cohort regardless of their incomes.

Accordingly, in this essay, I test whether small farm households' consumption behavior is inconsistent with the life cycle model predictions in the presence of market imperfections in

Uganda. By definition, a farm household is a group of people who have normally been living and eating their meals together for at least six of the twelve months preceding the interview. In the literature, empirical studies assessing whether life cycle theories in developing countries offer adequate descriptions of the unitary and collective household behavior have been inconclusive in developing a more satisfactory theory of economic growth (Deaton 1992; Phimister 1993). Moreover, in developing countries, especially in Sub-Saharan Africa, the resulting data inadequacies have seriously hampered progress in answering such questions (Deaton 1992). Beaman and Dillon (2010) and Deaton (1990) argue vehemently that small farm households in developing economies are large and poor and have different demographic structures and are likely to be engaged in agriculture.

Thus, small farm household models and decision profiles are hardly captured by econometric production/consumption models based on the neoclassical model of Browning and Crossley (2001). In the literature, Phimister (1993) argues that it is crucial that a farm household is not perceived as immutable and static, but rather as an institution evolving continuously over time, especially in East Africa. In Uganda, farmers are characterized by their agro-pedological and ecological locations, land tenure, specialization in commodity exports, dependence on family labor, and credit constraints. In Uganda, smallholder-farming accounts for approximately 75 percent of total employment in the country, 72 percent of all employed are women, and 90 percent of all rural women work in agriculture (Okoboi and Barungi 2012). The contributions of this essay are multiple. First, unlike the few existing papers focusing on developed countries (Islamaj 2016; De Magalhaes and Santaaulàlia 2016), the model in this essay considers the unusual challenges characterized by non-insurable risks in agriculture, income uncertainty, credit constraints, and price distortions for small farm households in Uganda. Consequently, I incorporate genuine features of a representative farm household economic environment to overcome unrealistic assumptions on agricultural and economic development relative to African countries. Farm household aggregate income declines steadily after age 45, while remaining somewhat constant among young farmers and those in the

age cohort between 25 and 45 years of age (Figures 1.1, 1.2, 1.3). Accordingly, this essay helps in understanding consumption patterns in Uganda and helps determine human welfare, the country's economic progress, poverty, and inequality. This implies different policy prescriptions for investment in agriculture and for the labor supplies decisions of farm households in different countries (Kose 2002; Islamaj and Kose 2016; Chugh 2016). Deaton (2016) states that for every level of income, consumption determines savings and investment in all economies.

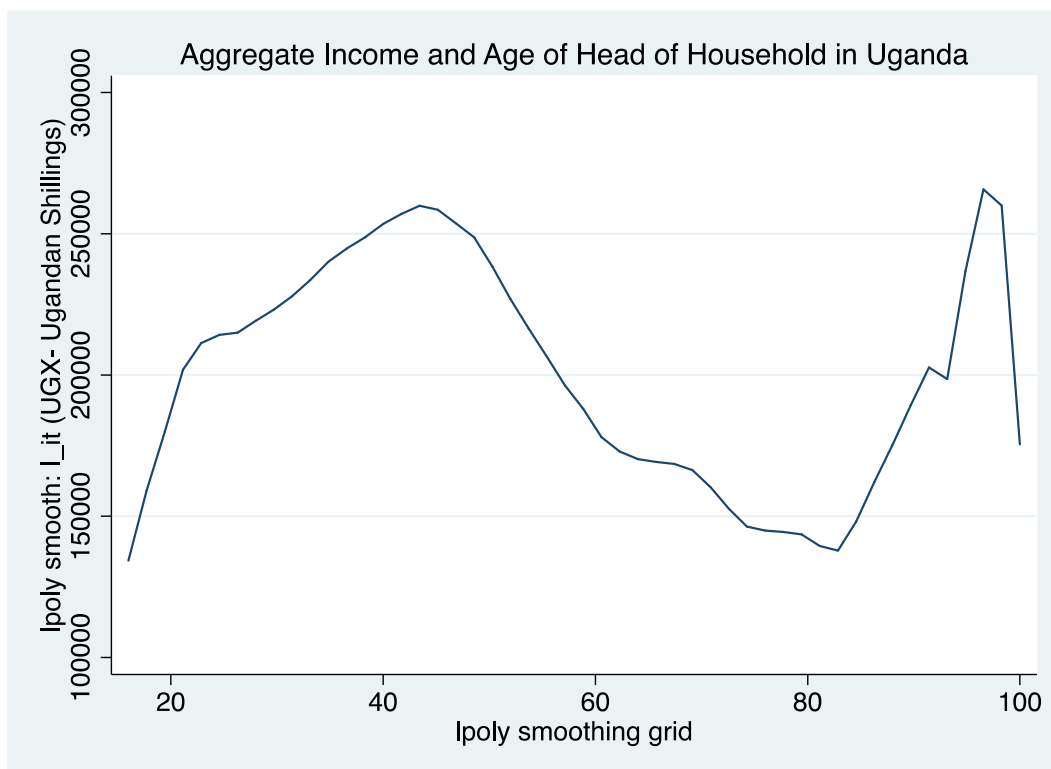


Figure 2:1: Farm Household Total Income and Age of Head of Household

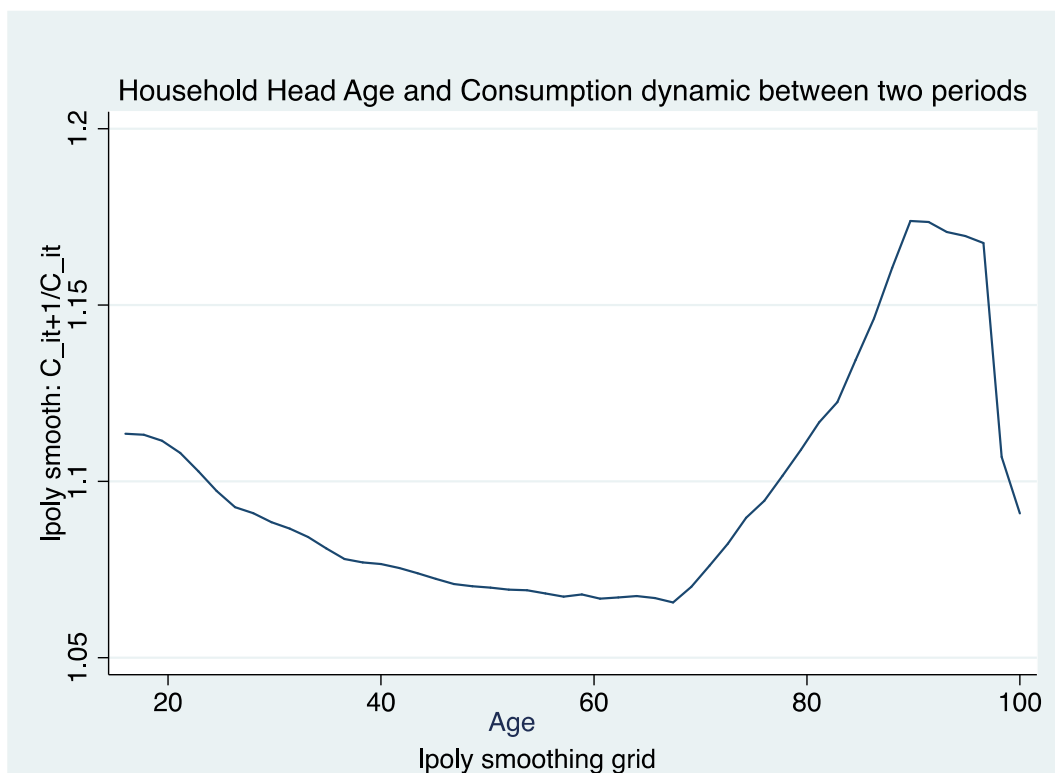


Figure 2:2: Farm Household Total Consumption and Age of Head of Household

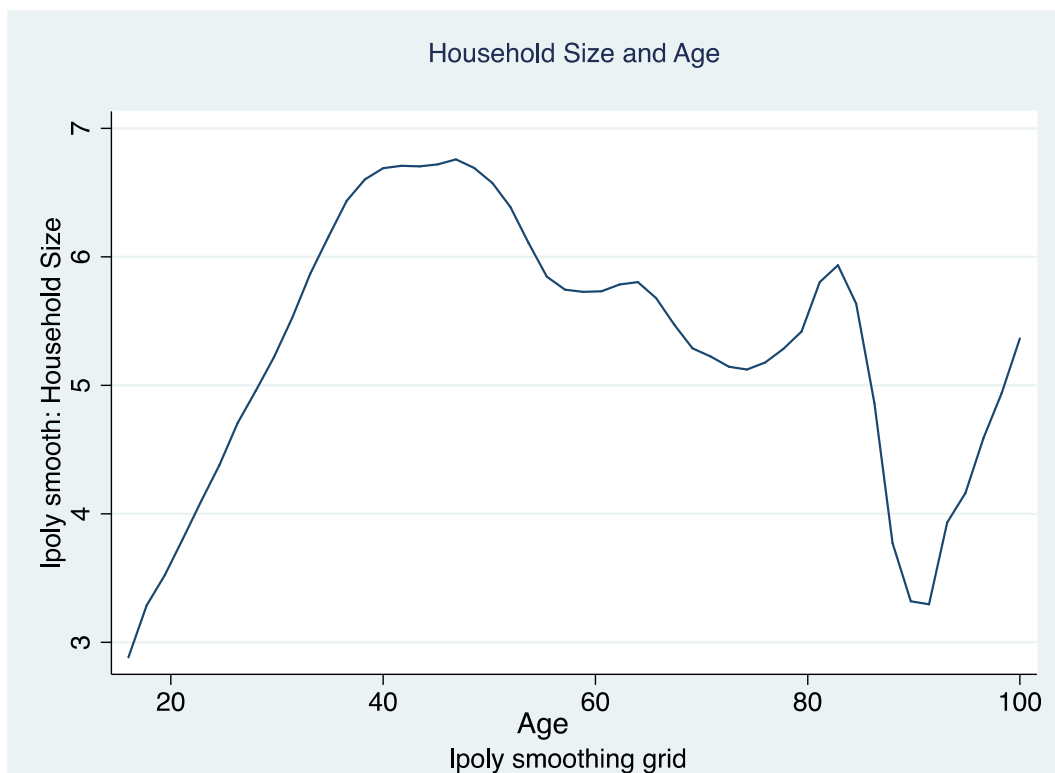


Figure 2:3: Farm Household Size and Age of Head of Household

Second, this essay overcomes the methodological weakness and mixed evidence in modeling small farm household consumption behavior and factors input decision profiles to correct

for the inconsistent policy implications in developing countries. Third, using micro panel data, this essay incorporates these features of life events in the model in a very systematic fashion to characterize market imperfections. For instance, on the preference of the agent problem, I assume that small farm households put less weight/value on future income because of the unpredictable nature of their economic environment. On the constraint side, the agents face market imperfections in the credit market with fluctuating lending rates on a risk basis and erratic agricultural prices and yield on production. On the information side, the agents keep updating their beliefs and revising their expectations, taking into account the interactions between labor demand and income, land tenure, household size, age, and financial performance. This approach presents useful policy insights into the annual implementation of the investment policy review (IIPRAD)³ on agricultural development.

The data used in this essay overcome various measurement issues and comes from the living standard measurement survey (LSMS). The data have already treated households that are not found and split-off, and individuals that are selected for tracking but not found in the following wave. The predicted response probabilities from a logistic regression model based on the covariate was used in order to address attrition issues following Rosenbaum and Rubin (1984; 2012). I extend the basic life cycle model under market imperfections to derive the inter-temporal marginal utility known as the inter-temporal Euler equation. I then test empirically to see if a small household farm consumption behavior is inconsistent with the life cycle model. I find that the specifications represented by the inter-temporal Euler equation are rejected. The tests conducted reject the life cycle model of inter-temporal consumption behavior in Uganda.

These findings are consistent with the literature in developed countries, and the rejection can be attributed to the model's inability to uncover consumer preference at the household level, such as the inter-temporal elasticity of substitution. This is significant and points to some bequest

³According the World Bank report, The IIPRAD occupies the third pillar since 1983 in reinforcing agribusiness success focusing on market infrastructure, land access and tenure, investment, and access to credit in the agricultural sector in Sub-Saharan Africa (see, NEPAD-OECD).

motives or precautionary motives for savings linked to the potential heterogeneous impact of credit constraints, which could be binding across specific groups and locations. This essay is organized as follows. Section II reviews the literature. Section III presents the theoretical framework and methods. Section IV explains the data collection methods and procedures and further introduces proposals for land reforms and customary rights in a peasant economy. Section V describes the econometric framework and applications. Section VI discusses the results and Section VII provides concluding statements.

2.2.Literature Review

This section of the literature review focuses on investigating empirical evidence regarding the adequacy of the life cycle model as an instrument for underpinning consumption behavior in developing countries. I review briefly what has been done in developed countries to inform and guide our understanding of the life cycle model application and its empirical predictions. Economic theories regarding the life cycle model or inter-temporal consumption behavior sought to characterize consumers' preferences relative to consumption and saving over the span of their lives. Drawing from the work of Modigliani and Brumberg (1954) and Friedman (1957), Ando and Modigliani's (1963) empirical evidence focused on testing the life cycle model in the literature reveals mixed results. Moreover, the divergence in findings paves the way for different synopses of the empirical research (Carroll 2001; McKay and Steinsson 2016; Gayle and Natalia 2016; Thimme 2016).

Thimme, who recently surveyed the literature, discussed the recent progress of the theories, but remained puzzled about the challenges inherent in the estimation of the log-linearized consumption represented by the inter-temporal Euler equations. He argued that the general discussion in the literature still seemed to be driven by Hall's (1988) estimates, which were close to zero, while most or several deviations from the model predictions were related to the relative risk aversion coefficient side in favor of considerably higher values of elasticity of inter-temporal

substitution. In fact, most of the recent papers in the literature concluded with mixed results. In particular, the assumption of elasticity of inter-temporal substitution slightly below or greater than one to calibrate economic models has shown to be inconclusive (Ai 2010; Bansal and Yaron 2004; Drechsler and Yaron 2011). Carroll (2001) used the standard methods for estimating log-linearized consumption represented by the inter-temporal function equations and argued that its empirical estimation should be abandoned. He further posited that alternative consumption functions, which do not have similar issues to the inter-temporal Euler equation, drive the upcoming research in the literature.

In the bulk of the literature, researchers disregard the use of the log-linearized consumption represented by the inter-temporal Euler equation advocates, who base their arguments on the fact that real world data cannot successfully unpack the structural parameters such as the coefficient of relative risk aversion from households behaving as predicted by the model. Moreover, the bulk of the literature has also tried to avoid the impact of data inadequacy and measurement error in the estimation of the log-linearized inter-temporal consumption function by relying exclusively on the Panel Study of Income Dynamics – (PSID)⁴. As a result, most of the studies in the literature have been done in developed countries while developing countries have been unexplored because of the lack of adequate data such as that in the PSID (Gayle and Khorunzhina 2016; Christelis et al. 2016; Alegre and Pou 2016; Battistin and Padula 2016). However, a few studies testing the life cycle model are emerging, but these use varieties of parameters characterizing financial integration in both developed and developing countries (Islamaj 2016; De Magalhaes and Santaaulàlia 2016).

In the search for empirical evidence to validate the theory of the inter-temporal choice, this essay depends on testing if small farm household choices at various points in time in Uganda

⁴Used in the United States, the PSID is roughly the longest survey of 6,000 families and 15,000 individuals conducted periodically from 1968 to the present. Similarly, the United Kingdom has the British Household Panel Survey (BHPS) started in 1991 following 5000 households for several years. Germany has the German Socioeconomic Panel (GSOEP) and the Medical Expenditure Panel Survey (MEPS). In the developing world, the living standard and measurement surveyed-integrated survey on Agriculture (LSMS-ISA) is the most recent data set.

influence the future possibilities of choices over the life span of farm household consumption behavior. Consequently, smallholder farm households can make provisions for their families, and more generally, adapt their consumption patterns to their needs at different and uncertain production levels, incomes, and leisure, independent of the age and household size. This theory leads to important and complex distributional and incidence analysis, and to non-evident predictions about farm household consumption behavior, saving, and investment. All of attributes have significant implications on the rate of growth of national income via agricultural development in Uganda, in particular, and Sub-Saharan Africa, in general.

In Uganda, market imperfections and the interactions between consumption, production uncertainty, and land tenure shape households' labor allocation decisions and food security within smallholder farm households. Therefore, a farm household model to explain and inform agricultural reforms and policy in Uganda under capital market imperfection is at stake. In Uganda, market imperfections not only impact transaction costs and market access, but also generate costs that interfere with household consumption decisions, production, and labor.

Consequently, identifying and alleviating the inherent agricultural problems linked to these imperfections creates an ongoing challenge to model farm household behavior in Uganda. In the literature, the requirement of perceiving a farm household as a separate entity of economic analysis dates back to several authors (Chayanov 1925; Nakajima 1957; Becker 1981; Singh and Strauss 1986; and Chayanov et al. 1986). Chayanov (1925) and Nakajima (1957; 1958) were the first to argue that behaviors of farm households were best understood in a household-farm framework.

However, according to Phimister (1993), the standard neoclassical approach of farm maximizing profits assumptions has been criticized and the theoretical models have progressively evolved to incorporate relevant behaviors of farm households, such as labor allocation, consumption, production uncertainty, and leisure (Gasson et al. 1988; Lau, Lin and Yotopoulos 1978; Adulavidhaya et al. 1979; Strauss 1984; Brase and Ladue 1989; Benjamin 1992; Jacoby 1993; Skoufias 1994; Salami et al. 2010). Given these variations, Phimister (1993) argues that in

the presence of market imperfections, the farm household should be perceived as a unique agent for economic analysis, an idea that challenges the assumptions of profit maximizing behavior.

As a result, in East Africa, where market imperfections prevail coupled with rapid demographic changes, the question is not whether smallholder farm households are rational, but whether this rationality assumption is useful in predicting farm household consumption behavior. A preview of the data reveals important changes and variations that have taken place in East Africa's typical farm household, the marketplace, and the community in the last 20 years. These changes highlight the impetus relative to the spatial distribution of smallholder farming and land tenure in Uganda, which motivate the quest for understanding and modeling farm household consumption behavior. Land tenure in Uganda mainly takes the form of land entitled and leased by the government, which tends to impose some constraints upon land use and development. However, According to the World Bank report, since the Land Act of 1998, which gives recognition to those who hold land under customary tenure, total land and land tenure have begun to play a major role in farm output, consumption, credit, and investment. In Uganda there are four types of land tenure systems: customary, Mailo, freehold and lease hold.

2.3.Theoretical Framework and Methods

In this essay, smallholder farm households are studied in the framework of the neoclassical economic perspective where each farm household is perceived as a distinct and unique entity, one that behaves differently from other agents in the economy. From this perspective, the interactions between consumption, production uncertainty, and land tenure are considered. Therefore, each inter-temporal, smallholder farmer in the economic setting of Uganda must decide his household's required level of consumption and simultaneously and concomitantly determine the level of production and investment in agriculture. This is a very important feature of farming in East Africa because the interactions between production uncertainty and consumption are entrenched in the distribution and attribution system of land tenure and control in the farm household family setting.

Furthermore, this gives rise to a potential tradeoff between a household's current consumption and farm investment, analogous to Chayanov's balance between household consumption and the drudgery of labor (Phimister 1993). The market imperfections in Uganda are characterized by capital market imperfections (e.g. time inconsistent preferences, non-competitive markets, asymmetry of information, principal agent problems) and the inherent existence of risk and uncertainty (e.g. price volatility, weather, frequency of droughts and floods, yield output variations). Within this framework, a basic life cycle model with production uncertainty is extended, following Phimister (1993).

According to Phimister, in the presence of uncertainty characterized by market imperfection, the opportunity of re-planning should be clearly taken into consideration, especially in Uganda. Thus, from a purely empirical standpoint, I approach the model with genuine variations to reflect the reality of East Africa's peasant economies while targeting the hypothesis of farm household consistent behavior. If the household can re-plan its stream of consumption and production at any given time in perfect market conditions, I should not observe any variations in the decision making process of the farm household behavior. That means farm household behavior in East Africa and especially in Uganda is subsequently consistent over time. However, in this essay, I do not have the privilege of such conditions because farm households in East Africa, especially in Uganda, face production uncertainty, credit constraints, lack of market and investment, land degradation, and precipitation issues.

Therefore, at the beginning of every period, for example, from 2009 to 2012, farm households in East Africa face a completely new wave of information, which also means that strategies and options for consumption, production, and investment might not follow past realizations and subsequent life events in farm households, respectively. Phimister argues, therefore, that the household decisions to consume, produce, and invest must be identified by the period τ in which the decision is happening. Thus, closely following Phimister (1993), the model is specified as follows:

$$\max_{C_t, K_{t+1}, d_t, I_t, Y_t} E_t \left(\sum_{t=\tau}^T \frac{U(C_t)}{(1+\rho)^{t-\delta}} \right) \quad [1]$$

Subject to:

$$d_{t+1} = (1+r)d_t - P_t Y_t + P_t^k I_t + C_t \quad [2]$$

$$Y_t = f(K_t, \Pi_t) \quad [3]$$

$K_{t+1} = (1-\delta)K_t + I_t$ where $d_{T+1} \leq 0$ and d_t and K_t are fixed and C_t – consumption expenditures, Y_t – production, k_t – capital stock, I_t – investment, d_t – debt owed, r_t – interest rate, p_t^k – capital goods price, ρ – rate of time preference, δ – depreciation rate, and Π_t – random shock at time t.

This optimization problem can be solved easily using the dynamic programming technique under the assumption that the sub-utility function is twice differentiable, strictly concave, and bounded above all parameters. In addition, the rate of time preference is set to be $\rho \geq 0$, and the production uncertainty is restricted such that in every period t there are multiple states of the world (N), and for every given level of capital, the corresponding level of production in state s for the household in East Africa is captured and expressed as $Y_t = \prod_s f(K_t)$, $s = 1, \dots, N$. Since the shocks are randomly distributed and the probability of realization in each state is assumed to be independent of time t, you can write $Pr(\Pi_{st} = \pi_s) = p_s$ when $s = 1, \dots, N$; $t = \tau, \dots, T$. It is also important to note that the production function $f(\cdot)$ is restricted to be twice differentiable, strictly concave, and bounded above in all parameters, and the initial level of production is revealed to the household at the beginning of time t before the household makes decisions on consumption or investment for the same time period. As a result, the constraints facing the household are reformulated by using the composite variable Z_t where:

$$Z_t = P_t Y_t - (1+r)d_t \quad [4]$$

Now substituting for d_t and d_{t+1} in the first set of constraints above yields the constraints in terms of Z_t and Z_{t+1} where:

$$Z_{t+1} = (1+r)(Z_t - P_t I_t - C_t) + P_{t+1} \pi_s f(k_{t+1}) \quad s = 1, \dots, N \quad [5]$$

Therefore, in the uncertain environment, any given value of C_t, Z_t, I_t , and k_t, Z_{t+1} could take the maximum N possible values. Now within this framework, the household decision problem at time τ is equivalent to solving the dynamic programming model expressed as follows:

$$V_t(Z_t, k_t) = \max \left[U(C_t) + \frac{1}{1+\rho} E_t V_{t+1}(Z_{t+1}, K_{t+1}) \right] [7]$$

$$C_t \geq 0 \text{ and } I_t \geq -(1 - \delta)K_t$$

where, $Z_{t+1} = (1 + r)(Z_t - P_t^k I_t - C_t) + p_{t+1} \pi_s f(k_{t+1})$, $s = 1, \dots, N$ and

$$k_{t+1} = (1 - \delta)k_t + I_t$$

and now equation [7] can be written as:

$$V_t(Z_t, k_t) = \max[U(C_t)] [8]$$

$$C_t \geq 0$$

$$I_t \geq -(1 - \delta)K_t \quad [9]$$

$$Z_t - P_t^k I_t - C_t \geq 0 \quad [10]$$

$$k_{t+1} = (1 - \delta)k_t + I_t [11]$$

Following Blume et al. (1982) and Phimister (1993), it is assumed that both the value functions and the optimal policy function C_t^* are differentiable, and it can be shown that the optimal solution to this problem is characterized by the state variable Z_t and K_t , so that a unique solution to this problem can be obtained with unique policy functions $C_t^* = C_t^*(Z_t, k_t)$ and $I_t^* = I_t^*(Z_t, k_t)$.

Solving for the first order conditions gives:

$$\frac{\partial U}{\partial C_t} - \frac{1+r}{1+\rho} E_t \frac{\partial V_{t+1}}{\partial Z_{t+1}} = 0 \quad [12]$$

$$E_t \left[\frac{\partial V_{t+1}}{\partial Z_{t+1}} \right] + E_t \left[\frac{\partial V_{t+1}}{\partial K_{t+1}} (P_{t+1} \frac{\partial f}{\partial K_{t+1}} \pi - (1+r)P_t^k) \right] = 0 \quad [13]$$

Up to now, the two equations above have not yet captured the behavior of the household to yield the optimal solution characterizing the interplay between production and consumption. The optimal solution is given as follows.

$$V_t(Z_t, k_t) = \max \left[U(C_t^*) + \frac{1}{1+\rho} E_t V_{t+1} [(1+r)(Z_t - P_t^k I_t^* - C_t^*) + p_{t+1} \pi_s f(1-\delta)k_t + I_t^*] \right] \quad [14]$$

Consequently, using the differentiability feature of the optimal value function concomitantly with the first order conditions, the indirect utility function is derived, which is strictly concave and increasing in Z_t and k_t (see appendix in Phimister (1993)).

$$\frac{\partial V_t}{\partial Z_t} = \frac{\partial U_t}{\partial C_t} [15]$$

$$\frac{\partial V_t}{\partial K_t} = \frac{\partial U_t}{\partial C_t} (1-\delta)P_t^k = \frac{\partial V_t}{\partial Z_t} (1-\delta)P_t^k [16]$$

Obviously, for consumption, take the expectations at time $t+1$ of the first equation above and write $E_t \left[\frac{\partial V_{t+1}}{\partial Z_{t+1}} \right]$, and substitute it into equation [12] to have:

$$E_t \left[\frac{\partial U / \partial C_t}{\partial C_t / \partial C_{t+1}} \cdot \frac{1+\rho}{1+r_{t+1}} \right] = 1 \quad [17]$$

Here, in equation (17), the state of the world is revealed to the household at $t+1$, and the household will choose a specific level of consumption. Therefore, the marginal utility between $t+1$ and t is expressed as follows:

$$\frac{\partial U / \partial C_t}{\partial C_t / \partial C_{t+1}} \cdot \frac{1+\rho}{1+r_{t+1}} = 1 + e_{t+1} \quad [18]$$

where the term e_{t+1} captures the household's struggle and innovations in solving the consumption constraints as explained in Hayashi (1985), or the forecast error as in Zeldes (1989) and Phimister (1993). The household capacity of production and interest rate variation are still not observed or information about production and interest rate is not perfect, and the state of the world at time t is even yet not fully realized. Consequently, equation [17] tells us that any available information w_t available to the household should and must be uncorrelated with the term e_{t+1} in equation [18]. As a result, the relationship between the term e_{t+1} and w_t is given as follows: $E \left(\frac{e_{t+1}}{w_t} \right) = 0$ or $(e_{t+1} \cdot w_t) = 0$. Assuming that the household's future expectations are rational, any information w_t available at time t has no role in explaining the left hand side of equation [18]. Therefore, one can

say without any loss in generality that a household has optimal plans when facing multiple strategies under market imperfections at time t . Thus, the relationship between the left and right sides of equation [17] at time t are assumed to have an impact on the prevalence of constraint and stock variables, such as income, debt (e.g. short term, long term), debt to wealth ratio, and land. Following Phimister (1993) and using the FOC (first order conditions) in equation [15] and [16] gives the following:

$$\frac{\partial U / \partial C_t}{\partial C_t / \partial C_{t+1}} \cdot \frac{1 + \rho}{1 + r} \geq 1 \quad [19]$$

where the inequality in [19] holds if and only if the household is not constrained by borrowing at time t . In equation [19] the relationship between two consumption periods is described by the rate of interest and time discount rate, which can determine if consumer is on the lending side or borrowing side of the market. If the consumer forgoes consumption today, the money or resource is saved and can earn a positive rate of interest. Now, bringing equation [17] to the data from 2009 to 2012, some re-parameterization needs to be done while assuming constant elasticity of substitution (CES) (Shapiro 1984; Mankiw 1981; Zeldes 1989). Consequently for the case of East Africa, if the households are assumed to have identical preferences, then the substitutability function for the i^{th} household is assumed to take the form expressed as follows:

$$U(C_{it}, Z_{it}) = \frac{C_{it}^{1-1/\eta}}{1-1/\eta} \exp(Z_{it}) \quad [20]$$

where Z_{it} represents the taste shifter and η represents the consumption substitution elasticity.

2.4.Data and Variables

The data used in this study is from the farmer household survey conducted in East Africa by the World Bank as part of the Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) project. Uganda has experienced strong economic growth over the past two decades, and important changes have taken place in East Africa's typical farm household, market structure, and community. The data years from the surveys range from 2009 to 2012 and

cover the district of Kampala and 72 Enumeration Areas (EAs) (58 rural and 14 urban) out of the 783 EAs in each of the following: the (i) Central Region with the exception of Kampala District, (ii) Eastern Region, (iii) Western Region, and (iv) Northern Region.

Moreover, the panel dataset covers multiple factors regarding the household, sex, and agriculture, including livestock, community, and market. It is important to note that the survey tracked all original households by locating the household members at their last known location. In each panel survey for the year 1 (2009-2010), 3,123 households were surveyed; year 2 (2010-2011), 2,716 households were surveyed, and in year 3 (2011-2012), 2,716 households were surveyed. The variables include age, A_{it} ; household size, HS_{it} ; the consumption levels at time t and $t+1$ C_{t+1} and C_t ; income, Y_{it} ; net worth, NW_{it} ; long term debt, LD_{it} ; short-term debt; total debt: gross output ratio, GO_{it}/TD_{it} ; total debt: net worth ratio, TD_{it}/NW_{it} , total asset, TA_{it} , and owned land: total land ratio, OL_{it}/TL_{it} .

In Uganda, there are different structures for land tenure⁵. According to the report from the surveys *Freehold* tenure is ownership of the land for an unlimited period. Thus, the owner of the land can pass it to another family member after death. The owner of a freehold title has full power to use and do anything with the land within the law. Leasehold tenure gives the tenant the right to own an interest in the land after he/she agrees with the principal owner of the land for a specified or limited period of time, usually either five or 99 years. *Mailo tenure* was enacted by the 1900 Agreement, and gives ownership of the land formerly to the Baganda chiefs mainly in Buganda. *Customary tenure* is a traditional method of land ownership. Under customary tenure, the community, clan, families, or individuals may own it: lawful and bona fide occupants on freehold-leasehold or Mailo land are included⁶. Like those of several previous authors (Hall and Mishkin 1982; Shapiro 1984; Altonji and Siow 1986; and Zeldes 1989b), our dataset distinguishes food expenditures, which allows for the direct application of the inter-temporal Euler equation if an

⁵For more details about the land system in Uganda reader can see the LSMS report from the surveys

additional separability assumption is imposed on the model. Previous papers by several authors (Hayashi 1985; Smith and Strauss 1986; Langemeier and Patrick 1993; and Phimister 1993) have left this issue unresolved. Tables 1-3 report the variables, descriptions, and summary statistics.

Table 1: Essay I, Definition of Variables

VARIABLES	DEFINITIONS
A_{it}	Age at time t (Year)
HS_{it}	Household size in at time t (numbers)
I_{it}	Aggregate Income at time t (shs)
C_{it+1}/C_{it}	Ratio of Consumption between t and t+1 (ratio)
STD_{it}	Short Term Debt at time t (shs)
LTD_{it}	Long Term Debt at time t (shs)
OL_{it}/TL_{it}	Own land (Ha) divide by total land (Ha)
GO_{it}	Gross output (shs)
TA_{it}	Total Asset (shs)
TD_{it}	Total debt at time t (shs)
NW_{it}	Net worth or total assets - total liabilities (shs)
TD_{it}/NW_{it}	Total debt divide by net worth is household financial leverage or Riskiness (shs)
GO_{it}/TD_{it}	Gross Output over Total Debt at time t (shs)

Note: Note: TD_{it}/NW_{it} is household financial leverage capturing how much capital comes from debt (loans), or assesses the ability of a household to meet long term financial obligations. GO_{it}/TD_{it} . A low ratio indicates that the household is able to produces and sells goods and services sufficient to pay back short term and long-term debts without borrowing more or financially constrained. Aggregate incomes are calculated at the household level, annualized, however, considers the gross value rather than net. Aggregate consumption are calculated using two approaches: the first using information from the agricultural module of the survey (as input to the variable and the second utilizing the data on own consumption from the expenditures module of the survey. The *Units* (shs) is the Ugandan Shilling 05/06 prices Spatially Temporally Adjusted by the Ugandan Bureau of Statistics.

Table 2: Summary Statistics

VARIABLES	Obs	Mean	Std. Dev.	Min	Max
Year	3,636	2010.5	0.5000	2010	2011
A_{it}	3,576	48.815	14.7958	16	100
HS_{it}	3,636	6.009	2.9144	1	29
I_{it}	3,636	215813.3	676744	2000	9810000
C_{it+1}/C_{it}	3,636	1.079	0.7883	0.0371	13.35698
STD_{it}	3,636	2610.249	12596.19	10	310000
LTD_{it}	3,636	4259.667	15277.67	10	320000
OL_{it}/TL_{it}	3,636	0.214	0.2661	0.0046	1
GO_{it}	3,636	115303.7	478471.5	100	13300000
TA_{it}	3,636	6535213	61000000	10	3210000000
TD_{it}	3,636	6869.917	22069.2	20	337000
NW_{it}	3,636	6528343	61000000	-274990	3210000000

Table 3: Summary Statistics in Panel

Variable		Mean	Std. Dev.	Min	Max	Observations
Year	Overall	2010.5	0.5000	2010	2011	N =3636
	Between		0	2010.5	2010.5	n =1818
	Within		0.5000	2010	2011	T = 2
A_{it}	Overall	48.81572	14.7958	16	100	N = 3576
	Between		14.7920	16	99	n =1803
	Within		1.2425	33.8157	63.8157	T-bar = 1.98
HS_{it}	Overall	6.0090	2.9144	1	29	N = 3636
	Between		2.7664	1	27	n = 1818
	Within		0.9181	0.5090	11.5090	T = 2
I_{it}	Overall	215813.3	676744	2000	9810000	N = 3636
	Between		484539.6	2000	4906000	n = 1818
	Within		472512.8	-4688187	5119813	T = 2
C_{it+1}/C_{it}	Overall	1.0796	0.7883	0.0371	13.3569	N = 3636
	Between		0.4632	0.3350	6.7437	n =1818
	Within		0.6379	-5.5335	7.692822	T = 2
STD_{it}	Overall	2610.249	12596.19	10	310000	N =3636
	Between		8762.277	10	155005	n = 1818
	Within		9050.278	-152384.8	157605.2	T = 2
LTD_{it}	Overall	4259.667	15277.67	10	320000	N = 3636
	Between		10814.07	10	160005	n = 1818
	Within		10793.3	-155735.3	164254.7	T = 2
OL_{it}/TL_{it}	Overall	0.2142	0.2661	0.0046	1	N = 3636
	Between		0.1770	0.0273	0.8615	n = 1818
	Within		0.1988	-0.2607	0.6892	T = 2
GO_{it}	Overall	115303.7	478471.5	100	13300000	N = 3636
	Between		367825.1	100	7185000	n =1818
	Within		306066.9	-6019696	6250304	T = 2
TA_{it}	Overall	6535213	61000000	10	3210000000	N = 3636
	Between		43100000	10	1610000000	n = 1818
	Within		43200000	-1600000000	1610000000	T = 2
TD_{it}	Overall	6869.917	22069.2	20	337000	N = 3636
	Between		15550.6	20	168510	n = 1818
	Within		15661.89	-161620.1	175359.9	T = 2
NW_{it}	Overall	6528343	61000000	-274990	3210000000	N = 3636
	Between		43100000	-137500	1610000000	n = 1818
	Within		43200000	-1600000000	1610000000	T = 2

2.5. Econometric Framework and Applications

Using equation [18] under the specification of equation [20], the consumption function of the household in subsequent periods for each household can be derived as follows:

$$\frac{1 + \rho}{1 + r_{it+1}} \left[\frac{C_{it+1}}{C_{it}} \right]^{1/\eta} \exp(Z_{it} - Z_{it+1}) = 1 + e_{it+1} \quad [21]$$

However, it is also important to note that the taste shift Z_{it} has a characteristic such that the individual effect for the household is constant between the two periods and will not affect the relationship established in the equation [21]. Moreover, the individual family's household taste shifter at time t is assumed to be determined as a simple linear function of time invariant household component φ_i , the age of the household head A_{it} , and the total household size, HS_{it} in the following linear expression:

$$Z_{it} = \varphi_i + \alpha_1 A_{it} + \alpha_2 A_{it}^2 + \alpha_3 \ln HS_{it} \quad [22]$$

The introduction of the age of the household and the taste shifter in equation [22] simply implies that the sub-utility function of the household is age dependent. Substituting Z_{it} and Z_{it+1} in equation [21], you obtain:

$$\begin{aligned} \ln \left[\frac{C_{it+1}}{C_{it}} \right] &= \eta [\alpha_1 + \alpha_2 - \ln(1 + \rho) + \ln(1 + r_{it+1})] + 2\eta \alpha_2 A_{it} + \eta \alpha_3 \ln[HS_{it}] \\ &+ \eta \ln(1 + e_{it+1}) \end{aligned} \quad [23]$$

From the basis of equation [23] an estimable function is built under rational expectations assumptions which are not bounded to imply that $e_{it+1} = 0$, but instead following Hayashi (1985), I can state: $1 + e_{it+1} = (1 + e_{it+1}^*)(1 + \vartheta_{it+1})$ where e_{it+1}^* is the aggregate shock and ϑ_{it+1} the individual specific effect, assuming that both ϑ_{it+1} and e_{it+1}^* have mean zero and are independent of each other and the forecast variance $\sigma_{uit}^* = \sigma_u^2$ varies over time and household. Individual interest rates $r_{it+1} = (1 + r_{it+1})\mu_i$ where μ_i is the household specific individual

factor, with $E(\mu_i) = 1$ and $\text{Var}(\mu_i) = \sigma_\mu^2$, and the common portion of the interest rate is independent of u_{it+1} and μ_i . Under this framework, equation [23] is rearranged to become:

$$\ln \left[\frac{C_{it+1}}{C_{it}} \right] = \beta_1 + \beta_2 A_{it} + \beta_3 \ln[HS_{it}] + \epsilon_{it+1} \quad [24]$$

where $\beta_1 = \eta[\alpha_1 + \alpha_2 - \ln(1 + \rho) + \alpha_2 + 1/2(\sigma_u^2 + \sigma_\mu^2)] + \ln(1 + e_{it+1}^*) + \ln(1 + r_{t+1})$ and $\beta_2 = 2\alpha_2\eta$; $\beta_3 = \alpha_3\eta$ and $\epsilon_{it+1} = \eta[\ln(1 + u_{it+1}) + \ln\mu_i - 1/2(\sigma_u^2 - \sigma_\mu^2)]$

Now, when applying the Taylor series expansion to $\ln(1 + u_{it+1})$ and $\ln\mu_i$, I have $E(u_{it+1}) = 0$ and $E(\mu_i) = 1$, then $E(\epsilon_{it+1}) \approx 0$. However, the coefficients β_1 and ρ are intertwined with the intercept and cannot be separated empirically from an estimation point of view, and also the identification of η ; β_2, β_3 is difficult. However, for the purpose of this essay, equation [24] can be used to test empirically if small household farm consumption behavior is consistent with the life cycle model in the presence of market imperfections and the interactions between labor, consumption, production uncertainty, and land tenure. Thus, the simple static consumption function can be estimated to test for our hypothesis.

$$\ln C_{it} = Z_i + \beta_1 A_{it} + \beta_2 A_{it}^2 + \beta_3 HS_{it} + \beta_4 Y_{it} + \beta_5 NW_{it} + \epsilon_{it} \quad [25]$$

where Z_i is the household individual component, A_{it} the age of the head of household, Y_{it} is the household disposable income, and NW_{it} is the household net wealth at time t. Equation (25) can be estimated in the first difference to eliminate the individual specific effects. Thus,

$$\ln C_{it+1} - \ln C_{it} = (\beta_1 + \beta_2) + 2\beta_2 A_{it} + \beta_3 \Delta HS_{it+1} + \beta_4 \Delta Y_{it+1} + \beta_5 \Delta NW_{it+1} + \Delta \epsilon_{it+1}$$

Which can be rearranged as follows:

$$\ln \left[\frac{C_{it+1}}{C_{it}} \right] = (\beta_1 + \beta_2) + 2\beta_2 A_{it} + \beta_3 \Delta HS_{it+1} + \beta_4 \Delta Y_{it+1} + \beta_5 \Delta NW_{it+1} + \Delta \epsilon_{it+1} \quad [26]$$

I can test the inter-temporal Euler equation [24] plus a set of financial variables exogenous at time t that are important in determining the impact of borrowing constraints and then use the non-tested hypothesis to evaluate [24] against the consumption function of equation [26]. The financial variables are as follows: net worth (NW_{it}); long-term debt (LTD_{it}); short-term debt

(STD_{it}); total debt/gross output ratio (GO_{it}/TD_{it}); owned land: total land ratio (OL_{it}/TL_{it}); total debt: net worth ratio (TD_{it}/NW_{it}), and total assets (TA_{it}). The strategy, approach, and benefit of this setting in this section provide new insights into the validity and relevance of the current theory of the life cycle model. The financial variables included in testing of equation [24] are financial variables relative to household income, debt, and asset levels which lenders around the world commonly enforce. These three segments capture the financial position of any household even though asset type and credit access and duration vary from one country to another and whether households are comprehensive planners or basic planners or limited planners or no-planners at all. In the case of Uganda, these financial variables available in the data are used and provide an understanding of resources allocation relative to the level of debt, asset, and land ownership. Moreover, the resulting analysis could help policy makers to understand what really works and the factors and constraints that alter household consumption behavior in Uganda. Furthermore, the resulting analysis provides guidance on how to improve income dynamics at the household level and provides policy insight on taxes, consumption expenditures, and poverty alleviation. Thus, following Phimister (1993), Shapiro (1984), Zeldes (1989), and the existing literature, I assume that the test of the basic life cycle model is an alternative hypothesis of a model of the household, especially in Africa.

2.6. Results

I estimate equations [24] and [26]. To address heteroscedasticity, I use the robust option to obtain Huber/White or sandwich robust standards errors in all estimation. To double-check my results, I also test for heteroscedasticity under the null of homoscedasticity and fail to reject the null of homoscedasticity at a 5 percent level of significance. I also test for serial correlation using the Lagrange-Multiplier test for serial correlation under the null of no first-order autocorrelation and the adjusted LM test for random effects, which works even under serial

correlation and handles unbalanced panels as long as there are no "gaps" in the series (time). I fail to reject the null and conclude that the data does not have first-order autocorrelation. I also tested for multicollinearity among the independent variables by computing the variance inflation factors (VIF), a standard approach to check for multicollinearity under panel structure. I computed time specific dummies as an equivalent for fixed effect estimation and then computed the VIFs and found that tolerance ($1/\text{VIF}$) values for each variable and multicollinearity issues were not present.

I report the results estimated from equation [24] and equation [26] in Table 4 and Table 5. Parameters shown in Table 4 are all estimated with robust standards errors. To find the suitability between the fixed and random effect model, I run the Hausman specification test. If the fixed effects (FE) model is more appropriate, I can remove the effects of household time-invariant characteristics and capture precisely the net effect of income and other financial variables on the ratio of consumption. Moreover, in FE model, time-invariant household characteristics are unique to each household and thus should not be correlated with other individual household characteristics.

Table 4: Results from the Intertemporal Euler Equation

VARIABLES	(1) $\left[\frac{C_{it+1}}{C_{it}}\right]$	(2) $\left[\frac{C_{it+1}}{C_{it}}\right]$	(3) $\left[\frac{C_{it+1}}{C_{it}}\right]$	(4) $\left[\frac{C_{it+1}}{C_{it}}\right]$
HS _{it}	-0.0054 (0.0037)	-0.0048 (0.0037)	-0.0048 (0.0037)	-0.0048 (0.0037)
A _{it}	1.73e-05 (0.0008)	0.0001 (0.0008)	0.0001 (0.0008)	0.0001 (0.0008)
I _{it}		2.27e-08 (0.0001)	2.27e-08 (0.0001)	2.25e-08 (0.0001)
OL _{it} /TL _{it}		0.251*** (0.0483)	0.251*** (0.0483)	0.251*** (0.0484)
TA _{it}		-1.45e-10*** (0.0000)	-1.12e-06** (0.000)	-1.45e-10*** (0.0000)
TD _{it} /NW _{it}		0.0002*** (0.0003)	0.0002*** (0.0003)	0.0002*** (0.0003)
GO _{it} /TD _{it}		-1.55e-07 (0.0004)	-1.55e-07 (0.0004)	-1.51e-07 (0.0004)
NW _{it}			1.12e-06** (0.0004)	
TD _{it}		-1.12e-06** (0.0004)		
STD _{it}				-1.59e-06** (0.000)
LTD _{it}				-7.77e-07 (0.0007)
Constant	1.111*** (0.0431)	1.052*** (0.0441)	1.052*** (0.0441)	1.052*** (0.0441)
Observations	3,576	3,576	3,576	3,576

Note: Column (1) is estimated from equation [24]. Column (2-3-4) reports the impact of some important Variables related to borrowing constraints. Column (3-4) tests the sensitivity for different specification of the intertemporal Euler. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Results from the First Difference Equation

VARIABLES	(1) $\left[\frac{C_{it+1}}{C_{it}}\right]$	(2) $\left[\frac{C_{it+1}}{C_{it}}\right]$	(3) $\left[\frac{C_{it+1}}{C_{it}}\right]$	(4) $\left[\frac{C_{it+1}}{C_{it}}\right]$
A_{it}	0.0002 (0.0008)	0.0003 (0.0008)	0.0001 (0.0008)	7.59e-06 (0.0008)
ΔHS_{it}	0.0327 (0.0572)	0.0339 (0.0570)	0.0370 (0.0567)	-0.00220 (0.0588)
ΔI_{it}	0.0138** (0.0057)	0.0130** (0.0057)		
$\Delta NetWort_{it}$	0.0080 (0.0096)	0.00825 (0.0096)		0.01000 (0.0094)
TD_{it}/NW_{it}		0.0001*** (0.0002)	8.11e-05*** (0.002)	
TD_{it}		-1.13e-06** (0.0004)	-1.23e-06*** (0.0004)	-6.92e-09 (0.0006)
GO_{it}/TD_{it}		-1.37e-07 (0.0004)	-2.77e-08 (0.0004)	-1.98e-08 (0.0004)
μ_{it}				0.998 (6.905)
Constant	1.055*** (0.0418)	1.062*** (0.0418)	1.082*** (0.0404)	0.00187 (0.331)
Observations	3,576	3,576	3,576	3,576

In column (1) equation [26], which is the static consumption function, is estimated at the difference level. In column (2-4) additional financial variables are added and use for testing and comparison with the Euler in equation [24]. Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

For the random effects model, the idea is that the unobserved individual household effect encompasses elements that are correlated with the independent variables in the model, but not if these effects are stochastic. Results from the Hausman test indicate that the error terms are correlated, and as a result, I reject the fixed effect model for the Euler equation in the estimation results reported in Table 4, at a 5 percent level of significance. Similarly, I reject the fixed effect model in all estimation in Table 5 column (2), where at a 5 percent level of significance. Accordingly, I adopt the random-effects models and estimate equations [24] and [26] using the generalized least squared method.

The estimation results with the inter-temporal Euler equation in Column (1) and with other additional variables with alternative specifications are in columns 2-4. Column (1) estimates the Euler

equation where both age of the head of household and household size are not significant. Column (2) reports the impact of some important variables related to borrowing constraints of the head of the household. The results in column (2) indicate that the ratio of won land over total land, total assets held by households and total debt age, income, total debt are individually significant at a 1 and 5 percent level respectively.

To conduct the test as hypothesis earlier, I compare and test specifications given in column (1) and column (2). In column (2), I test the coefficients estimated of the additional variables in column (2) if they are jointly and significantly different from zero. I reject the null that these coefficients are jointly equal to zero as indicated by the test statistics, which are $\chi^2_{(6)} = 38.47 > 12.592$ at a 5 percent level of significance. In column (2), Gross output to total debt ratio, which determines farm household capacity to repay debt is not significant as well as household size and age of the head of household. In column (3), I re-evaluate the model specification in column (2) and include household net worth (NW_{it}) from column (2) but exclude total debt (TD_{it}) and test against the model against the Euler equation in column (1). I again reject the null that the coefficients are jointly equal to zero at a 5 percent level of significance indicated by the test statistic, which are $\chi^2_{(5)} = 38.47 > 11.070$. The results in column (4) reinforce the findings in columns 2-3 at a 1 percent level of significance when households' short term debt and long-term debt are included in the model. The coefficients estimated in column (4) are jointly and significantly different from zero as indicated by the test statistics which are $\chi^2_{(8)} = 33.12 > 15.507$ at a 5 percent level of significance.

Table 5 report the estimation results from the model presented in equation [26], which is the simple static consumption function. I estimate the model using the first difference equation on the independent variables to eliminate household individual specific effects. I find that household income is positive and significant at a 5 percent level. However, net worth is not significant. The coefficient estimate in household size is also not significant. I also perform the joint test and reject the null hypothesis of coefficients as jointly insignificant, as indicated by the test statistics which are $\chi^2_{(3)} =$

14.023 > 7.815 at a 5 percent level of significance. Overall, the sensitivity of the model specification in column (2) using a different specification in Table (5) appears to be statistically robust to model specifications. Thus, based on these findings it is not clear whether the failure of the inter-temporal Euler equation is because farm households in Uganda optimize but are currently borrowing constrained. Or it may be because farm households make decisions about consumption based on a simple heuristics or rule of thumb. If this is the case, then one may argue that the utility lost by rule-of-thumb behavior in the decision-making processes of small farm households is relatively low.

2.7. Summary and Conclusions

In this essay, market imperfections are characterized by income uncertainty relative to erratic yield variations, output price distortions, and the inability to access credit markets, which grew unusually fast in Uganda. The importance of market imperfection in developing countries, especially Uganda, resides in the fact that any policy implementation should take into consideration these features. Moreover, since most of the production activities in developing countries are organized within the household setting, I defined household in the context of Uganda to capture household models and profiles of decisions in production and consumption. In the model derivations, I incorporate genuine features of life events in small farm households in Uganda and developed a tractable model of inter-temporal optimization tested against a simple static consumption function estimated for our hypothesis.

I estimate the life cycle model under market imperfection in Uganda using unbalanced panel data from 2009/2010, 2010/2011, and 2011/2012 available from the World Bank LSMS-ISA survey data. I reach the conclusion that the consumption function characterized by the Euler equation [24] is rejected. I also estimate the simple consumption function expressed by equation [26]. I find that even though the simple consumption function better characterizes the data, it is not clear why the inter-temporal Euler equation fails to describe household consumption dynamics in Uganda. It may be

because farm households in Uganda optimize but are currently borrowing constrained or because they just decide consumption based on a simple heuristics or rule of thumb.

Christelis et al. (2016) found that expected consumption uncertainty is higher for the young and the self-employed among Dutch farm households, and is correlated positively with income. Households might also save for different motives, but what is prevalent in the data is that most households that have experienced the death of the parents or household heads are definitely saving for bequests in Uganda and most of them do not have an excessive amount of debt in either the short or long term. In fact, the report from the Uganda Bureau of labor Statistics highlights that most households dislike talking about debt. Moreover, households facing income uncertainties and uncertain future economic circumstances will most likely display higher saving rates in the presence of a precautionary saving motive like securing land, or setting up a small business and investing in financial assets, making provisions for unexpected events, paying for debts, taking care of the elderly, and supporting orphan children who lost their parents from HIV or other related diseases.

Some argue that the specifications represented by the Euler equation are rejected by the data instead of the simple and static consumption function. But the simple consumption function could not clearly justify the rejection of the Euler specification. Even if the assumption of a rational consumer is very controversial in the literature, one can argue that consumers are not myopic and update their beliefs given current and future expectations of their local environment. The findings in this essay are consistent with the literature in developed countries, and the rejection can be attributed to the model's inability to uncover consumer preference at the household level, such as the inter-temporal elasticity of substitution. Additionally, among the possible explanations for the rejection of the inter-temporal Euler equation are saving motives, which also are linked to acquiring land, purchasing major household appliances and furniture, starting up a small business, investing in financial assets, providing for unexpected events, paying for debts, taking care of the elderly, or supporting orphan children who have lost their parents from HIV or other related diseases. This is significant and points to some bequest or precautionary motives for saving, linked to some potential heterogeneous impact of credit constraints

and adequate retirement plans, which could be binding across specific groups and locations. These findings have three main policy implications. First, policy makers in Uganda can alter household behavior by changing the decision making power of individual household members. Among the parameters used to articulate these policies are consumption and expenditure, production (such as the use of inputs), labor allocation, asset ownership, children's health, and education (Doss 2013). Second, in evaluating programs designed to improve the welfare of small farm household members, the results suggest that policy makers could adopt an alternative characterization of household models that allow for the lack of commitment to the head of household by members of the household.

As Deaton (2016) stated, any economic policy that seeks to promote welfare, tackle inequalities, and reduce poverty must first understand individual consumption and production choices. Consequently, the study of consumption behavior will remain at the center of major economic policy during our time, while imperfect and incomplete labor markets will continue to be a crucial feature of the microeconomics of economic development in many developing countries. This will encourage the youth to embrace agriculture and may reverse the decline in the revenue of farm households.

Future lines of inquiry should look at the impact of voluntary and involuntary default risks and associated borrower incentives among farm households in Uganda to understand the interplay with inter-temporal optimization behavior. Even though I cannot argue that farm households in Uganda are myopic, the search for better models capable of explaining farm household consumption behavior is critical. This is important for developing countries since a large number of credit transactions still take place in the informal sector, especially in Uganda. It seems that with large sample sizes, these tests are unlikely to lead to different conclusions compared to small sample size. Consequently, this needs further investigation and debt appears to be essential in poor rural and urban farm household economies since it is required to boost working capital and the investment in fixed capital, savings accumulation, and consumption.

2.8. References

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CHAPTER 3: FARM HOUSEHOLD CONSUMPTION BEHAVIOR IN THE PRESENCE OF UNCERTAINTY AND RESTRICTIONS ON CREDIT IN SUB-SAHARAN AFRICA: EVIDENCE FROM UGANDA

3.1. Introduction

This essay seeks to evaluate farm household consumption behavior in Uganda when consumers and producers do not have access to financial services due to market imperfections. In the analysis, this essay takes into consideration the aggregation of household idiosyncratic and aggregate shocks. The idiosyncratic nature of the shock is related to the credit constraints common among farm households' specific characteristics in Uganda, and aggregate shocks to the economy are more likely to be amplified in the presence of borrowing constraints. Mody et al. (2012), Campanale et al. (2015), and Teppa et al. (2013) indicate that since Keynes (1936) saving behavior relative to borrowing constraints has been closely associated with different motives, like precaution, foresight, fear, calculation, independence, enterprise ambitions, bequests, or down payments. For instance, Zeldes (1989) indicates that the success and validity of these types of endeavors depends crucially on observing individual household behavior over time. Verbeek (2008) surveyed the literature and indicates that there is a lack of genuine panel data tracking individuals or firms over time. Deaton (2015) advises against using cross sectional data that could mitigate dynamic aspects of the investigation. Wooldridge (2002) and Gardes et al. (2007) found that unobserved heterogeneity revealed the downward bias from cross-section estimates of income elasticities and the upward bias away from home food expenditures and income elasticities. Deaton (2015) points to measurement errors in both developed and developing countries. Deaton (1992) looked at the case of Cote Ivoire and indicated that the extent to which households can smooth consumption is a matter of debate and left many important policy issues unclear.

This essay draws from the work of Zeldes (1989), Shapiro (1984), Deaton (1992), and Phimister (1995) to develop testable implications derived from the life cycle model in the presence of borrowing constraints to shed light on the rejection of the inter-temporal Euler equation in the case of Uganda. In this essay, a household is defined as a group of people who have normally been living and eating their meals together for at least 6 of the 12 months preceding the interview. Households are considered fully borrowing constrained if they had applied for a loan and were rejected or if they did not have enough assets for collateral in Uganda.

This definition corroborates Boucher and Carter's (1996) standard definition of a credit constraint: households that were not rejected but received a loan less than what they requested is classified as partially constrained. Diagne, Zeller and Sharma (2000) argue that households are credit constrained when at least one of the members of the household above 17 years of age is facing a binding credit limit. Bali Swain (2002) argues that a credit constraint is present when the household members' probability of access to credit in the formal sector is less likely than in the informal. The resulting consequence from these financial barriers is that it locks out farm households from access to credit though they represent between 15 and 20 percent of the total credit demand and account for 85 percent of the total population (Keya and Rubaihayo 2013; Mpuga 2010; Timmer and Akkus 2008; Kasirye 2007). Keya and Rubaihayo (2013) show that private commercial banks are not eager to lend to farmers.

These stylized facts support an argument that farm households do not invest in agriculture because of a lack of finance, land ownership, and tenure issues (see Figure 5). A survey of 761 farm households in India indicates that 72 percent face credit constraints (Swain 2002; Chaudhuri and Cheral 2012). Barham, Boucher and Carter (1996) find that among 201 Guatemalan farmers, 34 percent were constrained from private banks, and 27 percent were partially borrowing constrained. Diagne et al. (2000) surveyed 350 Bangladeshi farm households

and found that 55 percent to 61 percent are borrowing constrained, while in Malawi Diagne and Zeller (2001) and Simtowe (2009) found 84 percent to 92 percent were borrowing constrained. In China, 37 percent of households are borrowing constrained (Feder et al. 1990), while in the United States 19 percent are credits constrained (Jappelli 1990). Thus information on farm household behavior in the presence of credit constraints could assist policymakers in devising policies to relax credit constraints in Uganda and boost farmers' investment in agriculture.

This essay also overcomes the empirical irregularities attributed to consumers' inability to access financial services and the data inadequacies to fit many of the stylized facts of borrowing constraints (Rampini and Viswanathan 2016; Cooper and Zhu 2016; Besley 2016). Rather than using equity, I use the debt to value added ratio, farm owned land to total land ratio, and household assets that are being financed with either long or short-term debt to capture asset ownership (Sun et al. 2013). I use panel longitudinal data from 2009 to 2012 and (1) trace the dynamics of farm households' consumption behavior, and (2) identify the inter-temporal decisions regarding consumption, and (3) control for unobserved fixed effects in the diagnosis of the effect of time-varying exogenous variables.

The model estimation under the hypothesis of no borrowing constraints is tested against the inter-temporal Euler equation, including financial and income variables. I find that the life cycle model without borrowing constraint restrictions is rejected by the data in Uganda. The results support previous studies (Zeldes 1989; Deaton 1991; Alessie et al. 1997; Boersch-supan and Lusardi 2003; Filer and Fisher 2007; Dogra and Dogra 2015). These findings are also consistent with Langemeier and Patrick (1990). These results are also consistent with others (Carroll and Samwick 1997; Carroll 1992, 1997; Deaton 1991; Cagetti 2003; Mishra et al. 2013; Dogra and Gorbachev 2015), especially for self-employed farm households in Uganda. The remainder of this essay is structured as follows. Section II reviews the literature; Section III describes the theoretical

framework, and Section IV describes the variables in the data. Section V presents the econometric framework and application. Section VI presents the results followed by major conclusions in Section VII.

3.2.Literature Review

The literature presents different approaches in modeling farm household consumption behavior with and without credit constraints. I review the different scenarios, comparing the interaction between the rate of time preference and the level of interest rate. The different approaches of incorporating the definition of credit constraint in the models and the empirical findings resulting from such models are also analyzed. As Deaton (2015) points out, studying individual consumption in adjacent periods is challenging in the presence of idiosyncratic shocks and liquidity constraints, providing three examples. In the first case: if you assume that the rate of preference is equal to the level of the interest rate, then consumption quickly converges to the mean of income (Lawrence 1991 and Kimball and Weil 2009). In the second case, if the rate of preference is less than the prevailing level of the interest rate, households will tend to accumulate assets indefinitely, and the income process becomes irrelevant when saving and not borrowing is the objective (Skinner 1988; Zeldes 1989; Carrol and Summers 1989; Ogaki and Atkeson 2015). In the third case: if the rate of time preference is greater than the level of interest rate, consumers are inclined to high frequency saving behavior and asset accumulation in developing countries (Deaton 1991). The lessons learned from the difference in time preferences relative to the level of the interest rate indicate hyperbolic time preference, which is a time inconsistent model where consumers have the tendency to prefer smaller gain to larger and later gain sometime in the future.

In fact Wang et al. demonstrate that, most households in all countries studied so far exhibit⁷ hyperbolic discounting patterns Wang et al.(2016). However, Loewenstein and O'Donoghue (2002) observed higher heterogeneity for households looking into shorter time horizons, which is prevalent in the literature. Becker and Mulligan (1997) posit that subjective time discounting can also be influenced not by income uncertainty alone but also by development trends, culture, and historical circumstances (see also Stern 2006; Higashi et al. 2014). In the current literature, the debate over what determines time preference challenges the traditional belief that preference has nothing to do with cultural or social norms. Fehr and Hoff (2011) argue that such attitudes toward time preference are no longer realistic and that discount rate of preference can be endogenous and shaped by social and cultural influences (Bowles 1998; Eugster et al. 2011).

To model credit constraints, the literature separates the empirical testing into two scenarios: when consumers are borrowing constrained and when consumers are not borrowing constrained (Jappeli 1993; Arthur et al. 2016; Alderman 2016; Bauer 2016). The first scenario implies that the Euler equation derived from the stochastic life cycle model without borrowing constraint is valid, and the marginal rate of substitution in consumption between t and $t+1$ converge to 1 (Je et al. 2011; Gorbachev 2011). For instance, Sarantis and Stewart earlier argue that the presence of current income resulting from liquidity constraints linked to precautionary saving is the major reason why the rejection of the life cycle model happens for almost all OECD countries. One of the important conclusions is that smoothing consumption is not equal to holding consumption or expenditures constant. The direct implications mean that the consumption path in the next period $t+1$ is quasi-independent of the anticipated labor income process relative to the current period t (Browning and Crossley 2001, Carroll 2001, Sarantis and Stewart 2003). Carroll

⁷This term refers to those households who are inclined to progressively prefer a smaller and sooner reward over a larger and later reward over certain period of time.

(2001) shows that under this scenario, the model explains the high marginal propensity to consume, the discount rate, and future labor income, as well as the motive for precautionary saving. The second scenario implies that the borrowing constraint is binding and its impact on consumption is positive while the marginal rate of substitution of consumption between t and $t+1$ is greater than 1 (Zeldes 1989; Dogra and Gorbachev 2015). Zeldes earlier showed that the inability to borrow against future income considerably and significantly affects consumption for a large proportion of the population.

Moreover, idiosyncratic shocks are revealed to be a major factor in explaining the inequality between consumption and income (Storesletten et al. 2004). Hai and Heckman (2016) demonstrate that when borrowing constraints are binding, individuals value education more in order to increase their consumption ability by pushing credit limit boundaries and thus provide insurance for idiosyncratic shock (see also Cooper and Zhu 2016). The direct implication of such findings corroborates Rossi and Trucchi (2016). In Italy, Rossi and Trucchi (2016) find that under financial market restrictions, the only way to increase consumption is by increasing labor supply to neutralize the presence of borrowing constraints instead of reducing consumption. However, Domeij and Floden (2005) argue that in the presence of incomplete markets the inter-temporal labor supply elasticity estimates are inconsistent.

Different approaches can be used to capture data on credit constraints. The first approach uses the indirect approach, which simulates the existence of credit constraints based on predictions from theories like the violation of the permanent income hypothesis, the discrepancy between the shadow price of capital and the cost of credit, and the variability in production relative to the uncertainty of meeting credit requirements and collateral (Hall and Mishkin 1982; Zeldes 1989; Deaton 1992). Godquin and Sharma (2005) use this approach and simulate an elicitation of credit to distinguish which of the household's decisions on consumption and agricultural and off-farm

production are affected by credit constraints (Feder, Lau, Lin, and Luo 1990). The second group involves a semi-direct approach and uses farm households' revealed access to credit from financial institutions and then determines the level of credit constraints (Jappelli 1990; Zeller 1994; Mushinski 1999; Barham et al. 1996; Godquin and Sharma 2005). The third group of approaches directly asks households the maximum limit of credit they could access from financial institutions in the market (Diagne and Zeller 2001; Godquin and Sharma 2005). Among the existing models, many researchers have adopted a time varying liquidity constraint model like Ludvigson (1999), Daley and Green (2016), and Seryoong et al. (2015). Buffer-stock dynamic stochastic optimizing models of liquidity constraints are also being used extensively by Carroll (1997), Ludvigson and Michaelides (2001), Carroll (2004), Carroll and Toche (2009), Jappelli (2008), and Carroll et al. (2015).

3.3. Theoretical Framework and Methods

I start with a very simple model and add some layers of realistic assumptions capturing farm household environments in Uganda. In analyzing farm-household consumption behavior and its agricultural system of production, the most obvious pitfall would be to circumvent the scope of a household's unique and specific system, a household's boundary, and its social environment, which are relevant for the purposes of this essay. The model is built around the framework in which current farmers in the household in Uganda own, operate, and manage their farms in each period and must choose certain levels of consumption, investment in the farm, and savings. However, in an imperfect capital market these choices are constrained by capital stocks, level of investment, production capacity, and credit available to the farm. Moreover, in many developing countries like Uganda, climate change is gradually affecting farm households' production yields both directly and indirectly and consequently also affecting the bottom lines, such as equity, profits, credits, and

level of debt. Therefore, in this environment, farm household decision problems in Uganda are assumed to maximize the expected lifetime utility derived from consumption in any period t . Thus this framework departs from the traditional approach of consumer behavior as a single decision maker and exploits the collective approach of consumer behavior, which takes into account the multi-person household preferences. As a result each decision node is perceived as social state at time t chosen by the members of the farm household to maximize their expected lifetime utility derived from consumption. Thus, this essay dwells from the general microeconomic theory of saving under liquidity constraints, which, at the aggregate level, reflect and capture many of the stylized facts in the actual data following Hall and Mishkin (1982), Phimister (1995), Zeldes (1989) and Deaton (1992) as follows:

$$\max_{C_{It+k}, K_{It+k+1}, d_{It+k}, I_{It+k}, Y_{It+k}} E_t \left[\sum_{k=0}^{T-t} \frac{1}{(1+\rho)^k} U(C_{It+k}) \right]$$

Subject to

$$d_{It+k+1} = (1 + r_{It+k})d_{It+k} - P_{t+k}Y_{It+k} + P_t^k I_{it+k} + C_{It+k} \quad K=0, \dots T-t \quad [1]$$

$$Y_{It+k} = f(K_{It+k}, \pi_{It+k}) \quad K=0, \dots T-t \quad [2]$$

$$K_{It+k+1} = (1 - \delta)K_{It+k} + I_{It+k} \quad K=0, \dots T-t \quad [3]$$

$$\alpha_l d_{it+k} \leq P_{t+k}^k K_{It+k} \quad K=0, \dots T-t \quad [4]$$

$$d_{it+k} \leq 0 \text{ and } d_{it}, K_{it} \text{ are invariables} \quad [5]$$

To describe the model, E_t is the expectations function given the information available at time t to the household. $U(C)$ is a strictly concave production function, and C_{It+k} = consumption or total household expenditures whereas Y_{It+k} is the production; K_{It+k} the capital stock; I_{It+k} is the household assets, which does not account for any depreciation. In fact in this essay this allows us

to capture the actual household figures more accurately when it comes to the actual commitment to an asset. From each asset a household expects a net return on investment. d_{It+k} is netting the household net debt, which captures the household's overall financial situation less the total value of household debts, cash and cash equivalents as well as others liquid assets. r_{It+k} is the interest, and P_t^k is the capital good price or consumer price index, which measures changes in the prices paid by consumers. ρ is the rate of time preference or discounting, which is the relative value placed on the goods at a date anterior compared to a future date. δ is the depreciation rate of all assets, and π_{It+k} accounts for the cyclical and random shocks to agricultural output at $t + k$.

Now let's turn our attention to the constraint. Constraint (1) represents the beginning period of household debts in period $t + k + 1$ set equal to the previous period's debt plus any interest payments minus all production value plus household consumption, and investment expenditures for the household economic activities. I also consider the level of production to be stochastic and determined at each period via the constraint set in equation (2) and the level of capital stock and the random shock parameters π_{It+k} . It is important to note that imperfection and uncertainty come into the model via agricultural output price P_{t+k} , the interest rate r_{It+k} and production or agricultural output Y_{It+k} . The capital stock in every period t in equation (3) encompasses new investment in farm households with a lag of one year. Now equation (4) restricts farm household level of debt in both the short and long run to gauge household access to and use of credit as well as financial solvency and experiences in the credit market. In this fashion I can depict the environment of the credit market in Uganda since access to agricultural credit by farm households remained stagnant between 10-20 percent in the last ten years. Moreover, the majority on the demand side are smallholder farmers, estimated to be over 80 percent Kasirye (2007). Moreover, to be realistic it is assumed that α_I in equation (4) is greater than 1 or $\alpha_I > 1$ to argue that in many developing countries like Uganda usually bank and microfinance and micro-credit institutions

charge high interest rates or require that farm households' assets are greater than total debt in the long-run. Moreover, in this environment the farm household is perceived to be constantly credit constrained, which means that equation (4) is binding at $t + 1$. To motivate this assumption, I found that in the data in Western Uganda, only 16 percent of farm households have access to financial institutions, compared to 11 percent in Eastern Uganda, 9 percent in Central Uganda, and 7 percent in Northern Uganda, where 69 percent of the households depend on subsistence farming, and 80 percent of the households are involved in agriculture according to the Uganda Bureau of Statistics (2014). Thus, farm households can decide on the level of investment to adjust or smooth consumption over the life cycle. To close the model, the settings in equation 1-4 ensure that investment decisions and consumption of farm households are taking place simultaneously and instantaneously. However, I must acknowledge that a close form solution to the household's optimization problem is hard to find, but the Euler equation defined here can be derived following Phimister (1995) and Zeldes (1994) consumption between t and $t+1$ as follow:

$$\frac{1}{1 + \alpha_I \lambda'_{it}} E \left[\frac{U'(C_{it})}{U'(C_{it+1})} \frac{1 + \rho}{1 + r_{it+1}} \right] = 1 \quad [6]$$

Now, the dual variable in the numerator λ_{it} links the borrowing constraint to equation [4] at $t+1$. Consequently, any time the constraints in the model relax to allow for more flexibility and less imperfection in the environment, I could estimate the marginal effect of lifetime expected utility, which is nonnegative since a household can't borrow more than its total capital stocks. Using equation [6] I can discuss two possible situations: (a) in the absence of borrowing constraints $\lambda_{it} = 0$ and then [6] become the standard Euler equation without the inclusion of borrowing constraints derived from the stochastic life cycle model under consumption only or production. Thus, in this situation the marginal rate of substitution between consumption at time t and $t+1$ is

equal to 1. (b) In the presence of binding borrowing constraints, then λ_{it} and λ'_{it} will be positive integers, and, consequently, the farm households' possibility or flexibility to smooth consumption is increasing compared to situation (b). Moreover, the argument $E(1 + r_{it+1})$ times the marginal rate of substitution between t and $t+1$ is greater than 1. In conclusion, the basis of our empirical implementation and testing lies between these two situations (a) and (b) where farm households can be determined and confirmed as financially unconstrained or constrained.

3.4. Data and Variables

The data used in this essay is from the Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) conducted by World Bank and the Uganda Bureau of Statistics National Data Archives⁸. The surveys covered the district of Kampala and 72 Enumeration Areas (58 rural and 14 urban) in each of the (i) Central Region with the exception of Kampala District, (ii) Eastern Region, (iii) Western Region, and (iv) Northern Region. Moreover, the panel dataset covered multiple objectives comprising the household, sex, and agriculture, including livestock, community, and market. In this essay, I used data from 2009 and in year one (2009-2010), 3,123 households were surveyed, and year two (2010-2011), 2,716 households were surveyed. In year three (2011-2012), 2,716 households were surveyed.

⁸The surveys were done using computer assisted personal interviews (CAPI) - CWest and Surveybe applications, which capture the data directly during interviews. Moreover, the questionnaires were then preloaded onto ultra mobile personal computers (UMPCs) so that researchers did not perform data entry. In order to apprehend the agricultural outcomes linked to the two cropping seasons in Uganda, the surveys were conducted in two visits every six months. The project was designed to develop an understanding of economic policy that accurately addresses welfare and poverty alleviation via the development of agriculture and consumption choices (see World Bank LSMS Surveys)

Table 6 presents the descriptions of the variables. Tables 7 and 8 present the summary statistics of unbalanced panel data. The variables include HS_{it} , farm households' numbers of month live in the household at time t. The variable EXP_{it} is farmer's years of experience. The variable DY_{it} , is the head of household's disposable income after taxes and transfers. The variable NW_{it} , is the farm household's net worth, or the amount by which a farm household's assets exceed its liabilities. The variable LD_{it} , is farm household's long-term debt; LA_{it} is the farm household's liquid assets; STD_{it} is the farm's short term debt; (TD_{it}/TA_{it}) is the farm household's total debt to asset ratio or an indicator of financial leverage, which measures the percentage of farm household total assets that were financed by credit, liabilities or debt; (OL_{it}/TL_{it}) is farm owned land to total land ratio, and (C_{it+1}/C_{it}) is the ratio of consumption between time t+1 and t.

Table 6: Essay II, Definition of Variables

Variables	Definitions
HS_{it}	Household Size at Time t
EXP_{it}	Experience (Years)
LA_{it}	Liquid Asset (shs)
C_{it+1}/C_{it}	Consumption at t+1/ Consumption at t
OL_{it}/TL_{it}	Owned Land to Total Land Ratio) (Ha, GPS)
DY_{it}	Disposable Income at Time t (shs)
TA_{it}	Total Assets (shs)
NW_{it}	Net Worth measures if Household Assets Exceed its Liabilities (shs)
STD_{it}	Short Term debt (shs)
LTD_{it}	Long Term debt (shs)

Table 7: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Year	3,636	2010.5	0.500	2010	2011
HS _{it}	3,636	6.009	2.914	1	29
EXP _{it}	3,636	3.882	4.846	2	70
LA _{it}	3,636	96910.73	291485.9	1000	6600000
C _{it+1} /C _{it}	3,636	1.079	0.788	0.037	13.356
OL _{it} /TL _{it}	3,636	0.214	0.266	0.004	1
DY _{it}	3,636	203978.5	530407	2000	6867000
TA _{it}	3,636	6535213	61000000	10	3210000000
NW _{it}	3,636	6528343	61000000	-274990	3210000000
STD _{it}	3,636	2610.249	12596.19	10	310000
LTD _{it}	3,636	4259.667	15227.67	10	320000

Table 8: Summary Statistics Panel

Variable		Mean	Std. Dev.	Min	Max	Observations
Year	Overall	2010.5	0.5000	2010	2011	N = 3636
	Between		0.7071	2010	2011	n = 2
	Within		0	2010.5	2010.5	T = 1818
HS _{it}	Overall	6.009	2.9144	1	29	N = 3636
	Between		0.0369	5.9829	6.0352	n = 2
	Within		2.9143	0.9738	28.9738	T = 1818
EXP _{it}	Overall	3.882	4.8461	2	70	N = 3636
	Between		0.0482	3.8481	3.9163	n = 2
	Within		4.8460	1.9658	70.0341	T = 1818
FLA	Overall	96910.73	291485.9	1000	6600000	N = 3636
	Between		11893.01	88501.1	105320.4	n = 2
	Within		291364.5	-7409.629	6591590	T = 1818
C _{it+1} /C _{it}	Overall	1.079	0.7883	0.0371	13.3569	N = 3636
	Between		0.2122	0.9295	1.2297	n = 2
	Within		0.7739	-0.1019	13.5070	T = 1818
OL _{it} /TL _{it}	Overall	0.2142	0.2661	0.0046	1	N = 3636
	Between		0.1565	0.1035	0.3249	n = 2
	Within		0.2420	-0.1060	1.1106	T = 1818
DY _{it}	Overall	203978.5	530407	2000	6867000	N = 3636
	Between		7640.034	198576.2	209380.9	n = 2
	Within		530379.5	-3402.32	6872402	T = 1818
TA _{it}	Overall	6535213	6.10E+07	10	3.21E+09	N = 3636
	Between		96095.39	6467263	6603163	n = 2
	Within		6.10E+07	-67939.7	3210000000	T = 1818
NW _{it}	Overall	6528343	6.10E+07	-274990	3210000000	N = 3636
	Between		101041.7	6456896	6599791	n = 2
	Within		6.10E+07	-203542.7	3.21E+09	T = 1818
STD _{it}	Overall	2610.249	12596.19	10	310000	N = 3636
	Between		1973.994	1214.425	4006.074	n = 2
	Within		12518.59	-1385.824	308604.2	T = 1818
LTD _{it}	Overall	4259.667	15277.67	10	320000	N = 3636
	Between		2972.322	2157.918	6361.416	n = 2
	Within		15132.37	-2091.749	317898.3	T = 1818

Regarding the variable of owned land and total land, Uganda has different regimes for land tenure. Freehold tenure is ownership of land for an unlimited period. It means that one can pass this land on to another person after one's death. The owner of a freehold title has full powers to use and do anything with the land as long as it is not against the law. Leasehold tenure is a way of owning an interest in the land based on an agreement with the owner of the land, allowing another person to take possession and use the land to the exclusion of anyone else for a specified or limited period of time, usually five years, forty-nine years or ninety-nine years. Mailo tenure, created by the 1900 agreement, is ownership of land formerly given to the Baganda chiefs mainly in Buganda (figure 2.1 and figure 2.2).

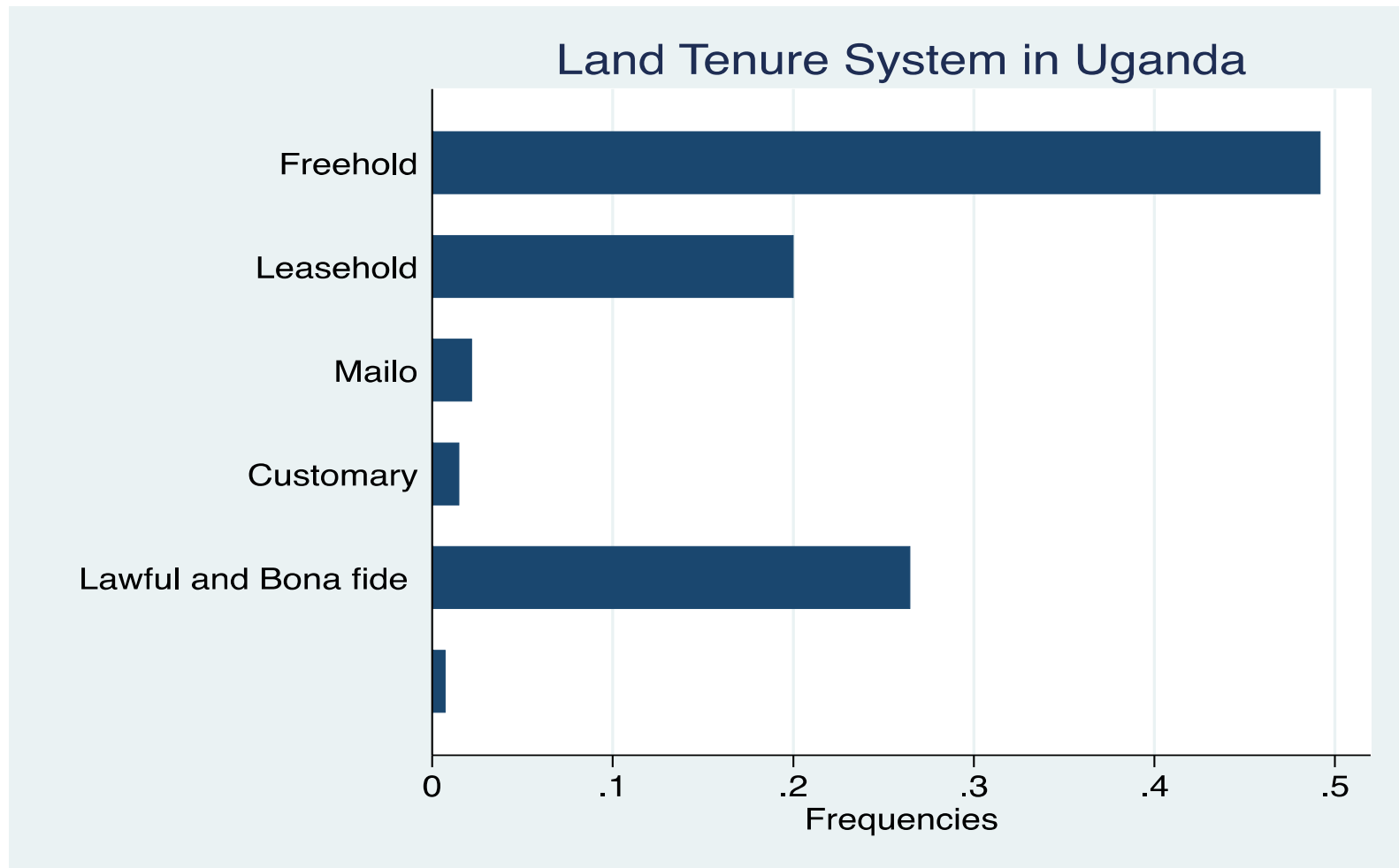


Figure 3:1: Land Ownership System in Uganda and Tenure Category

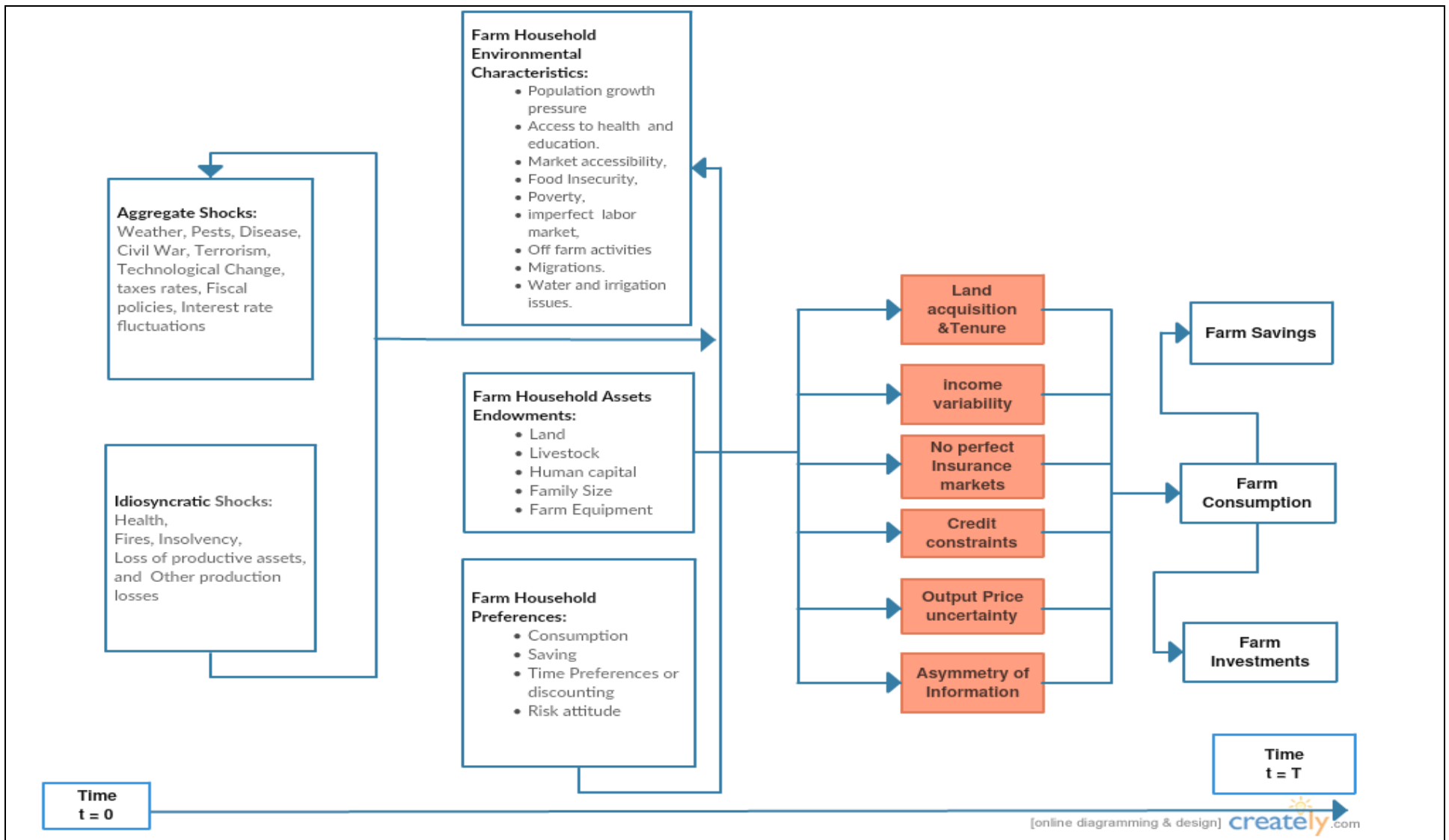


Figure 3:2: Farm Household Environments, Institutions, and Resources.

According to the LSMS reports, *Mailo tenure* is similar to freehold tenure except that tenants on Mailo land have security of tenure. *Customary tenure* is a traditional method of owning land. Customary tenure may be owned either by the community, the clan, families, or individuals. *Lawful and bona fide* occupants on freehold, leasehold or Mailo land are the last two forms of tenure. The former refers to a person staying on the land with the permission of the owner and with respect to some payments to the owner. The latter refers to a person who has stayed on and used the land or improved the land for a minimum of twelve years without being threaten or asked to leave by the owner before the date of the 8th of October 1995. Like Hall and Mishkin (1982), Shapiro (1984), Altonji and Siow (1986), and Zeldes (1989), I use aggregate consumption instead of only food expenditures, which allows for the direct application of the Euler equation characterizing the life cycle model. To the best of my knowledge, this essay is among the first to use aggregate consumption as it was left unsolved in Hayashi (1985), and Phimister (1995).

3.5.Econometric Framework and Applications

As mentioned above, the basis of our empirical testing is described by two situations: (a) farm households are not borrowing constrained, or (b) farm households are borrowing or financially constrained. In these two cases, the relationship among the parameters in equation [6] should hold, and thus, the marginal utility between t and t+1 can be described following Zeldes (1989) and Phimister (1995) as follows:

$$\frac{1}{1 + \alpha_I \lambda'_{it}} \frac{U'(C_{it})}{U'(C_{it+1})} \frac{1 + \rho}{1 + r_{it+1}} = \exp(e_{It+1}) \quad [7]$$

where e_{It+1} is described in the literature as the consumption innovation (Hayashi 1989; Zeldes 1989; Phimister 1995) or forecast error, which is realistic in the environment of this model given that the future is uncertain under market imperfections. Consequently, information available to farm households regarding agricultural output and prices are uncorrelated with e_{It+1} . As a result, if I assume that farm households in Uganda are rational and that the distribution of all probable realizations resulting from the model yields the true distributions and information at time t available to farm households, this has no power to explain equation (8). The next final step before the empirical estimation is to parameterize the model, which is feasible under the constant elasticity of substitution adopted by Phimister (1995). Most importantly, the model features take into consideration farm households' demographical distributions in Uganda. Thus, I adopt a sub-utility function specified in Phimister (1995), and Zeldes (1989) as follows:

$$S_{it} U\left(\frac{C_{it}}{S_{it}}\right) = S_{it} \frac{1}{1 - \eta} \left[\frac{C_{it}}{S_{it}}\right]^{1-\eta} \quad [8]$$

In equation [9], S_{it} represents each household's (i) size and weight at time t, and the consumption substitution elasticity with respect to each household is captured by the parameter η . According to the Uganda Bureau of Labor Statistics and the World Bank report, household demographic weighting in the data already addressed the inverse of selection probabilities, which reduces selection bias in the sampling procedures, reduces variances, and adjusts for attrition issues in the data. The adjustments were done following Rosenbum and Rubin (1984). Most studies using the panel study of income dynamics use the predicted response probabilities from a logistic regression based on the covariate to form the weighting classes or cells in the data (Gouskova et al. 2008). According the surveys, the Oxford scale is also used, in which the first adult in a household is given a weight 1; the second (spouse), a smaller weight like 0.7, and the children a much smaller weight like 0.5. The logic behind this is that there are scale economies in households, where some goods are consumed collectively and the head of household privately consumes others. Accordingly, household size and age composition are also important determinants of household consumption patterns (Villaverde et al. 2007; Curtis et al. 2015). Thus, in this essay, I assume that the weighting procedure used here is a simple function of the number of individuals in the household, thus $S_{it} = HS_{it}^b$. Now substituting this equation into equation [8] and taking log for both equation [7] and [8] and substitution [7] into [8] Phimister (1995), I have derived the inter-temporal Euler of the consumption function which I will be using to test the impact of credit constraints on consumption (see derivation in the Appendix).

$$\ln \left[\frac{C_{it+1}}{C_{it}} \right] = \frac{1}{\eta} [\ln(1 + r_{it+1}) - \ln(1 + \rho)] + b \ln[HS_{it}] + \frac{1}{\eta} \ln(1 + \alpha_I \lambda'_{it}) + \frac{1}{\eta} e_{It+1} \quad [9]$$

To estimate this equation, I adopt suggestions of Hayashi (1987) and Phimister (1995) and decompose e_{It+1} into agriculture sector-wide shock and an idiosyncratic shock as follows:

$e_{it+1} = e_{it+1}^a + u_{it+1}$ where e_{it+1}^a is the common aggregate shock to all households and u_{it+1} is individual household specific with $E[e_{it+1}^a] = 0$ and $E[u_{it+1}] = 0$ and $\text{Cov}(e_{it+1}^a; u_{it+1}) = 0$ and where $a = \frac{1}{\eta} [\ln(1 + r_{it+1}) - \ln(1 + \rho) + e_{it+1}^a]$ and $\varepsilon_{it+1} = \frac{1}{\eta} \mu_{it+1}$. Moreover, even though it is true that household variances differ across individual households and time, I assume that $\sigma_{uit}^2 = \sigma_u^2$. In addition, in this essay, I did not have to worry about computing the marginal tax rate for each household because in Uganda a statutory marginal effective tax rate (METR) is applied to the taxable income of individual households. Thus, I follow Zeldes (1989) and Phimister (1995) to write the equation [9] as follows:

$$\ln \left[\frac{C_{it+1}}{C_{it}} \right] = a + b \ln[HS_{it}] + \frac{1}{\eta} \ln(1 + \alpha_i \lambda'_{it}) + \varepsilon_{it+1} \quad [10]$$

For empirical testing, it is clear from the equation [10] above that if farm households are not credit constrained at time t, then $\lambda'_{it} = 0$. Consequently, if this hypothesis is true, information relative to market price, income variability, climate forecasts, and agricultural inputs, and variability has no power in determining or explaining the inter-temporal marginal utility of consumption equation [7] between time t and time t+1. However, if now it is true that farm households are credit constrained, then the estimated values of

$$\alpha_i \lambda'_{it} > 0 \text{ where } 0 < \lambda'_{it} < 1 \text{ and } \sum \lambda'_i = 1.$$

However, given that locally owned private banks and non-bank financial institutions (NBFIs) have gained huge market shares in Uganda, many of the collateral instruments to manage risk are not easily observable. Thus, I expect $\alpha_i \lambda'_{it}$ to be correlated with income variability due to crop failure, and other financial instruments gauging farm household borrowing constraints or repayment probabilities. As a result, proxies for domestic borrowing encompass liquidity; credit flows in addition to current income are well considered by this model. Now, ex-ante if I claim that

farm households in Uganda are credit unconstrained, our immediate conclusion will be the income and financial variables listed above at time t have no statistical power to determine ex-post the marginal utility of consumption between time t and $t+1$ in equation [7].

In addition, tighter current credit constraints mean that farm households have less access to credit. Therefore, the saving behavior hypothesized earlier is rational and the forward-looking risk averse household anticipating tighter constraints on access to credit amplifies the effect. Consequently, I would expect that farm households would opt for a buffer-stock savings. However, I am also aware that the validity of the life cycle model derived in equation [6] from Hall (1982), Phimister (1995), and Deaton (1992) is based on the orthogonality conditions embodied in the first order condition, the arbitrary assumptions of the functional form, and parameter specifications. Consequently, any violation of the modeling framework and parameter specifications and assumptions makes any rejection of an unconstrained borrowing household unclear and far from conclusive. Fortunately, using the data at hand, I can test if the variables at time t in the model can significantly determine the marginal utility of consumption between the current and next year of consumption in equation [6] and have the predicted signs as described by Phimister (1995). This means that, on one hand, if farm households are borrowing constrained, the variables, which relax the impact of credit constraints in the credit market captured by λ'_{it} should be negatively correlated with the marginal utility of consumption between the current and next year of consumption in equation [10]. The key understanding behind this approach of testing liquidity constraints is that the marginal utility of money is unobserved; therefore, I rely on indirect measures as a proxy. On the other hand, the variables that worsen the impact of credit constraints in the credit market are captured by λ'_{it} and expected to be positively correlated with the consumption ratio between time t and time $t+1$ in equation [10] (Phimister 1995, and Cole et al. 2013). Hence, LTD_{it} - farm long-term

debt is expected to be negative; STD_{it} - farm short-term debt should be positive. For instance, let's assume that farm households in Uganda randomly select the most profitable crops combined with abundant rainfall and the efficient use of fertilizers and technologies and achieve higher yields, at time t . As a result, farm revenue increases as well as profit; thus, the need for credit diminishes, and the value of λ'_{it} becomes closer to zero. If farmers are risk averse and forward looking, the persistent behavior of precautionary saving from the extra income can be channeled towards investment, and one would expect consumption at time t to increase slightly. Similarly, from the above specifications, I expect the variables would tend to lessen the impact of the borrowing constraints to be negatively correlated with the dependent variables. Thus, I expect Exp_{it} - farm experiences or business capacity to be negative since they generally do not have access to credit. I would expect DY_{it} - farm disposable income (after taxes and transfers) to be negative meaning that as farm that the lower the household is disposable income, the higher the probability of to be credit constrained in the financial market in Uganda. I would expect NW_{it} - farm net worth (total assets minus total outside liabilities) to be negative because a positive net worth means that household asset are greater than its liabilities and therefore can be used as a leverage. However, it is important to also note that even though net worth provides a good measure of household liquidity constraints, some households with positive net worth may also be liquidity constrained depending on the market value of those assets. I would expect LA_{it} - farm liquid assets to be negative since transaction costs might be high when it comes to selling land and that households are most likely to finish using their liquid assets first in the case of credit constraints. Finally, I would expect OL_{it}/TL_{it} - (farm owned land to total land ratio) to be negative.

3.6.Results

I test misspecification using the RAMSEY RESET test and perform a joint F test (Wald) on the two higher order powers of the residuals. I found that the higher order powers of the fitted values of the dependent variable are not significant, and the Ramsey RESET test suggests no evidence of functional form misspecification rejected as indicated by the test statistics which is a $\chi^2_{(7)}=14.17>12.5$ at a 5 percent level of significance. For robustness of the model, I reevaluate the model using ovtest for the Ramsey RESET test using powers of the fitted values of the dependent variable in column (2) without specifying the right and side. I fail to reject the null (H_0) that the model has no omitted variables at a five percent level of significance implying that the model passes the test. I also perform the test again using the right hand side variables to specify the powers rather than powers of the fitted values and I fail to reject the null hypothesis. However, I do not argue that this is the best model; rather, I simply argue that the model specified in column (2) is adequate according to the RESET diagnostic.

Table 9 reports the GLS estimation results of equation [10] under the hypothesis of no borrowing constraints in column (1), tested against the inter-temporal specification of the Euler equation, including the financial and income variables in column (2). All variables are estimated using robust standard errors to take into consideration heteroskedasticity. To find the suitability of fixed or random effects model, I run the Hausman specification test. If fixed effects (FE) are more appropriate, I can remove the effects of household time-invariant characteristics and capture precisely the net effect of income and other financial variables on household consumption behavior. In the FE model, time-invariant household characteristics are unique to each household and thus should not be correlated with other individual household characteristics. The rationale behind the random effects is that the unobserved individual household effect encompasses

elements that are correlated with the independent variables in the model, but not if these effects are stochastic. Results from the Hausman test indicate that the error terms are correlated, and as a result, I reject the fixed effects model as indicated by the Hausman test statistics, which is $\chi^2_{(1)} = 6.05 > 3.841$ at a 5 percent level of significance for the model estimated for equation [10] in column (1). Similarly, I reject the fixed effects model for the specification of financial variables testing borrowing constraints in column (2) as indicated by the test statistics at a 5 percent level of significance. In conclusion, the random effects GLS estimation is more efficient and consistent than FE, OLS, or pooled OLS estimation.

Table 9: Results from the Intertemporal Euler Equation

VARIABLES	(1) $\left[\frac{C_{it+1}}{C_{it}} \right]$	(2) $\left[\frac{C_{it+1}}{C_{it}} \right]$
HS _{it}	-0.0064* (0.0036)	-0.0056 (0.0036)
EXP _{it}		-0.0031 (0.0023)
LA _{it}		-2.94e-08 (0.0003)
OL _{it} /TL _{it}		0.262*** (0.0479)
FHDI		1.32e-08 (0.0002)
NW _{it}		-1.24e-10** (0.0005)
LTD _{it}		-1.03e-06 (8.09e-07)
TD _{it} /NW _{it}		0.0002*** (3.15e-05)
Constant	1.118*** (0.0254)	1.075*** (0.0281)
Observations	3,636	3,636

Column (1) estimate the Euler Equation and Column (2) estimate the Euler equation plus variables characterizing credit constraint from the test. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Column (1) reports the results from the Euler equation and indicate that the coefficient when consumers are not borrowing constrained using equation [10] is not significant. Column (2) presents the results when the variables relative to the borrowing constraint are included in the model to test the hypothesis of no borrowing constraint specified in column (1). The hypothesis is that if the life cycle model describing farm household consumption behavior is true, then all the coefficients estimated in column (2) are jointly equal to zero and have no impact on consumption. To test this hypothesis, I perform the joint test (Wald test) in column (2) and strongly reject the null, as indicated by the test statistics of $\chi^2_{(7)} = 46.58 > 12.5$ at a 5 percent level of significance. As a result, I reject the hypothesis of the model describing farm household consumption behavior in column (1). In conclusion, the life cycle model without borrowing constraint restrictions is rejected by the data in Uganda.

The total number of people within a household is negative as expected but not significant in column (2) and significant in column (1). However, even though household size affects farm households' present and future consumption, when it comes to credit constraints, household size does not significantly increase the impact of credit constraint on consumption.

The results indicate that a farm household's liquid assets if looked at carefully does not significantly lessen the impact of credit constraints. This is important since in many developing countries barriers to financial markets is an incentive for constrained households to revert to the hoarding of cereal (such as rice or millet) or non-perishable demonstration goods (such as jewelry). Moreover, this result might indicate that farm household's liquid assets are not sufficient to lessen the impact of credit constraints. Farm disposable income is positive as expected and significant statistically at a one percent level. This result suggests that farm household income is not yet enough or substantial enough to mitigate the risk of default if farmers were to be approved on loans

by financial institutions in Uganda. Moreover, even though farm household income has been increasing slightly in recent years it is still not sufficient for these households to escape out of poverty or use it as a collateral in the long run. Consequently, farm households in Uganda might consider the importance of non-farm income in non-farm activities. The variable farm net worth (total assets minus total outside liabilities) is negative as expected and significant at a 5 percent level of significance. However, even though the level of debt is not significant among farm households, the level of debt impacts farm household is total assets.

As a result, in the case of Uganda, net worth does lessen the impact of borrowing constraints on consumption. The variable OL_{it}/TL_{it} - (farm owned land to total land ratio) is positive but not negative as expected and does not lessen the impact of credit constraint on consumption. However, this result highlights the importance of land accessibility and ownership in Uganda. Land ownership for farm households in Uganda is very important and could be used as leverage to penetrate financial markets and facilitate access to credit. I argue that land tenure and titling do increase access to credit because these offer enhanced land security, which can be used as collateral. This might explain the reason why policy makers in Uganda have initiated land reform in the last ten years.

This result can be extended to all of Sub-Saharan Africa since land reform has been one of the most important and ongoing policy debates in the region. However, in the case of Uganda, policymakers need to pay greater attention to the difference between (1) farm households who have customary land versus households who have freehold land, (2) farm households with a title or leasehold having freehold versus customary tenure, and (3) households without a title or leasehold versus freehold and Mailo tenure. Net worth being negative suggests also that in the case

of Uganda the impact of short-term debt and long-term debt remains unclear but if the level of debt increases one might observe significant changes in assets accumulation.

I also investigate the variable household size for endogeneity since many other studies (Phimister, 1995, Fernandez, 2011) have used instrumental variables. Moreover, the way endogeneity enters the equation is in the case where the random effects are correlated with a level 1 covariate called level 2 endogeneity, an issue well known in a panel data setting as indicated by Hausman. I estimate the sum of residuals within groups and the sum of residuals, which are $\widehat{\sigma_U^2} = 0.000$ and $\sigma_e^2 = 0.891$ for the model specification in column (2). The test indicates that in the sample of farm households used in this essay, the variance between households is significantly less than the variance within households in the panel. Therefore, I use both variances estimated above to compute an overall measure of serial dependence with the dependent variables, which is known as the intra-class correlation coefficient estimated to $\rho = 0.0001$ as indicator of the extent of within household.

Next, I test for strict exogeneity of household size regressing family on the others regressors of equation [10] in column (2) and get the residual. Then, I estimate the full model in column (2) using the robust option and test if the coefficient of residual is different from 0. I fail to reject the null hypothesis of strict exogeneity at a five percent level. I must acknowledge that a good instrumental variable would have been ideal to use as a precautionary measure in order to apply the Hausman test for exogeneity of household size HS_{it+1} . However, I concur with Phimister's argument that the number of family members at any time period is already known by the head of household as given before deciding on consumption at time t or $t + 1$ (Phimister 1995). Thus, I argue that household size is not endogenous.

The estimation results in column (2) are consistent with the hypothesis derived from the implications of the buffer stock model, indicating that farm households are using savings, hoarded assets, or rely on off-farm activities to buffer income fluctuations (Ludvigson and Michaelides 2001, Carroll 2004, Carroll & Toche 2009, Jappelli 2008, Carroll et al. 2015).

The variable called “farmer experience” reflecting the business capacity of farm experience with credit and profitability is negative as expected, and insignificant in the case of Uganda. As a result, farmer’s experiences or business capacity in Uganda do lessen the impact of borrowing constraints on consumption but the magnitude remains unclear.

This could be due to the fact that at all times farmers are classified among the poorest of the poor in developing countries. Therefore, experience as a farmer might not incorporate information relative to farm household experience of handling credit and cannot be used as leverage. In fact, in many developing countries like Uganda, farmers are credit constrained already and struggle to access the financial market opportunities to foster their businesses. Household liquid assets are negative, but insignificant. This result suggests that even though farm household liquid assets were expected to lessen the impact of borrowing constraints, in the case of Uganda, liquid assets do not have meaningful value in terms of credit repayment and do not affect day-to-day consumption significantly. However, even though liquid assets, especially livestock and poultry and derived products, when sold in the market place are important sources of income, these cannot consistently sustain day-to-day consumption

3.7. Summary and Conclusions

In this essay, I evaluated the inter-temporal farm households’ consumption behavior when consumers and producers do not have access to financial services and, therefore, are

borrowing constrained under market imperfections in Uganda. The data used in this essay provide an understanding of farm households' resource allocations and distribution over time, such as farm household income, assets, liquidity, and net worth, as well as both short-term and long-term debt. The data also provide a deeper understanding of how farmer welfare has changed over time and the impact of land acquisition and tenure in the recent decade in Uganda.

The model estimation under the hypothesis of no borrowing constraints is tested against the inter-temporal specification of the Euler equation, including financial and income variables. Some of the variables that tend to lessen the impact of the borrowing constraints are expected to negatively correlate with the dependent variables. Some have opposite signs, and I provided some explanations about them. Similarly, the variables that tend to increase the impact of borrowing constraints were expected to positively correlate with the dependent variable.

However, the Euler equation estimation did not successfully uncover farm household preference parameters, such as the inter-temporal elasticity of substitution, which remains unresolved in the literature. From a policy standpoint, given the varieties of credit constraint definitions, one cannot just generalize its implications. I suggest that one should exercise caution because the impact of credit constraint depends on a study-specific setting and time frame, type of household or consumers' wealth distribution, and inequality.

The weakness of the model is that the life cycle model of consumption does not seem to fail consistently and remains unresolved in the literature. Moreover, data shortage could be a shortcoming given that in this essay I only use three years. It is desirable to use many years over a long period of time for this type of analysis. In this essay, the results suggest that farm household consumption behavior seems to be in accordance with the "buffer-stock" models of saving described in Carroll (1992, 1997) or Deaton (1991) over the household's working lifetime in

Uganda. Moreover, the presence of credit constraints in Uganda implies that land titling or subsidy programs targeting farm households in Uganda are more likely to boost aggregate consumption and national income via access to credit.

When farm households believe that income is stationary, assets like land act as a buffer stock when borrowing constraints are severe. Consequently, future studies should investigate why farm households in Uganda hold assets instead of investing in agriculture. Another important issue of farm consumption behavior in the case of developing economies is how to develop ways to analyze the interrelation between monetized transactions and in-kind flow transactions. The problem is that the theory on consumption and liquidity constraint itself may need modification to accommodate the in-kind flows in the agricultural sector in the system, especially for developing economies in Sub-Saharan Africa. Further study could evaluate evidence on excess sensitivity tests to predict income changes and estimate the marginal propensity to consume out-of- income to better assess credit limits and creditworthiness.

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CHAPTER 4: THE DETERMINANTS OF OFF-FARM LABOR SUPPLY IN SUB-SAHARAN AFRICA: EVIDENCE FROM UGANDA

4.1.Introduction

Farm households in Uganda rely heavily on subsistence agriculture as the main source of their income, consumption, and welfare. Consequently, agricultural shocks do negatively impact their income earning capabilities and make farmers vulnerable to persistent variations and a significant level of uncertainties. To cope with these challenges, farm households have developed a number of strategies and mechanisms to mitigate these risks. One of the most common strategies for dealing with agricultural shocks is working off-farm.

Uganda's labor force is estimated to be 9.8 million for persons aged between 16-64 years, of which 53 percent are female, 85 percent of the workers live in rural areas, and 75 percent below 40 years of age are self-employed. In the data, close to 39.50 percent have either no education or have only attained primary education, which indicates that the majority of the people engaging in the off-farm labor supply have no skills besides farming. Thus, in this essay, the household is defined as all members of the family living in the same dwelling space who acknowledge a common household head and eating together. In Sub-Saharan Africa and specifically in Uganda, research has established that agrarian households not only experience income uncertainty and credit restrictions, but they also face challenges in meeting debt obligations (Bongaarts 2001; Beaman 2011). Mishra and Goodwin's study (1997) shows that if farmers are risk averse, it is likely that subsequent income variability leads to a significant increase in the off-farm household labor supply (Rosenzweig and Stark 1989; Kochar 1999; Fafchamps 1999; Diagne et al. 2000).

The findings of Holden et al. (2004) demonstrate that in Ethiopia, access to low-wage off-farm income is constrained by lack of employment opportunities since households otherwise would be willing to engage in off-farm income rather than improving investments in water conservation and land degradation. Bardhan and Udry (1999) show that the inexistence of comprehensive insurance and credit markets push households to engage in off-farm income to stabilize the stream of income to hedge risks (Abdulai and CroleRees 2001). For instance, Kazianga and Udry (2006) find that households rely solely on self-insurance in the form of adjustments to grain stocks to smooth out consumption and there is no risk sharing among them. Thus, access to credit, education level, cash crop field and the proportion of land allocated to cash crop, remittances, distance to nearest market or public place, asset level, number of children, and the age of head of household could be determinants to understanding engagement in off-farm income.

Beyene (2008) argues that very few studies had investigated the push factors or determinants of rural and urban farm households to participate in non-farm production and off-farm labor supply, especially in developing countries. Beyene's conclusion about the paucity of studies on the factors of determinants in urban and rural households' participations in off-farm economic activities is consistent with existing literature. Beyene further asserts that existing studies in rural non-farm income in Sub-Saharan Africa have focused on the characteristics and determinant of micro-enterprises, measuring the share of non-farm income in total revenues and employment (Abdulai and Delgado 1999). Arguably, few existing studies in the literature have made substantial efforts to identify the constraints to income diversification (Reardon et al. 1992). However, findings from past studies in the empirical literature on this subject are mixed and thus require further investigation for a more nuanced documentation of factors driving income diversification (Abdulai and CroleRees 2001).

This essay on the push factors for off-farm economic activities among agrarian households in Uganda contributes to the literature by examining the determinants of off-farm labor and possible policy actions to reverse trends that are undermining the development of agriculture in Uganda. I hypothesize that as long as the mean earnings in the informal economy, which is 60 percent of local economies, are higher than those of farming, off-farm hours will crowd out on-farm activities. If this is true, then households in similar settings will tend to take on longer-term positions of livelihood security rather than merely focusing on sustainable income earning in agriculture. This essay, more specifically, investigates participation decisions in off-farm work in Uganda and hours on off-farm labor and compares it to a single decision-making process. I use Tobit and Cragg's double hurdle models on the data collected from the new household surveys of the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) from 2009 to 2011. The double hurdle model is used to estimate the decision to engage in off-farm work and hours of work.

I find that occupational flexibilities in the informal sector in Uganda are the main driver of off-farm income determined by some predictor variables used in this essay relative to the head of household. The decisions of the head of household to engage in off-farm activities and hours of work supplied in the market are generated by two different decision making processes. As a result, in this essay a "two-tier" or double hurdle model is more appropriate compared to the Tobit specification. Moreover, a head of household who completed a formal education above the primary level engages less in off-farm work at the prevailing market wage *ceteris paribus*. The lowest wage at which an educated head of household is willing to work off farm given the current activities in the labor market is above the current market wage. However, in the data used in this essay, 39 percent of heads of household with no formal education remained engaged in agricultural work,

relative to those who completed primary or level A education (41 percent). I find that 25 percent of working individuals with educations beyond the secondary level remained in the non-agriculture sector. Additionally, if heads of households decide to join off-farm work, they are likely to supply more hours.

The rest of the paper is organized as follows. Section II reviews the literature. In Section III, I describe the data. In section IV, I present the model and conceptual framework applied in the study. Section V and VI discuss the study results and conclusions respectively.

4.2.Literature Review

In this section, I focus the review of the existing literature on the determinants of off-farm labor supply in both developed and developing countries. This is very important because many studies have also shown that household labor supply in developed economies tends to decrease significantly in the presence of credit availability, cash support programs, and government subsidies (Mishra and Goodwin 1997, 2001; Fink et al. 2014). Similarly, in developing economies, existing studies document that places where households share resources among themselves and across villages, the effect of income variability might be overlooked or underestimated (Obaa and Mazur 2016). This shows that the issue of off-farm income is happening not only in developing countries but also in developed economies. Russell et al. (2013) show that 90 percent of all income for farm households in the US came from off-farm activities in 2008. Therefore, one can argue that global economic crises and financial contagion send strong disturbances into farm households (Russell et al. 2013). However, many scholars argue that dependence on off-farm income varies by agricultural enterprise type and location, especially when crop area, land size, and cash crop revenues are negatively correlated (Briggeman 2013;

Gibbs et al. 2005; Mishra and Goodwin 1997, 2001). Barrett et al. (2001) posit that if a difference is to be made, it goes along the sectorial and spatial lines of every study's context. In Mexico, de Janvry and Sadoulet (2001) find that on average off-farm income accounts for 55 percent of total household income, increasing from 38 percent on the largest farms to 77 percent on the smallest. Howard and Swidinsky (2000) model the off-farm labor supply using separate off-farm labor participation and off-farm labor supply equations and find that age, education, and wages have significant and opposite effects.

Many studies on off-farm income focus on the U.S. and Canada, and those attempt to draw similarities between farmers' behaviors in these two countries (Mishra and Sandretto 2002; Scharf and Rahut 2014; Howard and Swidinsky 2000). Poon and Weersink (2011), using Statistic Canada's Farm Micro-Longitudinal Dataset of 17,000 farm operators, demonstrate that the coefficient of variation (CV) in farm income is significantly greater than that for off-farm income. However, on-farm income and off-farm income are inversely related to the magnitude of the income provenance. Chaplin et al. (2004) use a multinomial logit in Central European countries to identify the degree of non-agricultural farm diversification in households and corporate farms.

In developing countries, however, the traditional image of farm households exclusively focused on farm labor supply income (Dethier and Effenberger 2012). As a general pattern, the few studies existing in the literature have used a probit model (Lim-Applegate et al. 2002; Bharadwaj and Findeis 2013). For instance, in their paper, Fink et al. (2014) have dealt with similar challenges in trying to isolate the effect of credit availability on off-farm labor income using ATE (average treatment effects). For people leaving the farm, informal employment is often the "first stop" and is usually in petty trades and services where the barriers to entry are low (Adams 2008). Babatunde (2013) adopts a farm production outcome model to study whether off-farm income is

used to complement or substitute for income in Nigeria. He finds that an increase of 100 Naira (Nigeria) in off-farm income reduces the value of family labor input by 10 Naira. Similarly, Mathenge and Tschirley (2015) in Kenya, Maertens (2009) in Senegal, and Lamb (2003) in India concur with Babatunde's findings.

Moreover, Babatunde et al. (2010) use 220 households in Kwara State in Nigeria and find that even though limited farmland is not a major constraint, off-farm income still accounts for 50 percent of total household income. The average income of people employed in the non-farm informal sector in developing economies exceeds earnings in the farming sector (Adams et al. 2013). This corroborates my hypothesis that as long as agriculture remains the largest employer in Sub-Saharan Africa, in the presence of a lack of credit and comprehensive insurance, agricultural labor will continue to leave farmers in search of better employment in off-farm work in the informal sector.

The most relevant variables that can explain off farm employment are household characteristics including education and age (Chaplin et al. 2004), family size/household size (Mishra and Goodwin 1997), farm household disposable income (Beyene 2008), the farm household's distance to the nearest market (Babatunde 2010, 2015; Goodwin and Mishra 2004; Chaplin et al. 2004), and finally, occupation in the informal sector (Leeuwen and Dekkers 2013).

The existence of an informal sector that offers non-agricultural employment is not unique to Sub-Saharan Africa. In countries in South Asia, Latin America, and Middle Eastern and North African countries, a similar condition prevails. For example, 62 percent of the population in Sri Lanka, 84 percent in India, 42 percent in Thailand and 73 percent in Indonesia work in the informal sector. Latin America registers 51 percent with 40 percent in Uruguay and 75 percent in Bolivia.

In the Middle East and North Africa, I find 45 percent and 57 percent of the population in the West Bank and Gaza respectively work in the non-informal sector.

4.3.Theoretical Framework and Methods

The model is built on the framework that current farmers in Uganda operate and manage certain types of agricultural activities. Thus, head of households in each period must choose a certain level of consumption, hours of work on the farm, and off-farm income through labor supply and wage earned, and leisure. I relax the assumption of perfect competition to reflect realities in Uganda and let the labor market be flexible such that farm household labor allocation decisions remain in equilibrium. On the one hand, those who are engaged in off-farm jobs or are actively looking for jobs in Uganda are doing so by replying to an advertisement in newspapers or making inquiries to neighbors and public offices in their respective localities. On the other hand, those people who are not working or engaging in off-farm activities are those who have chosen not to work at the prevailing non-agricultural market wage available in the informal sector and maybe decide to enjoy leisure time.

Consequently, the decision of a head of the farm household not to work at the market wage has no effect on the aggregate demand, supply, and price of labor. The reasons are simple: if the head of a farm household chooses to work on the farm and not off-farm, it is because the marginal product of labor on-farm is greater than the wage rate prevailing off-farm. Thus, within this framework, this essay is based on the pioneering household economic model of Paxson et al. (1986), which encompasses most of the case studies analyzed so far in the literature. The primary argument of this essay echoes the ideas of Paxson et al. (1987) that farm household participation in off-farm labor is perceived as price taker characterized by the recurrence or repetitive decision-

making process. Thus, the decision to demand agricultural inputs for production and how much to consume and save out of a farm household's output directly affects labor supply both on-farm and off-farm in Uganda. As Paxson et al. (1987) posit, in countries like Uganda semi-commercial farm households that produce multiple crops with a large proportion of their land size make up a huge part of the agricultural sector. Given that farm households in Uganda combine the household spirit of consumption and the production characteristics of a firm, I draw on the conceptual frameworks of Sadoulet and de Janvry (1995) and Benjamin and Guyomard (1994) where the household is set to maximize utility that is a function of goods G for consumption at price p_g , leisure time L , and farm household income described as follows:

$$U = F(G, L^H, Y^H, F^H M^H, H_i)$$

where G denotes the good and services produced and consumed in the household. The variable L^H denotes leisure time for both the male and female as head of household. The variable Y^H denotes head of household's income, F^H , M^H denotes the vector of both the male and female characteristics, and H_i denotes a vector of head of household's characteristics. Farm households face the usual constraints relative to labor time spread between on-farm and off-farm jobs for both males and females in the household such that:

$$T^H = L_O^H + L_p^H + L^H \quad [1]$$

$$L_p^H \geq 0, L_O^H \geq 0, L^H \geq 0 \quad [2]$$

where ($H = \text{Head of Household Male or Female}$)

$$Y = \mathcal{H}(P_0, P_i, L_{i,j}^H, A, F^H, M^H, H_i) + W^H L^H + R \quad [3]$$

where L_O^H and L_p^H denote labor time spent on the farm and off-farm given that each household member is endowed with total time T^H . Y describes farm households' conditional profit function (\mathcal{H}), which depends on P_0 , the price of agricultural output, P_i , the variable price of agricultural

input, L_{IJ}^H , the *on* – farm labor of the head of the household, other fixed farm inputs A such as off-farm income, land, off-farm wage rate, remittances, machinery, household members' individual characteristics, F^H and M^H , and farm household characteristics H_i . Assuming that the usual properties of the profit function hold⁹, thus Hotelling's Lemma holds, and the optimal off-farm labor allocation with respect to time can be derived, and an interior solution is assumed for all choice variables. However, for the choice of the off-farm labor time, I cannot assume an interior solution because a farm households' off-farm labor supply can be zero. As a result, these are the first order conditions for maximum yield:

$$-\frac{\partial U / \partial L_o^H}{\partial U / \partial Y} = \frac{\partial \mathcal{H}}{\partial L_o^H} \quad [4]$$

$$-\frac{\partial U / \partial L_p^H}{\partial U / \partial Y} - \frac{\lambda^H}{\partial U / \partial Y} = W_o^H \quad [5]$$

where λ^H captures the Lagrange multiplier relative to the positive constraints on off-farm work. The equality in equation [4] describes the marginal rate of substitution between on-farm family labor supply for money income and the shadow price of on-farm labor. Equation [5] states that the marginal rate of substitution of off-farm labor supply for income surpasses the off-farm wage rate if the household members decide not to engage in off-farm activities. Consequently, the decision of any household member to participate or not participate in off-farm activities depends on the household member's reservation wage and the market wage rate. Thus,

$$L_p^H = 0 \text{ If } W_r^H \geq W_o^H \quad [6]$$

⁹The production function and profit function keeps their usual properties.

$$L_p^H = 0 \text{ If } W_r^H < W_0^H [7]$$

In equation [6], if market wages is greater than worker reservation wages, then worker decides to participate and 0 otherwise like in equation [7]. The reservation wage W_r^H in both equation [6] and equation [7] is an endogenous variable depending on the other exogenous variables in the model relative to input and output prices, farm household fixed assets, and both the individual and household characteristics. As a result, the variables that increase the reservation wage diminish the probability of engaging in off-farm activities. Similarly, the variable that increases the market wage rate increases the probability of engaging in off-farm activities or second jobs.

4.4.Data and Variables

Data used in the essay are from the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA), conducted jointly by the World Bank and the Uganda Bureau of Statistics National Data Archives from 2009 to 2011. The project was designed to develop an understanding of economic policy that accurately addresses inequality, welfare, and poverty alleviation via the development of agriculture, consumption choice, market access, and the role of gender distribution. Moreover, I consider informal characteristics of off-farm work in the market place in Uganda. For instance, the occupations in the informal sector range from food processing, clothes or shoe manufacturing, metal fabrication, wood products, handicrafts, construction, services, transportation, petty trading, and boda-boda driving. These measures looked closely into the collective aggregates measured on farm households in Uganda and describe useful stylized facts relative to off-farm income activities.

The data also provide information on the head of household's characteristics, such as age, sex, education, and ethnic group. The data also provide information on the household farm

characteristics, such as land area, cash crop activities, and the distance to the nearest public places. The data used in this essay are from three years and starts in 2009/2010 covering the district of Kampala and 72 Enumeration Areas (58 rural and 14 urban) in each of the (i) Central Region except of Kampala district, (ii) Eastern Region, (iii) Western Region, and (iv) Northern Region. In year 1 (2009-2010), 3,423 households were surveyed. In Year 2 (2010-2011), 3,716 households were surveyed.

Table 10 presents the description of the variables, and Tables 11 present the summary statistics. The variable $offarm_{it}$, indicates the decision of farm households to engage in off-farm activities which is 1 if the head of the household participates in the off-farm labor market for a wage prior and 0=otherwise. The Variable $offwkhrs_{it}$ is the time allocated to off-farm activities for wages once a household head decides to participate in them. The variable Age_{it} is the head of household's age. The variable $Educ_{it}$ is the number of years of schooling completed by the individual household members surveyed, ranging from no formal education to a completed university degree. Like Huffman (1992) and Matshe and Young (2004), the level of education captures the human capital effect on the determinants of off-farm activities, which is revealed to play an important role in labor time allocation of agricultural households in both developed and developing countries (Matshe and Young 2004). The variable $Male_{it}$ is the sex of the head of household (1=Male and 0= Female). The variable $Baganda_{it}$ is the ethnic group/tribe to which the head of household belongs. The largest ethnic group in Uganda is the Baganda (18.98 percent), followed by the Langi (9.42 percent), the Banyakole (9.17 percent), the Basoga (8.08 percent), and the Teso (7.7 percent).

Table 10: Variables Descriptions Used in Essay III

Year	Year Survey
Male	Household Head is Male who had live there in the past 12 months (1=Male and 0= Female)
Age	Age of head of Household
Offfarm	(1= If head engaged in off-farm for a wage and 0 otherwise)
Offwkhrs	Hours work off-farm in the second income generating activities (hrs)
Cropdiv	The diversity of crop grown for all plot in each household combining both diversity of crop and plots
Adulth	Adult male in the Household (numbers)
Childh	Children in the Household (numbers)
Educ	Education (1 for all who had attended secondary school or above as 1 and 0 otherwise)
AreaLand	Area of land planted for the surveyed crop year (Ha of total land own cultivated in each household)
Baganda	Ethnic Group/Tribe in which the household members belong (1 if you belong to Baganda and 0 otherwise)
Remtot	Remittance received from abroad and remittances from household members working in other areas of Uganda (shs) in cash the past 12 months
Credac	Credit access to operate farm or expand a business (1=Yes 0=No)
Tassets	Total Asset own (shs)
Distage	HH Distance from your household to the nearest public transport point/ bus stage (km)
Trunkrd	Type of road for public transportation to nearest point or bus station using trunk (tarmac/murram) or feeder road all year around (equals 1 if household is in community with a usable trunk (tarmac) road")
ToTdis	District Market price which is equal to the mean market price for each district to proxy for Trade Index between farm and off-farm prices of agricultural products (ratio, shs)

Note: (shs) is the Ugandan Shilling is the currency of Uganda. Its ticker Symbol is UGX. 1 UGX = 0.000280740 \$ and 1\$ = 3,562.01 UGX but varying with time. The inflation rate is hovering around 4percent (11/5/2016)

Table 11: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Year	5,147	2010.4	0.499	2010	2011
Male	5,147	0.701	0.457	0	1
Age	5,146	45.886	15.261	16	100
Offfarm	5,147	0.401	0.490	0	1
Offwkhrs	5,147	15.781	24.388	0	123
Cropdiv	5,147	4.358	3.377	0	24
Adulth	5,147	2.173	1.143	0	12
Childh	5,147	2.798	2.179	0	14
Educ	5,147	0.265	0.441	0	1
Arealand	5,147	3.706	14.44	0	602
Baganda	5,147	0.176	0.381	0	1
Remtot	5,147	257165.6	5626065	0	400000000
Credac	5,147	0.420	0.493	0	1
Tassets	5,147	19400000	106000000	0	3230000000
Distage	5,076	2.836	5.702	0	180
Trunkrd	5,147	0.362	0.480	0	1
TOTdis	3,780	1.389	0.886	0.125	5.5

These variables will help to capture individual shadow prices of time and reservation wages since the data did not have reliable and explicit observations regarding the ongoing market wage rate. The variables $Adulth_{it}$ and $Childh_{it}$ represent the number of adult and children in the same farm household including the nonresidents respectively. The variable $Tassets_{it}$ is the total estimated value in Ugandan shilling (shs) of household assets during the immediate 12 months prior to the survey. The variable $Credac_{it}$ is credit access, determined by asking if the household members received a credit to operate the farm or expand business in the twelve months prior to the interview with (1=Yes 0=No). The variable $RemToT_{it}$ is the total estimated amount (shs) received in cash by farm households from abroad in the twelve months prior to the interview. According to the literature, these variables and the amount of cash received as remittances might affect the decision to engage in off-farm activities and the hours of labor supply. The variable $cropdiv_{it}$ is used to understand the impact of growing multiple crops on the decision to participate in the labor market and hours to supply. The variable $cropdiv$ is calculated as follow: The diversity of crop grown for all plot in each household. $Arealand_{it}$ is the total area of land planted for the surveyed crop year in hectares using GPS. The variable $ToTdis_{it}$ is the district market price is equal to the mean market price for each district to proxy for Trade Index between farm and off-farm prices of agricultural products (ratio, shs). The term of trade index or the opportunity cost between farm and off-farm wages in the labor market relative to the reservation wage of the member of the household. The variable $Distage_{it}$ is measured in kilometers. This variable specifically describes the type of road for public transportation to nearest point or bus station using trunk (tarmac/murram) or feeder road all year around (1=Good; 0=Poor). The variable $Truncrd_{it}$ is defined as what type of road is this public transportation point/stage or practicability of roads all year around. The quality of the roads in the community is evaluated and classified as tarmac,

murram, and community road. The district road within the community access road is called district/feeder road. I expect variables explaining household characteristics to be either positive or negative. As for the age of the head of household, it enters the model in quadratic form, and I expect Age^2 to be negative, meaning that as a head of household grows older, he or she is less likely to engage in off-farm labor (Mishra and Goodwin 1997; Alasia et al. 2009). Given that land tenure determines the value of assets and long-term risk in agricultural production and investment, I expect farm household land area used for crops in a year relative to its tenure to have a negative effect on off-farm labor income. I also expect that the number of dependent children in the household to have an adverse impact on the decision to engage in off-farm work and labor supply hours. I expect variables explaining spatial characteristics (transportation costs) like distance to the nearest market or bus station and the quality of the associated tarmac or murram to have a positive effect on both the decision to engage in off-farm labor, as well as in the number of labor supply hours. Thus, the closer a market is to farm household compounds, the shorter the distance and the cheaper the head of household search costs. I also expect the available alternative sources of income like remittances to hurt off-farm labor participation and hours of work as well.

4.5. Econometrics Framework and Applications

The theoretical importance of this methodological framework is that it takes into consideration the imperfect characteristics of market conditions where agents' choices are constrained by capital stocks, credit constraints, production capacity, or climate variability. This approach also represents the head of household with an aim toward studying how household member's micro-behavior generates aggregate stylized facts in Uganda (Epstein 1999). Information about farm household individual agents is perceived as a list instead of large scale-

matrices. The heterogeneous characteristics of head of households observed in the data fully characterize a probabilistic model such as Tobit or Probit (Howard and Swidinsky 2000; Beyene 2008; Leeuwen and Dekkers 2013; Nasir 2014). Because of this complexity, I abstract from the interaction between the head of household and the rest of the members (Mertz 1991). One of the major disadvantages of the Tobit model is that the number of farm household heads who choose not to engage in off-farm activities is interpreted as a corner solution (Matshe and Young 2004). However, this argument might not always hold because some people might decide not to engage in off-farm activities due to individual preference, age, disability, education, and household related constraints. Moreover, individual members of the household who are not among the categories listed above might also decide not to engage in off-farm activities because of the reservation wage at the current ongoing labor market. Compared to the static model, where household responses do not change, I can capture individual heterogeneity in the spatial context and analyze the policy implications inherent to the spatial relation between farm households and the informal sector (Ballas and Clark 2001; Ballas et al. 2006; Tanton 2011). I map out occupations in the informal sector together with distance and the decision to engage in off-farm activities, on-farm activities, and labor hours. Even though the Tobit model is good at estimating the share of off-farm income in the total farm household's disposable income, the decision to engage and supply hours in off-farm activities poses a problem for the Tobit estimation procedures. The problem is that both the choice to work off-farm and the hours chosen to allocate are affected by the same variables. Matshe and Young (2004) provide a rich example of the influence of education on the decision to engage in off-farm labor, which is positive, and maintains an insignificant effect or negative impact on the number of hours supplied by the head of household. A two-tier model (Tobin 1958; Maddala 1986; Lee 2010) that combines Probit and truncated regression can account for off-farm labor supply

(Howard and Swidinsky 2000), but not the subsequent decision to engage in off-farm activities and the hours of work to supply. Scholars such as Senadza (2014) use a multinomial logit model to investigate the determinants of various income strategies in Ghana.

Heckman (1979, 2010) proposes a sample selection model to illustrate the two subsequent decisions. Matshe and Young (2004) point out that the decision to abstain from off-farm activities may be solely intertwined with the social or psychological aspects of the household member, or individual household members might abstain from off-farm activities because of some other relevant consideration. However, one segment of the literature suggests that the Heckman sample selection model is more flexible than the Tobit model (Goodwin and Mishra 2004). This argument relies on the fact that the corner solution implies that the decision to engage in off-farm activities means censoring or selection issues. Other scholars suggest a two-part model, which is usually estimated by a logit or probit model for the probability of observing a positive value of the outcome. However, this resembles to a greater extent the sample selection model. Another strong segment argues that the former is still too restrictive and thus the double hurdle model with a different process on the decision to participate in off-farm work and labor supply hours may be desirable (Cameron and Trivedi (1998, 2013). In this essay, the double hurdle model (Cragg 1971) is estimated since it allows for the modeling of the participation and hours allocated to off-farm work simultaneously as:

$$f(x) = \begin{cases} y_{2i}^*, & \text{if } y_{2i}^* > 0 \text{ and } y_{1i}^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

Consequently, the generalized model is motivated by a two-variable latent variable set up where the observed dependent variable is written regarding two dependent variables y_1^* and y_2^* where:

$$y_{ij}^* = x_{ij}\beta_j + \varepsilon_j, j = 1, 2 \text{ [8]}$$

$$\text{and } (\varepsilon_1 \varepsilon_2) \sim \mathcal{N}(0, \Omega) \Omega = \begin{bmatrix} 1 & \sigma_{12} \\ \sigma_{12} & \sigma^2 \end{bmatrix} [9]$$

$$\text{and } y_{2i}^* = \begin{cases} \frac{y_i^\lambda - 1}{\lambda} \text{ for } \lambda > 0 \\ \log(y_i^*) \text{ for } \lambda = 0 \end{cases} [10]$$

$$y_{2i}^* = 0 \text{ otherwise } [11]$$

The latent variables have a bivariate normal conditional distribution so that engagement in off-farm activities depends on both sets of regressors x_{i1} and x_{i2} with a possible strong or weak correlation between the error terms. The joint log-likelihood function in this framework is specified as follow:

$$\begin{aligned} \text{Log} L \approx \sum_{y=0}^L & [1 - \phi \left\{ x_1 \beta_1, \frac{x_2 \beta_2 + \frac{1}{\lambda}}{\sigma}, \rho \right\}] + \sum_{y>0} \log \phi \left\{ x_1 \beta_1 + \left(\frac{\rho}{\sigma} \right) \right\} * \frac{\left(\frac{y^\lambda - 1}{\lambda} - x_2 \beta_2 \right)}{\sqrt{1 - \rho^2}} \\ & + \sum_{y=0} (\lambda - 1) \log(y_i) + \sum_{y=0} \log \left\{ \frac{1}{\sigma} \phi \left(\frac{\frac{y^\lambda - 1}{\lambda} - x_2 \beta_2}{\sigma} \right) \right\} [12] \end{aligned}$$

However, as Matshe and Young (2004) and Balylock and Blissard (1992) argue, this general specification can collapse if the correlation between tier one and tier 2 is $\rho = 0$. However, the Tobit model is generated within this framework when it is further assumed that the probability of engaging in off-farm labor is equal to 1. Thus, each decision node within the household is considered as a social state at time t chosen by the head of household.

4.6.Results

I estimate the double hurdle or "two-tier" Cragg (1971) model and Tobit model to understand the factors affecting the determinants for off-farm labor participation and labor hours by the head of the household. Table 12 presents the results from the joint maximum likelihood estimation of the two independent processes, explaining the probability of the head of the household to decide to participate in off-farm labor and the number of hours to supply. As mentioned above, Tobit estimation results (column 3-4) are also nested in Table 12. Instead of using the usual Wald test, I perform a likelihood-ratio (LR)¹⁰ test of the null hypothesis that the parameter vector of a statistical model satisfies some smooth constraint against the alternative by using both the unrestricted and the restricted model, fitting the maximum likelihood method. The null hypothesis H_0 is that the Tobit model is not the appropriate specification, which means would mean $\beta_1 = \beta_2 / \sigma$. This test provides a valuable alternative to the Wald test, which requires only one model (the unrestricted model). Most statisticians, however, favor using the likelihood-ratio tests whenever feasible because the null-distribution of the LR test statistic is often more closely chi-squared distributed than the Wald test statistic. Thus, from the calculated LR test $\chi^2(14) = 16.541$ that is smaller than the critical value of 23.685 at a 5 percent level significance. Consequently, I fail to reject the null that the restricted model (Tobit) is not the appropriate specification. As a result, I argue that the decisions of farm households to engage in off-farm activities and the hours of work supplied in the market are generated by two different decision making processes. Accordingly, in this essay the Cragg

¹⁰ $\Gamma = -2[\ln LT - (\ln L_p + \ln LT_R)] \sim \chi_k^2$ where LT = likelihood for the Tobit model; L_p = likelihood for the Probit model; LT R = likelihood for the truncated regression model; and k is the number of independent variables in the equations.

(1971) double hurdle model is more appropriate than the Tobit specification. As a result, the assumption that the same process that drives the censoring part of the Tobit model is also driving the levels of y is shown to be problematic as in the literature.

Table 12: Result from Double Hurdle & Tobit Model

	Double Hurdle Cragg's Model		Tobit
VARIABLES	Offfarm First Tier	Offwkhrs Second Tier	Offwkhrs Tobit
Male	0.217** (0.0890)	4.666*** (0.802)	9.030*** (1.963)
Age	0.0682*** (0.0162)	0.341*** (0.126)	1.781*** (0.357)
Age ²	-0.000930*** (0.000169)	-0.00576*** (0.00114)	-0.0250*** (0.00368)
Cropdiv	-0.0796*** (0.0117)	-1.526*** (0.116)	-3.159*** (0.287)
Adulth	0.00840 (0.0358)	0.377 (0.376)	0.905 (0.855)
Childh	-0.0170 (0.0187)	-0.217 (0.179)	-0.441 (0.422)
Educ	0.860*** (0.0915)	9.895*** (0.959)	20.55*** (1.760)
Arealand	-0.00463 (0.00345)	-0.0629** (0.0283)	-0.206* (0.113)
Baganda	0.253*** (0.0961)	6.689*** (1.075)	9.507*** (2.075)
Remtot	-8.29e-08* (0.000)	-9.60e-08*** (0.000)	-2.28e-06** (0.000)
Credac	0.214*** (0.0652)	3.171*** (0.734)	6.525*** (1.612)
Tassets	6.42e-10* (3.83e-10)	5.33e-09 (0.000)	1.39e-08** (6.73e-09)
Distage	0.00551 (0.0052)	-0.0521 (0.115)	0.0342 (0.208)
Trunkrd	0.308*** (0.0713)	4.659*** (0.808)	9.882*** (1.705)
TOTdis	0.0510 (0.0396)	0.834* (0.443)	1.835** (0.902)
Constant	-1.670***	9.083***	-40.25***
Observation	3725	3725	3725
Number of Year	2	2	2

Note: I computed $\rho = \sigma_v^2 / \sigma_\epsilon^2 + \sigma_v^2 = 1.673$ which is different from 0, indicating that the panel-level variance component is important, and the panel estimator in the double hurdle model is different from the pooled estimator (Tobit). Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Based on the tests conducted, the results show a clear preference for the double hurdle model specification to identify the determinants of off-farm jobs and household labor allocations in Uganda. Moreover, looking at the variable coefficients estimated in the participation equation of the double hurdle model, the interpretation of the magnitude suggests that the probit regression coefficients provide the change in the Z score or probit index for a one-unit change in the predictor. The double hurdle estimation results in column (1) of Table 12 suggest that a head of household male are more likely to engage in of farm work and once decided to participate in the labor market the number of hours to supply also tend to increases *ceteris paribus*. Moreover as age of head of household increases both the decision to participate in the labor market and numbers of hours to supply decreases significantly. This finding is also consistent with the existing literature. Given that household decision concerning the cropping activities and cropping choice, I used the variable *cropdiv* to understand the impact of growing multiple crops on the decision to participate in the labor market and hours to supply. The variable *cropdiv* is calculated as follow: The diversity of crop grown for all plot in each household. Therefore, this measure of diversity combines both diversity of plots and diversity of crop. For instance, a household that grew only maize in 2 different plots would get a score of 2 and a household that only had one plot in which they grew maize and beans would also get a score of 2. As a result, crop diversity decreases significantly the likelihood to participate in both the labor market and number of hours supply. Moreover, if more unique crops are grown on the farm, it takes more time and attention to grow those crops. Consequently farmers would not have sufficient time to work off farm. However, in many cases in this study, households grow the same crop(s) in different plots (maize, beans). *Educ* is education and because in the sample used in this study the majority of people surveys 66% have approximately completed primary school through grade seven, I created *educ* variable which

represents all who attended secondary school or above as 1 and zero otherwise. I found that head of household who completed a secondary education above the primary level engages, in the past 12 months, more in off-farm work at the prevailing market wage. Moreover, the coefficient is significant in both participation and hours supplied. The variable arealand represents all land owned for each household and indicate that as land owned gets bigger, farmers have less time to work off farm and the impact is even more significant when it come to the decision on much hours to supply in labor. However, it is important to note that in this study not all land is cultivated, most of it was during at least the first of the two growing seasons within the past year of 2010 and 2011. But it is important to note that, the more time the head of household will allocate to the hours of labor on the farm. This also might indicate that closer to the South (where there are two rainy seasons, from March to May and September to November) and in the Northeast, with its long rainy season, heads of households have more incentive to increase income for investment in agricultural input and labor on the farm. Baganda represents the ethnic group in which the head of household belongs. In Uganda, a majority of the people who live in the central, southern, and western parts of the country belong to the Baganda ethnic group and represent the base in this analysis looking at the total population of those engaged in off-farm work. Results suggest that most likely the head of the household belonging to the dominant ethnic group has more incentive to participate in the currently available off-farm jobs. The results are significant and point out to the majority of the population surveyed comes from that ethnic group which represents approximately 17.6% followed by the Banyakole. The variable Remtot is household all remittance received from abroad. The levels of household remittances received from abroad have a significant negative effect on the hours of labor supplied and probability of engaging in off-farm work respectively. Remittances may provide extra income to fund children's educations and other related

consumption need, thus allowing the household head to enjoy more leisure. However, the magnitude and impact of remittances on the decision to engage in off-farm work also depends on the head of household's attitude toward risk and return and reinvestment into agriculture. These findings concur with the existing literature (Mishra and Goodwin 1997; Furtan 1985; Van Kooten and Thompson 1985, and Sander 1983). Moreover, the level of farm household's total assets increases the likelihood to participate in the labor market but not the number of hours supply. As a result, assets could determine the socio-economic class of the head of household, and, therefore, reduce his or her incentive to engage in off-farm work. The amount of assets held by the head of the household suggests that at some point assets can act as a buffer and prepare household against shock in an imperfect environment. The variable Credac measures credit access or financial sources in the last 12 months, by any household member who used financial institutions for loans. Household credit access is also determinants in the decision to engage in both off-farm activities and hours of labor supply. If households have access to credit the more likely it is they will engage in off-farm work, which could underline the concern over credit repayment and default.

ToTdis, which is the district market price, is equal to the mean market price for each district to proxy for Trade Index between farm and off-farm prices of agricultural products (ratio, shs). The term of trade represents the opportunity cost of household labor employed on the farm relative to off-farm wages. The district market price suggests as the mean market price increase, farmers are likely to supply more hours of work once they decide to engage off farm. The implication of this is that a household's utility could depend not merely on the household's total labor supply but also on the decision to allocate total labor between on-farm and off-farm within their own community. ToTdis is the district market price, which is equal to the mean market price for each district to proxy for Trade Index between farm and off-farm prices of agricultural products (ratio,

shs). Heads of farm households in Uganda are also very sensitive to the changes in agriculture prices in the marketplace versus those of non-agricultural products in Uganda. Distance is the distance from your household to the nearest public transport point/ bus stage (km). The result indicates that distance variable is not determinant in the decision to engage in off-farm work but determinant in the number of hours to supply. However, the impact is greater once households decide to engage in off-farm activities. One could argue however that the quality of the road could offset the negative effect of distance on the number of hours to supply significantly.

These results are consistent with findings in the literature as opposed to the empirical evidence for Zimbabwe (Matshe and Young 2004) and Ethiopia (Beyene 2008). However, the number of adults living in the household seems not to have an impact on the probability of the head of the household engaging in off-farm jobs. This result is somewhat surprising contrary to some existing studies in the literature. Matshe and Young (2004) found that the number of adults in the household increases the opportunity of the head of household to diversify income. Nonetheless, Mishra and Goodwin (1997) found that once the head of household decides to engage in off-farm work, the number of hours worked decreases as the number of children present in the house increases. The analysis in this study does clearly shed light on the impact of the number of children on the decision to engage off-farm which is clearly argued in the literature the presence of children in the farm household has a significant negative effect on the off-farm work activities. However, Matshe and Young (2004) argue that child rearing and off-farm work are not substitutes.

The amount of time allocated to labor in the farm household is modeled in terms of the structure of time where the head of the household must choose among various activities based on their opportunity cost and their relative utilities measured in terms of money. Among these choices are incomes from credit, liquid assets, and remittances that will allow one to enjoy more leisure

and income from paid work? Thus, I include the financial status of farm households to capture the impact of earned revenues and unearned income in the form of remittances and credit access. If farm households have access to credit, the probability that the head of household will enter the labor market increases significantly to a one percent level. Consequently, one can argue that in the presence of credit and insurance constraints, assets and other unearned income may improve the household's welfare and ability to work the farm. The location variable (Distage), which also captures the transaction cost of job searches and travel time to the workplace and marketplaces using the available road to the nearest bus station is describe as distage which is characterized in four categories in Uganda. Those Trunc roads are called tarmac or murram and the district road within the community access road is called district/feeder roadand define aswhat type of road is this public transportation point/stage. Distage has the expected signs and significantly affects positively hours of labor by the head of household in Uganda. But once the head of household decides to work, the type of transportation using the roads in the community has a positive effect on the hours supplied. The direct implications of this finding indicate the importance of road quality and its impact on wages, agricultural prices, and consumption in general. For robustness check, I explore the data further for multicollinearity even though variables, which are near collinearity or perfect collinearity, will be automatically dropped out from this type of estimation. However, I compute the variance inflation factors (VIF) and the reciprocal ($1/VIF$ s) to check for multicollinearity. I find that the tolerance ($1/VIF$) values for each variable were less than the commonly recommended value of 10 and I conclude that multicollinearity issues are not present.

4.7. Summary and Conclusions

In this essay, I sought to investigate the determinant of off-farm income and labor supply in Uganda. To do so, I compared simultaneously both the unrestricted model by Cragg (1971), known as the “two-tier” model or “double-hurdle,” versus the restricted model such as the Tobit. The model specifications worked well and the results indicated that the “two-tier” model is more suitable than the Tobit specification. Thus, I rejected the null that the restricted model is true. The estimation procedure follows Cragg (1971) and fits a regression model that allows these outcomes to be determined by separate processes. Moreover, the “two-tier” model goes beyond the Tobit model, which is too restrictive. Wooldridge (2002) shows that the Tobit framework assumes that a single mechanism governs the participation decision and the “amount decision” by assuming that a censoring limit depends on the same distribution as the uncensored observations.

I found that heads of households who completed a secondary level of education above the primary level engaged more in off-farm work at the existing market wage. In the data, 26.5 percent of the household heads have a secondary level of education against 73.5 who have not attained secondary education level but remained involved in agriculture. As a result, among those 26.5 percent of working persons with a secondary education level if these heads of households decided to work off-farm, they were likely to supply more hours of work off the farm. Moreover, one can argue that occupational flexibility in the informal sector in Uganda facilitates participation in off-farm income generating activities by a predominantly self-employed head of household. As a result, it is possible that given the size of the informal economy in Uganda, off-farm activities will continue to drive farmers off the farm if market imperfections, urbanization, internal migration, or credit constraints continue to hamper the development of agriculture in Uganda.

Household characteristics and their spatial location contributed significantly to the decision to supply more hours even though the impact of public transportation and road type in Uganda does

not show clear show a direct link on the decision to participate in off farm jobs. Asset endowments combined with the socio-economic status of the heads of household in Uganda established a link with decisions to work off-farm and how many hours to allocate. However, the impact of assets endowments does not shown to have an impact on the decision to supply more hours. The importance of parameters such as (1) (sex), (2) Age, (3) education and skills, (4) socio-economic status or assets, (5) ethnicity, (6) land area, (7) remittances and credit access, (8) distance and type of road have been found to be determinants in the empirical literature in almost all studies. Moreover, crop diversity, which is the diversity of crop grown for all plot in each household combining both diversity of crop and plots, is also determinants for both the decision to engage off farm and labor supply

This essay, could be improved if there were more data on wages to precisely derive the opportunity cost of off-farm wages and off-farm payments. Understanding the determinants of off-farm income is crucial in both developed and developing economies. However, the extent to which households rely on off-farm income depends on age, household size, and land tenure, the type of business, and the spatial characteristics of the environment in which they live. Future studies should test the non-parametric aspects of explanatory variables as in Pandit et al. (2013) and compare the results from a nonparametric model to a parametric approach like the double hurdle model (Figures 4.1 and 4.2).

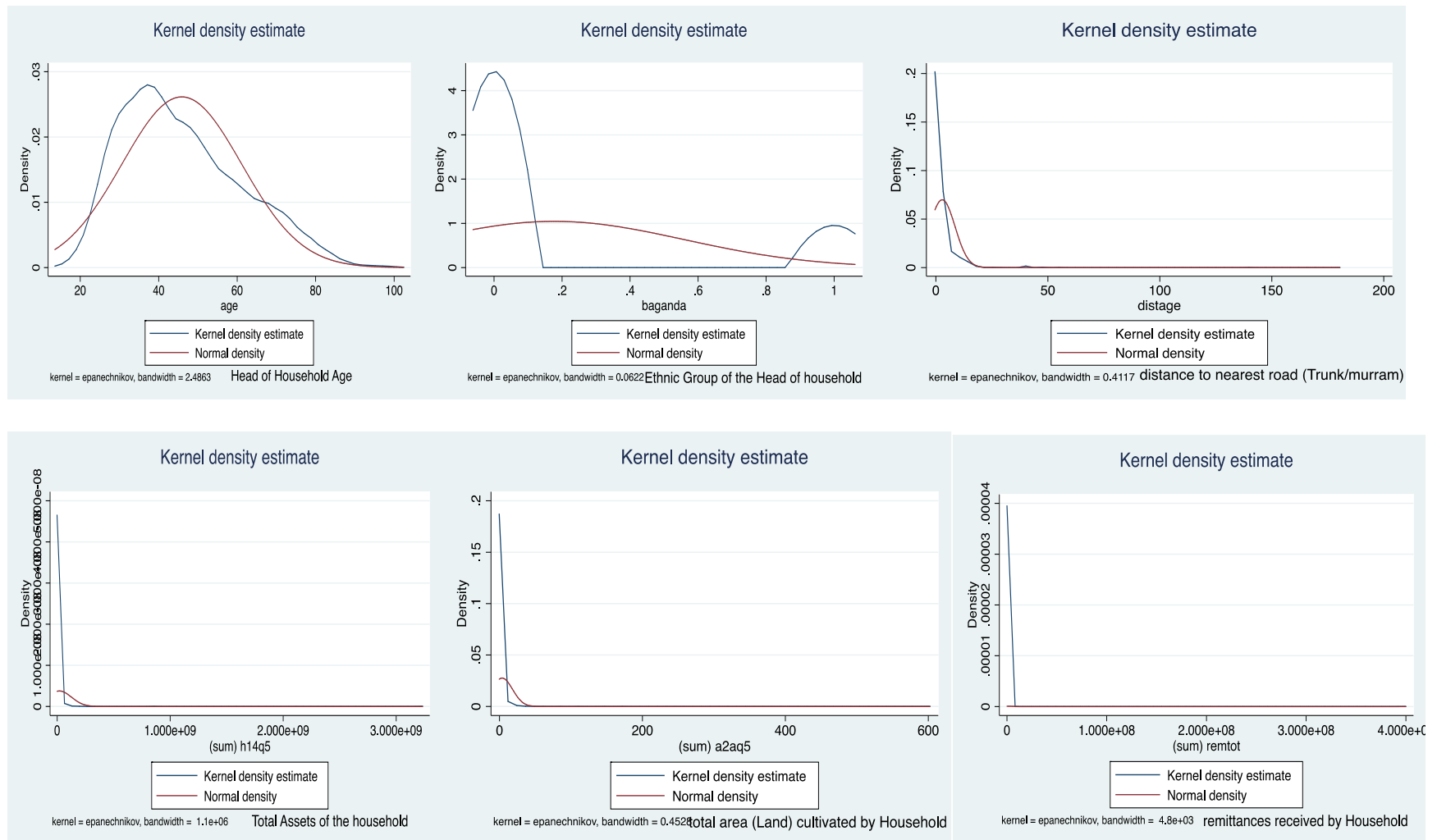


Figure 4:1: Kernel Distribution: Nonparametric Probability Density (ESSAY 3-A)

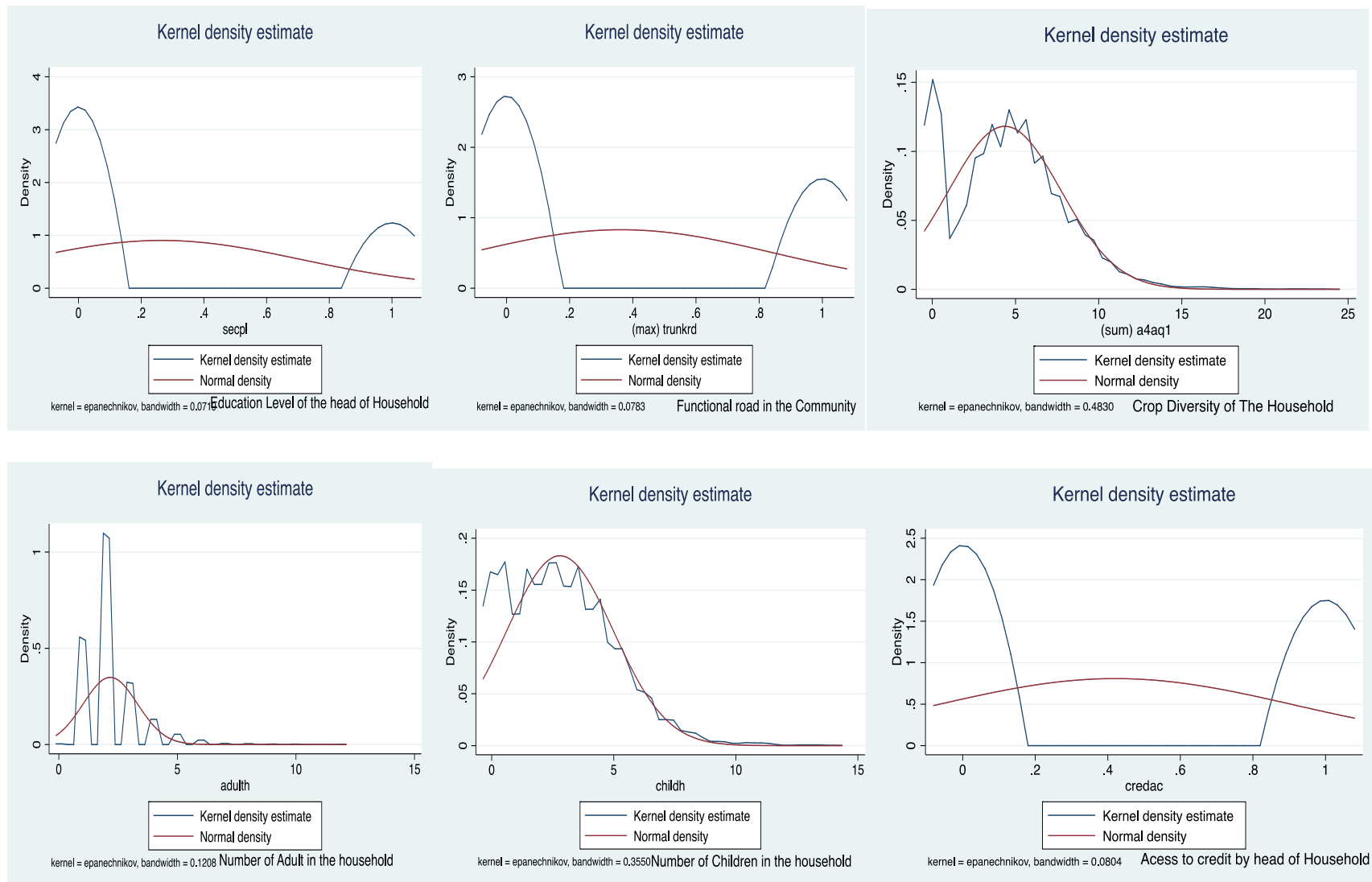


Figure 4:2: Kernel distribution: Nonparametric Probability Density (ESSAY 3-B)

4.8. References

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CHAPTER 5: Conclusions and Policy Implications

This dissertation systematically studied farm households' consumption behavior, the relative impact of credit constraints on consumption and saving, as well as the decision to participate in off-farm work in Uganda. I evaluated how suitable existing farm household models in the last 20 years attempt to describe consumption behavior and study aspects of access to credit and off-farm work in relation to agricultural development, income growth, saving, and investment in Uganda in particular, and Sub-Saharan Africa in general. Farm households in Uganda represent more than 70 percent of the labor force, and thus their consumption and saving behaviors need to be understood to alleviate poverty, combat inequality, and increase investment in agriculture in Uganda.

In Chapter 2, I draw from Phimister (1993) and develop a model to test if small household farm consumption behavior is consistent with the life cycle model of an inter-temporal optimization in the presence of market imperfections in Uganda using the Living Standards Measurement Survey (LSMS-ISA) data from 2009-2012. Unlike previous studies, the Living Standards Measurement Study (LSMS), established by the World Bank in 1980, helped explore ways of improving farm household modeling, along with the quality of the policy decision-making derived from farm household studies. The analysis reaches the conclusion that farm household consumption behavior characterized by the Euler equation and describing the life cycle model of intertemporal optimization in Uganda is rejected. In another words, the life cycle model under market imperfection does not characterize consumption behavior in Uganda. Moreover, in Chapter 2 the progress in raising the level of living standards via consumption behavior and saving under market imperfections in Uganda was monitored. One of the major policy recommendations is that

an alternative farm household model under market imperfections capable of depicting the farm's economic environment is at stake and needs to be identified. The resulting debate revisits past farm households and proposed government policies, and calls for the need to improve communication and cooperation between survey statisticians, economic analysts, and policy makers in developing countries. According to the Uganda Bureau of Labor Statistics and World Bank (2013) the sub-sampling that occurs at the level of the household while tracking at the level of the individual gave rise to a number of issues related to sub-sampling in the data¹¹. In Uganda and its surrounding countries, there is instability due to civil wars and consequently internally displaced communities seek refuge in more stable countries like Uganda. Therefore, according to the Uganda Bureau of Labor Statistics and the World Bank, the data collection procedures account for the observed baseline characteristics of farm households who moved from 2009 to 2012 using a tracking household identification number (HHID). This tracking identification allowed calculating weights for a panel survey using the predicted response probabilities from a logistic regression model based on the covariate (Rosenbaum and Rubin 1984, 2012).

In Chapter 2, I used random-effects under the generalized least squared estimation method warranted by the Hausman test under the null hypothesis that the preferred model is random vs. the alternative fixed effects. I assumed that the variation across farm households is random and uncorrelated with the predictor or independent variables included in the model. This is a reasonable assumption given the prediction I get from the data in Tables 2 and 3 showing the

¹¹Imelein, Kristen. 2013. *Weight calculations for panel surveys with sub-sampling and split-off tracking*. Policy Research working paper; no. WPS 6373. Washington, DC: World Bank. <http://documents.worldbank.org/curated/en/886921468318879957/Weight-calculations-for-panel-surveys-with-sub-sampling-and-split-off-tracking>

descriptive statistics. Derivations of the mean, overall household mean, between household mean, and within household mean in panel are all shown in Appendix E.

In Chapter 3, I evaluated the intertemporal farm households' consumption behavior in Uganda, when consumers and producers do not have access to financial services under market imperfections. In both developed and developing economies, there is an emerging consensus that credit constraints exist and do affect purchase of both durables and non-durables in consumption. The model is built around Phimister (1995) under the hypothesis of no borrowing constraints and tested against the inter-temporal specification of the Euler equation, including financial and income variables. In the case of Uganda, I took into consideration both the households' idiosyncratic and aggregate shock to model the impact of financial variables. I used the LSMS-ISA and identified the intertemporal influence of past behaviors on current behaviors while controlling for the unobserved fixed characteristics in the diagnosis. The life cycle model characterized by the Euler equation and describing farm household consumption behaviors in Uganda rejected. The presence of credit constraints in Uganda implies quantity rationing or interest rate differentials, especially when actual farm household short term and long term debt are lower than desired. Farm household behavior for precautionary saving could be justified by the relationship between borrowing constraints and income uncertainty, which also provides the motive for hoarding assets in Uganda.

Consequently, policy makers in Uganda should consider lessening the control over financial institutions as the owners and allocators of financial resources in order to let the market become free of constraints and imperfections. The economy in Uganda responded well to the changes in international development strategy and financial challenges while agriculture remained the main source of income and represented the work of more than 70 percent of total population.

Moreover, in term of access to credit, financial institutions should take into consideration that the agricultural sector is evolving and tends to be less homogenous as farm households evolve from subsistent to semi-commercial and commercial. The approach in Essay II will help readers understand risk and evaluate loan applications on a risk basis, not to consider all as financially insolvent and highly risky.

In Chapter 4, I investigated the determinants of off-farm household labor supply in both rural and urban settings in Uganda. Farm households in Uganda have developed some strategies and mechanisms to mitigate agricultural shocks via income variability. One of their strategies is participation in off-farm work for earning additional income. The chapter used also the LSMS-ISA and a “two-tier” or double hurdle model to do the estimation and the tests reject the Tobit specification in the study. I found that heads of households who completed secondary education and above engaged more often in off-farm work at the prevailing market wage. The reservation wage at which an educated head of a farm household in Uganda is willing to work off the farm is seems to match the market wage in the informal sector. However, the evidence is not yet clear since I did not have data on market wage in this study. Twenty five percent of heads of households with education above the secondary level remained in the non-agriculture sector, and if they decided to join the quest for off-farm wages, they were likely to supply more hours of work off the farm regardless of sex. The variable *cropdiv* is calculated as crop grown for all plot in each household measure diversity both diversity of plots and diversity of crop. I found that crop diversity decreases significantly the likelihood to participate in both the labor market and number of hours supply. Moreover, if more unique crops are grown on the farm, it takes more time and attention to grow those crops. Consequently, farmers would not have sufficient time to work off farm.

APPENDIX A: CORRESPONDENCE (CHAPTER 2)

Model Setup and Environments

Model Setup and Environments: With slight variations in this dissertation, Phimister derived most of these equations in his book (see Phimister, 1993).

The constraints facing the households have been reformulated using the composite variable Z_t

$$Z_t = P_t Y_t - (1 + r)d_t \quad [4]$$

Now substituting for d_t and d_{t+1} in the first set of constraints above yield the constraints in terms of Z_t and Z_{t+1} where:

$$Z_{t+1} = (1 + r)(Z_t - P_t I_t - C_t) + P_{t+1} \pi_s f(k_{t+1}) s = 1, \dots, N \quad [5]$$

Therefore, under the uncertainty environment, for any given value of C_t , Z_t , I_t , and k_t , Z_{t+1} can take at the maximum N possible values. Now within this framework, the household decision problem at time τ is equivalent to solving the dynamic programming model express as follow:

$$V_t(Z_t, k_t) = \max \left[U(C_t) + \frac{1}{1+\rho} E_t V_{t+1}(Z_{t+1}, K_{t+1}) \right] \quad [7]$$

$$1. \quad C_t \geq 0 \text{ and } I_t \geq -(1 - \delta)K_t$$

where, $Z_{t+1} = (1 + r)(Z_t - P_t^k I_t - C_t) + p_{t+1} \pi_s f(k_{t+1})$, $s = 1, \dots, N$ and

$k_{t+1} = (1 - \delta)k_t + I_t$ and it can be written:

$$V_t(Z_t, k_t) = \max[U(C_t)] \quad [8]$$

$$\begin{aligned} C_t &\geq 0 \\ I_t &\geq -(1 - \delta)K_t \end{aligned} \quad [9]$$

$$2. \quad 3. \quad Z_t - P_t^k I_t - C_t \geq 0 \quad [10]$$

$$4. \quad k_{t+1} = (1 - \delta)k_t + I_t \quad [11]$$

Now following (Blume et al, (1982) and Phimister (1993), it is assumed that both the value function and the optimal policy function C_t^* are differentiable and it can be shown that the optimal

solution to this problem is characterized by the state variable Z_t and K_t so that you can have a unique solution to this problem with a unique policy functions $C_t^* = C_t^*(Z_t, k_t)$ and $I_t^* = I_t^*(Z_t, k_t)$.

Solving for the first order conditions as usual you have:

$$\frac{\partial U}{\partial C_t} - \frac{1+r}{1+\rho} E_t \frac{\partial V_{t+1}}{\partial Z_{t+1}} = 0 \quad [12]$$

$$E_t \left[\frac{\partial V_{t+1}}{\partial Z_{t+1}} \right] + E_t \left[\frac{\partial V_{t+1}}{\partial K_{t+1}} (P_{t+1} \frac{\partial f}{\partial K_{t+1}} \pi - (1+r)P_t^k) \right] = 0 \quad [13]$$

Up to now these two equations above have not yet quiet capture the behavior of the household yielding the optimal solution characterizing the interplay between production and consumption.

Therefore, evidently I know that at the optimal solution:

$$V_t(Z_t, k_t) = \max \left[U(C_t^*) + \frac{1}{1+\rho} E_t V_{t+1} [(1+r)(Z_t - P_t^k I_t^* - C_t^*) + p_{t+1} \pi_s f(1-\delta)k_t + I_t^*] \right] \quad [14]$$

Consequently, using the differentiability feature of the optimal value function concomitantly with the first order conditions I derived the following indirect utility function which is strictly concave and increasing in Z_t , and k_t (see appendix in Phimister (1993)).

$$\frac{\partial V_t}{\partial Z_t} = \frac{\partial U_t}{\partial C_t} \quad [15]$$

$$\frac{\partial V_t}{\partial K_t} = \frac{\partial U_t}{\partial C_t} (1-\delta)P_t^k = \frac{\partial V_t}{\partial Z_t} (1-\delta)P_t^k \quad [16]$$

Obviously, for consumption I can take the expectations at time $t+1$ of the first equation above and

write $E_t \left[\frac{\partial V_{t+1}}{\partial Z_{t+1}} \right]$ and substitute it into equation [12] to have

$$E_t \left[\frac{\partial U / \partial C_t}{\partial C_t / \partial C_{t+1}} \cdot \frac{1+\rho}{1+r_{t+1}} \right] = 1 \quad [17]$$

Here in equation [17] the state of the world is revealed to the household at $t+1$ and the household will choose a specific level of consumption. Therefore, the marginal utility between $t+1$ and t is expressed as follows:

$$\frac{\partial U / \partial C_t}{\partial C_t / \partial C_{t+1}} \cdot \frac{1 + \rho}{1 + r_{t+1}} = 1 + e_{t+1} \quad [18]$$

where the term e_{t+1} capture the household struggle and innovation in solving his consumption constraint as explain in Hayashi (1985) or forecast error as in Zeldes (1989b) and Phimister (1993). Then the household capacity of production and interest rate variation is not observe or information about production and interest rate is not perfect and the state of the world at time t is even not yet fully realized. Consequently, equation [17] tells us that any available information w_t available to the household should and must be uncorrelated with the term e_{t+1} in equation [18]. As a result the relationship between the term e_{t+1} and w_t is given as follows:

$E\left(\frac{e_{t+1}}{w_t}\right) = 0$ or $(e_{t+1} \cdot w_t) = 0$, assuming that household future expectations are rational and that any information w_t available at time t has no explanatory power in explaining the left hand side of equation [18]. Therefore, one can say without loss of generality that household has optimal plans when facing multiple strategies under market imperfections at time t . thus the relationship between the left and right side of equation [17] at time t are assumed to have an impact on the prevalence of constraint and stock variables such as follows: income, debt (short term, long term), debt to wealth ratio, and land. Now using the first order conditions (FOC) in equation [15] and [16] I derive the following:

$$\frac{\partial U / \partial C_t}{\partial C_t / \partial C_{t+1}} \cdot \frac{1 + \rho}{1 + r} \geq 1 \quad [19]$$

where the inequality in [19] hold if and only if the household is not constraint by borrowing at time t . Now bringing equation [17] to the data from 2005 to 2012 I need to do some re-

parameterization beforehand and assumed constant elasticity of substitution (CES) (Shapiro (1984); Mankiw (1981); Zeldes (1989b). Consequently, for the case of east Africa if household are assumed to have identical preferences, then the substitutability function for the i th household is assumed to take the form expressed as follows:

$$U(C_{it}, Z_{it}) = \frac{C_{it}^{1-1/\eta}}{1-1/\eta} \exp(Z_{it}) \quad [20]$$

where Z_{it} represents the taste shifter and η represent the consumption substitution elasticity. Now using equation [18] under the specification of equation [20] I can derive the consumption of the household in subsequent period for each household in East Africa especially in Uganda as:

$$\frac{1 + \rho}{1 + r_{it+1}} \left[\frac{C_{it+1}}{C_{it}} \right]^{1/\eta} \exp(Z_{it} - Z_{it+1}) = 1 + e_{it+1} \quad [21]$$

However, it is also important to note that I assumed that the taste shift Z_{it} has a very seductive characteristic such that the individual effect for the household is constant between the two periods and will not affect the relationship established in equation [21]. Moreover, the individual family's household taste shifter at time t is assumed to be determined in a simple fashion as a simple linear function of time invariant household component φ_i , age of the head household, A_{it} and total household size, HS_{it} in the following linear expression:

$$Z_{it} = \varphi_i + \alpha_1 A_{it} + \alpha_2 A_{it}^2 + \alpha_3 \ln HS_{it} \quad [22]$$

Here (22) the introduction of the age of the household and the taste shifter simply implies that the sub-utility function of the household is age dependent and if I substitute Z_{it} and Z_{it+1} in equation [21] I get:

$$\begin{aligned} \ln \left[\frac{C_{it+1}}{C_{it}} \right] &= \eta [\alpha_1 + \alpha_2 - \ln(1 + \rho) + \ln(1 + r_{it+1})] + 2\eta \alpha_2 A_{it} + \eta \alpha_3 \ln[FS_{it}] \\ &+ \eta \ln(1 + e_{it+1}) \end{aligned}$$

APPENDIX B: CORRESPONDENCE (CHAPTER 2)

Derivation of the Intertemporal Euler Equation (Phimister has already derived most of these equations in his book). However, in this section I derived steps by steps the model setup and results, which were used for econometric applications (see Phimister (1993)).

Following Phimister, I use equation [18] under the specification of equation [20] the consumption function of the household in subsequent period for each household can be derived as follow:

$$\frac{1 + \rho}{1 + r_{it+1}} \left[\frac{C_{it+1}}{C_{it}} \right]^{1/\eta} \exp(Z_{it} - Z_{it+1}) = 1 + e_{it+1} \quad [21]$$

However, it is also important to note that the taste shift Z_{it} has a very appealing characteristic such that the individual effect for the household is constant between the two periods and will not affect the relationship established in equation [21]. Moreover, the individual family's household taste shifter at time t is assumed to be determined in a simple fashion as a simple linear function of time invariant household component φ_i , age of the head household, A_{it} and total household size, HS_{it} in the following linear expression:

$$Z_{it} = \varphi_i + \alpha_1 A_{it} + \alpha_2 A_{it}^2 + \alpha_3 \ln HS_{it} \quad [22]$$

Here (22) the introduction of the age of the household and the taste shifter simply implies that the sub-utility function of the household is age dependent. Substituting Z_{it} and Z_{it+1} in equation [21], I get:

$$\begin{aligned} \ln \left[\frac{C_{it+1}}{C_{it}} \right] &= \eta [\alpha_1 + \alpha_2 - \ln(1 + \rho) + \ln(1 + r_{it+1})] + 2\eta \alpha_2 A_{it} + \eta \alpha_3 \ln[HS_{it}] \\ &\quad + \eta \ln(1 + e_{it+1}) \end{aligned}$$

$$\begin{aligned}
& \frac{1 + \rho}{1 + r_{it+1}} \left[\frac{C_{it+1}}{C_{it}} \right]^{\frac{1}{\eta}} \exp(Z_{it} - Z_{it+1}) = 1 + e_{it+1} \\
& = \left[\frac{C_{it+1}}{C_{it}} \right]^{\frac{1}{\eta}} = \frac{(1+e_{it+1})(1+r_{it+1})}{1+\rho \exp(\alpha_1 A_{it} - A_{it+1}) + \alpha_2 (A_{it}^2 - A_{it+1}^2) + \alpha_3 \ln([HS_{it}])} \\
& = \ln[FS_{it}] = \eta [\ln(1 + e_{it+1}) + \ln(1 + r_{it+1}) - \ln(1 + \rho) - \alpha_1 (A_{it} - A_{it+1}) - \alpha_2 (A_{it}^2 - A_{it+1}^2) + \alpha_3 \ln([HS_{it}])] \text{ where } FS_{it} = \frac{HS_{it+1}}{HS_{it}} \text{ if no variation}
\end{aligned}$$

I want to get this term to identify the parameters in the model econometrically speaking:

$$\begin{aligned}
5. \quad & \alpha_1 (A_{it} - A_{it+1}) - \alpha_2 (A_{it}^2 - A_{it+1}^2) = \alpha_1 + \alpha_2 + 2\alpha_2 A_{it} \\
& = \alpha_1 (A_{it} - A_{it+1}) - \alpha_2 (A_{it} - A_{it+1})((A_{it} + A_{it+1}))
\end{aligned}$$

the above relationship is key to this demonstration, but it is also simple math rule applied here:

$$(a^2 - b^2) = (a + b)(a - b)$$

thus, I can write

$$= (A_{it} - A_{it+1})[-\alpha_1 - \alpha_2 (A_{it} + A_{it+1})]$$

Since $(A_{it+1}) = A_{it} + P$ where $P = \text{period}$

$$\text{Then } A_{it+1}^2 = (A_{it} + P)^2 = A_{it}^2 + 2pA_{it} + p^2$$

and everything else become easy considering that $p=1$ or 1 period and that the taste shifter z_{it} for each household means that individual fixed effect which is constant between t and $t+1$ will not affect the relationship between consumption in two consecutive periods for each household:

$$\frac{1 + \rho}{1 + r_{it+1}} \left[\frac{C_{it+1}}{C_{it}} \right]^{1/\eta} \exp(Z_{it} - Z_{it+1}) = 1 + e_{it+1}$$

then I can write the following expression

$$= \alpha_1 P + \alpha_2 (2PA_{it} + p^2) = \alpha_1 + 2\alpha_2 A_{it} + \alpha_2 = \alpha_1 + \alpha_2 + 2\alpha_2 A_{it}$$

APPENDIX C: CORRESPONDENCE (CHAPTER 3)

Model Setup and Environment: With slight variations in this dissertation, Phimister derived most of these equation in his book (see Phimister, 1993). Thus, reader can also look into Phimister (1993).

In this essay, I assume that the weighting procedure used here is a simple function of the number of individuals in the household, $S_{it} = N_{it}^b$. Now substituting this equality into equation [10] and taking log for both equation [9] and [10] and substitution [9] into [10] I derived the first difference of the consumption function.

$$(11) \ln \left[\frac{C_{it+1}}{C_{it}} \right] = \frac{1}{\eta} [\ln(1 + r_{it+1}) - \ln(1 + \rho)] + b \ln[N_{it}] + \frac{1}{\eta} \ln(1 + \alpha_i \lambda'_{it}) + \frac{1}{\eta} e_{it+1}$$

To estimate this equation I adopt Hayashi (1985) and Phimister (1993) suggestions by decomposing e_{it+1} into agriculture sector wide shock and an idiosyncratic shock as follows:

$e_{it+1} = e_{it+1}^a + u_{it+1}$ where e_{it+1}^a is the common aggregate shock to all household and u_{it+1} individual household specific with $E[e_{it+1}^a] = 0$ and $E[u_{it+1}] = 0$ and $\text{Cov}(e_{it+1}^a; u_{it+1}) = 0$. Moreover, even though it is true that household variance differs across individual household and time, I assume that $\sigma_{uit}^2 = \sigma_u^2$. In addition, in this paper I did not have to worry about computing the marginal tax rate for each household because in Uganda a statutory marginal effective tax rate (METR) is applied to the taxable income of individuals' household. Following Phimister (reference), I rewrite equation (11) as follow:

$$(12) \ln \left[\frac{C_{it+1}}{C_{it}} \right] = a + b \ln[N_{it}] + \frac{1}{\eta} \ln(1 + \alpha_i \lambda'_{it}) + \varepsilon_{it+1}$$

where $a = \frac{1}{\eta} [\ln(1 + r_{it+1}) - \ln(1 + \rho) + e_{it+1}^a]$ and $\varepsilon_{it+1} = \frac{1}{\eta} u_{it+1}$

Following Phimister (1993), for empirical testing its clear from the equation [12] above if household is not credit constraint at time t then $\lambda'_{it} = 0$. Consequently, if this hypothesis is true information relative to market price, income variability's, climate forecast and agricultural inputs variability have no power in determining or explaining the intertemporal marginal utility of consumption equation [9] between time t and time t+1. As a result, Phimister indicates that the log difference in equation [12] which describe the consumption behavior of farm households becomes:

$$(13) \ln \left[\frac{C_{it+1}}{C_{it}} \right] = a + b \ln[HS_{it}] + \varepsilon_{It+1}$$

However, if now it is true that farm household is credit constraint then the estimated values of $\alpha_i \lambda'_{it} > 0$ where $0 < \lambda'_{it} < 1$ and $\sum \lambda'_i = 1$.

APPENDIX D: CORRESPONDENCE (CHAPTER 3)

Derivation of the Intertemporal Euler Equation

(CHAPTER III)

Derivation of the Intertemporal Euler Equation: see Phimister (1993) for complete steps.

However, this part is not included in Phimister derivations. He mentioned that upon request he could forward these derivations.

$$\frac{1}{1 + \alpha_I \lambda'_{it}} \frac{U'(C_{it})}{U'(C_{it+1})} \frac{1 + \rho}{1 + r_{it+1}} = \exp(e_{It+1}) \quad (8)$$

$$S_{it} U\left(\frac{C_{it}}{S_{it}}\right) = S_{it} \frac{1}{1 - \eta} \left[\frac{C_{it}}{S_{it}}\right]^{1-\eta} \quad (9)$$

$$\ln \left[\frac{C_{it+1}}{C_{it}} \right] = \frac{1}{\eta} [\ln(1 + r_{It+1}) - \ln(1 + \rho)] + b \ln[HS_{it}] + \frac{1}{\eta} \ln(1 + \alpha_I \lambda'_{it}) + \frac{1}{\eta} e_{It+1} \quad (10)$$

$$\ln \left[\frac{C_{it+1}}{C_{it}} \right] = a + b \ln[HS_{it}] + \frac{1}{\eta} \ln(1 + \alpha_I \lambda'_{it}) + \varepsilon_{It+1} \quad (11)$$

where $a = \frac{1}{\eta} [\ln(1 + r_{It+1}) - \ln(1 + \rho) + e_{it+1}^a]$ and $\varepsilon_{It+1} = \frac{1}{\eta} \mu_{It+1}$

$$\ln \left[\frac{C_{it+1}}{C_{it}} \right] = a + b \ln[HS_{it}] + \varepsilon_{It+1} \quad (12)$$

To help to understand the estimated model this derivation aimed to help understand the testing procedures in the empirical application and how the conclusion within the study is reach.

Step 1: Using equation [9] and given that $HS_{it} = S_{it}$ I total differentiate the equation.

$$\frac{U'(C_{it})}{U'(C_{it+1})} = \left(\frac{1}{1 - \eta} \right) * (1 - \eta) \left[\frac{\frac{C_{it}}{C_{it+1}}}{HS_{it}} \right] * \frac{1}{\frac{1}{\eta}} * \left(\frac{C_{it}}{HS_{it}} \right)$$

Step 2: Now under the assumption that at the beginning of the period households consumption level at time t much the household size or number of people living in the house which is equal to

1. $(C_{it} = HS_{it}) = 1$ Consequently, $C_{it+1} = HS_{it+1}$ Then the last component of the above expression is equal to 1. Moreover, the expression $\left(\frac{1}{1-\eta}\right) * (1 - \eta) = 1$.

Step 3: Thus, I can write:

$$\frac{1}{1 + \alpha_I \lambda'_{it}} \left[\frac{\frac{C_{it}}{C_{it+1}}}{HS_{it}} \right] * \frac{1}{\frac{1}{\eta}} \frac{1 + \rho}{1 + r_{it+1}} = \exp(e_{It+1})$$

Step 4: Taking the log on both part of the above expression, you can write:

$$\ln \left[\frac{C_{it+1}}{C_{it}} \right] - \frac{1}{\eta} [\ln(1 + r_{It+1}) + \ln(1 + \rho)] - b \ln[HS_{it}] - \frac{1}{\eta} \ln(1 + \alpha_I \lambda'_{it}) = -\frac{1}{\eta} e_{It+1}$$

$$\text{or } \ln \left[\frac{C_{it+1}}{C_{it}} \right] = \frac{1}{\eta} [\ln(1 + r_{It+1}) - \ln(1 + \rho)] + b \ln[HS_{it}] + \frac{1}{\eta} \ln(1 + \alpha_I \lambda'_{it}) + \frac{1}{\eta} e_{It+1}$$

Step 5: Thus, I rewrite the whole an expression as follows:

$a = \frac{1}{\eta} [\ln(1 + r_{It+1}) - \ln(1 + \rho) + e_{it+1}^a]$ and $\varepsilon_{It+1} = \frac{1}{\eta} \mu_{It+1}$ which now give the basis of testable model of liquidity constrained farm households in this chapter.

$$\text{Step 6: } \ln \left[\frac{C_{it+1}}{C_{it}} \right] = a + b \ln[HS_{it}] + \varepsilon_{It+1} \quad (12)$$

Most importantly the expressions

$$\begin{aligned} \left[\frac{1}{\eta} \ln(1 + \alpha_I \lambda'_{it}) \right] &\neq 0 \text{ or} \\ \left[\frac{1}{\eta} \ln(1 + \alpha_I \lambda'_{it}) \right] &= 0 \text{ or} \\ 0 &\leq \left[\frac{1}{\eta} \ln(1 + \alpha_I \lambda'_{it}) \right] \leq 1 \end{aligned}$$

$$\frac{HS_{it}}{HS_{it+1}} = HS_{it} \text{ when ther is no variation in family size from year to year}$$

These above possible results from the empirical estimation are the parameters, which guide the testing outcome in equation [12]. And this farm household characteristics or demographics combine with Bank and Non-bank financial institutions: Assessment of credit worthiness or repayment rate. However, these criteria differ from country to country, bank to bank, and household to household on risk basis. In the context of this study see the financial variables included in the model to bring bank and non-bank financial institutions requirements and assessments.

APPENDIX E: (CHAPTER 2 & 3 & 4)

DESCRIPTIVE STATISTICS

Tables 2, 6, and 9 display the summary statistics for all variables. The “Between Variance” statistics are computed using six parameters independent of time. The “within Variance” statistics are computed using time periods of the parameters to calculate the overall, between, and within variance for each variable

1. Individual mean : $\bar{x}_t = \frac{1}{T} \sum_t^n x_{it}$
2. Overall mean : $\bar{x} = \frac{1}{NT} \sum_i \cdot \sum_t x_{it}$
3. Overall Variance: $\sigma^2 = \frac{1}{n(T-1)} \sum_i \cdot \sum_t (x_{it} - \bar{x})^2$
4. Between Variance: $\sigma_b^2 = \frac{1}{n-1} \sum_i^n (\bar{x}_i - \bar{x})^2$
5. Within Variance:

$$\sigma_w^2 = \frac{1}{nt - 1} \sum_i \sum_t (x_{it} - \bar{x}_i)^2 = \frac{1}{nt - 1} \sum_i \sum_t (x_{it} - \bar{x}_i + \bar{x})^2$$

The overall variance is decomposed into between variation and within variation:

$$\sigma_o^2 \simeq \sigma_b^2 + \sigma_w^2$$

[illegible]

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VITA

Seydina Ousmane Sene earned his Ph.D in Applied Economics, Agiculture and Agribusiness from Louisiana States University in the United States. Prior to that, Seydina earned a Master degree in Corporate Finance with specialization in Investment, Risk Analysis, Mergers and Acquisition from Louisiana States University. Seydina also earned a graduate Certificate in Applied Econometrics from the Department of Economics at Louisiana States University. Prior to coming to Louisiana, Seydina earned a Master degree in Agriculture Economics (University of Kentucky, Lexington), a Master in Financial Economics (West Virginia University), a Master in Applied Economics, and a Master in International Development from Ohio University respectively. Seydina is certified in Bloomberg Market Platforms, and expert in Stata, Eviews, Matlab, and R.

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