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# LANDHOLDING, FOREST EXTRACTION AND POVERTY IN UGANDA

LANDEIENDOMMER, BRUK AV SKOGRESSURSER OG FATTIGDOM I UGANDA

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# **Landholding, Forest Extraction and Poverty in Uganda**

**Landeiendommer, Bruk av Skogressurser og Fattigdom i  
Uganda**

Philosophiae Doctor (PhD) Thesis

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UMB School of Economics and Business  
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## **Dedication**

To my late father, Raphael Bafokworora, a man whose hard work founded the cornerstone in my life, and who often reminded me that 'success is a cost not an endowment'.



## Acknowledgement

### *The PhD ‘walk’ between Advisor and Student:*

Advisor: ‘What does this “blah blah” mean? I think it is not necessary...’

Student: ‘... but I thought that ...’ Keeps quiet and silently grumbles saying, ‘... but the point is clear, it is easy to see what I mean. Any way let me drop this paragraph since the Advisor thinks it is unnecessary’.

A revised copy is re-submitted.

Advisor: ‘You should include “blah blah” in this section’.

Student: ‘In fact “blah blah” is in my first draft’. Responds the brave one, otherwise silence prevails.

Advisor: ‘You should incorporate “blah blah” as it is necessary’.

Such is the cyclical ‘walk’ walked by many students, but did I walk the same ‘walk’? Perhaps not, instead I was persistently reminded to write in a language that is easily understood by a ‘grandma’, which was straight but a tough walk.

Pursuing a PhD program was one thing but the continuous chase for my dreams was another. I combined the two. What seemed to be a long journey was made short not because I could, but the Grace of the Lord Almighty made it possible. I am greatly indebted to my main advisor, Professor Arild Angelsen, who not only offered me professional guidance that shaped this thesis to conform to the standards of scholarly writing without the PhD ‘walk’, but also kept his door open for parental and career guidance. I express my gratitude to my co-advisor, Professor Stein Holden, for his critical comments. Many thanks also go to Professor Ian Coxhead and Professor Gerald Shively for their valuable time and constructive criticisms that contributed to the scientific quality of this thesis.

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Finally to my dearest wife, *Alice*, and our adorable sons, *Chad* and *Shaun*. To you, there is no way I can express my appreciation, but only to say that you are special and only God knows how appreciative I am to you. Sorry for not being there when you needed me most, but know that you have a reserved place in my heart. *Alice*, your unreserved patience and unyielding love did not only reveal who you are to me, but also shaped the destiny of my career. Thank you so much and God Bless you.

Ainembabazi John Herbert  
Ås, 2012

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# Introduction



# Introduction

## Landholding, Forest Extraction and Poverty in Uganda

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John Herbert Ainembabazi

### 1 Introduction

Research in development economics has for a long time focused on the causes of rural poverty in agrarian economies and how poverty can be alleviated. The investigation so far has covered almost all possible fields that may explain rural poverty, ranging from access and ownership of productive assets (Binswanger et al., 1995; Deininger and Feder, 2001) to outbreak of negative shocks (Lybbert et al., 2004; Carter et al., 2007), adoption of risky agricultural technologies (Feder et al., 1985; Besley and Case, 1993) and economic reforms (Winters et al., 2004). Nevertheless, limited progress has been made in reducing poverty in absolute terms following the implementation of economic policy reforms in most developing countries (Winters et al., 2004; World Bank, 2008), and poverty has remained frustratingly high – especially among rural households in sub-Saharan Africa. In a quarter-century, poverty rates in sub-Saharan Africa have dropped only by three percentage points, from 54% in 1981 to 51% in 2005, while the absolute number of people living below the poverty line has nearly doubled (World Bank, 2008).

The general impression emerging from research on rural poverty is that the focus has been on identifying *who* are the poor and *why* they are poor, but the success in resolving the latter remains mixed. As Krishna (2007, p. 1947) clearly states this point: “... the major focus so far has been *whom* to target and not so much on *what* to target, which is a mistake.” Although there is no single factor solely responsible for high rates of rural poverty, access to land has been found to have a significant impact on poverty reduction (Winters et al., 2009). Indeed, the effects of land reforms resulting in land redistribution, increased agricultural growth and reduction in rural poverty are hardly contentious, and empirical support has been found in India (Besley and Burgess, 2000), Vietnam (Ravallion and van de Walle, 2008; World Bank, 2008) and China (Lin, 1997). However, these impressive effects of land reforms have not been equally manifested in

sub-Saharan Africa, although progress has been made. Land reforms have been predicted to increase land productivity in Ethiopia (Holden and Yohannes, 2002; Deininger and Jin, 2006) and in Uganda (Deininger and Ali, 2008), and the share of population below the international poverty line of \$1.25 a day decreased from 55.6% in 1999/2000 to 39% in 2005 in Ethiopia and from 57.4% in 2002 to 51.5% in 2005 in Uganda (World Bank, 2010).

Access to land is one area that has so far received much interest in the existing literature, but many specific topics have received scant attention, for example: the initial mode of land acquisition, how landholding influences the decisions pertaining the choice of production technology, and the interaction between cropping and extraction of uncultivated products like those from the forest. Understanding the dynamic nature in which landholding, among other factors, influences the choice of livelihood activities formed the motivation for this thesis. The analytical approach used in this thesis thus seeks to provide further understanding of not only Krishna's '*what*' to target for poverty reduction, but also '*when*' to take action against the identified causes of rural poverty.

In pursuit of understanding '*when*' and '*what*' to consider as the measures for reducing rural poverty, this thesis is structured under four different but linked essays. The essays analyze the differentiated responses of rural households in two dimensions: time and location. As described here briefly and in detail in individual essays, an analysis that uses such differentiated responses helps to improve our understanding of the diversity of the economy in a country like Uganda, and learn important lessons that might feed into the policy framework for development.

The first essay examines how initial landholding and the mode of land acquisition evolve into land accumulation and decumulation over time. More explicitly, the thesis tests the hypothesis that the presence of active land markets reduces the probability of land transfers through non-market transactions such as land inheritance.

The second essay seeks to understand how farmers respond to changes in crop marketing policies conditional on their resource endowments, particularly landholding. Incomplete rural markets, particularly output markets, influence the choice of agricultural production technologies and promote diversification (de Janvry et al., 1991; Kurosaki, 1995). This in turn may compel households to trade the use of land productivity

enhancing technologies for participation in commercial oriented production that increases income irrespective of associated high transaction costs (Omamo, 1998). And such tradeoffs are common among households with large landholding which encourages participation in cash crop production (Heltberg and Tarp, 2002). This motivated the hypothesis tested in this second essay: new market opportunities resulting from output price liberalization encourage participation in cash crop production, but this participation is non-linearly related to market access.

The third and fourth essays explore the livelihood strategies of rural households with limited resource endowments. The third essay examines how household resource endowments like landholding govern the rural household's decision to rely on easily accessible forests resources. Can such resources provide a pathway out of poverty? The fourth essay evaluates a government policy initiative in the form of private commercial forest plantations that aims to limit extraction of forest products by rural households. I examine how the rural households can or will withdraw from extraction of forest resources given that they have limited resource endowments such as land and livestock.

In order to understand this link between forest extraction and household resource endowments, I revisit the long held hypothesis that forest extraction is primarily for the rural poor households (Campbell et al., 2002; McSweeney, 2005) unable to lift themselves out of poverty due to limited resource endowments and the low return of most open/easy access resources. The analysis in these two essays challenges this hypothesis by showing that it is to a large extent the differences in returns to various household and village characteristics that determine forest extraction, rather than the differences in the characteristics themselves (such as land). The hypothesis is further challenged by testing an alternative hypothesis, namely: extraction of non-timber forest products that can be commercialized, such as charcoal, can lift the resource (land) poor households out of poverty.

This thesis attempts to address some of the issues above using household data collected from Uganda. The increasing demand for woody biomass as an energy source and the introduction of individual forest plantations policy (MWLE, 2001), the enforcement of economic reforms in the early 1990s resulting in abolition of state monopolized export crop marketing boards, and the land reforms since mid 1990s

resulting in active land markets (Deininger and Mpuga, 2009) make Uganda an excellent case study area to study these issues and test related hypotheses.

The structure of this introduction is as follows. Section 2 presents the general theoretical framework backed up with empirical literature. Section 3 describes the data sources and gives a snapshot of the thesis. A summary of key findings are presented in section 4. Section 5 draws general conclusions and implications.

## **2 Conceptual framework**

This section outlines the overall conceptual framework upon which empirical analyses are based. The conceptual framework builds on the sustainable livelihood approach (Ellis, 2000), which can be seen as an extension of the basic logic of microeconomic theory by including elements typically ignored in formal models due to the complexity they would impose. In developing countries – particularly in rural economies – households pursue a wide range of livelihood strategies (Ellis, 2000), which are comprised of choices and resulting activities undertaken in order to maximize household welfare (Ellis, 1998; Barrett et al., 2001a). At the core of these choices and activities lies the endowment of assets which interact with policies, institutions and processes to determine which livelihood strategy to pursue (Adato and Meinzen-Dick, 2002). These assets are categorized as: *natural* (land, forests, biodiversity and so forth), *human* (education, skills and health), *physical* (roads, transportation, farm equipment, etc), *financial* (savings, credit, insurance and remittances), *social* (social networks and memberships in associations). In this thesis, attention is given to the *natural* assets, particularly landholding and forest resources, upon which rural farm households draw their livelihood strategies. Winters et al. (2009) demonstrate that landholding dictates labor allocation among income generating activities and hence determines the economic pathways for improving household welfare.

Figure 1 presents a framework of interactions between different components and their feedbacks that shape the livelihood strategies of rural households. It is difficult to present all the interactions (feedbacks) in the figure, and hence only key interactions are stated in the figure and details are provided in the subsequent paragraphs.

The starting point of the framework is the initial access to land, as this is often argued to be the key asset that influences production decisions by rural households (Ellis, 2000). A number of empirical studies in agrarian economies show that the stock of land influences several household decisions ranging from household resource allocation to the choice of livelihood strategies and consumption decisions. Not surprisingly, Abdulai and CroleRees (2001), Barrett et al., (2001b) and Winters et al. (2009) find that larger landholding encourages rural households to participate in crop and livestock production. As a result, larger landholding increases crop income (Gunning et al., 2000) and reduces household poverty (Haddad and Ahmed, 2003; Bigsten, and Shimeles, 2008). On the other hand, smaller landholding encourages labor allocation into off-farm activities (Lanjouw et al., 2001; Woldenhanna and Oskam, 2001; Winters et al., 2009), and is an important incentive for the rural households to choose forest extraction as a major livelihood strategy (Fisher, 2004; Babulo et al., 2008; Narain et al., 2008a, b).

Underlying access to land is the initial mode of land acquisition. Land can be acquired through land markets and/or non-market transactions such as inheritance. As Figure 1 shows, initial land access is conditioned on the institutional policy framework such as land reforms, human forces such as population pressure, and the level of development of rural markets such as labor, input, output and credit markets. Land policy reforms in many developing and transitional economies have led to land redistribution and enabled the initially landless or near landless households to acquire fairly sufficient land (Besley and Burgess, 2000; Deininger, 2003; Deininger et al., 2009). Similarly, where land policy reforms – driven by population pressure – have allowed active functioning of land markets and non-market transactions such as inheritance, such transactions have facilitated land transfers from large holders to smallholders or the landless (Deininger, 2003; Holden et al., 2009).



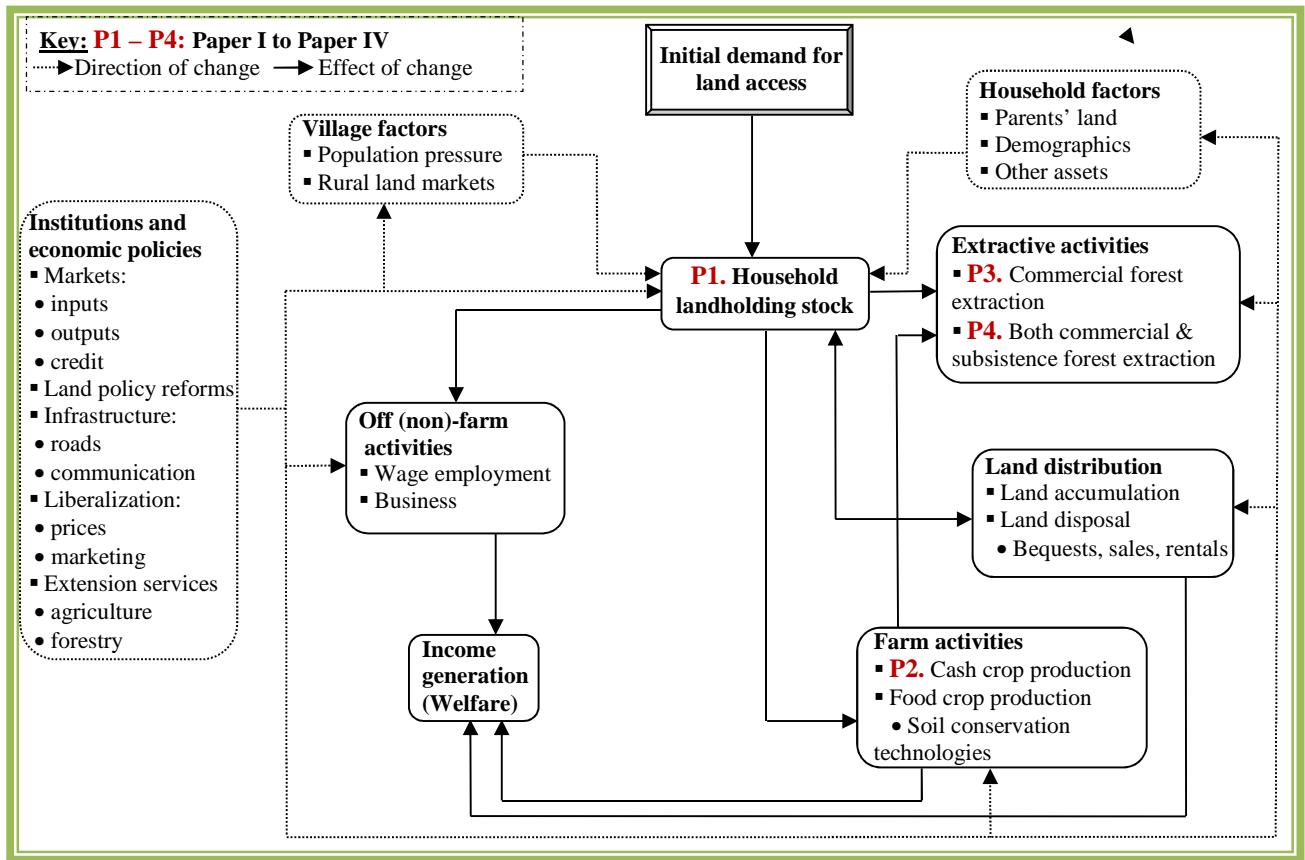


Figure 1. Landholding, resources and productivity – a schematic illustration of the papers of the thesis

The foregoing discussion underlines landholding and access to natural resources as a basis for the choice of livelihood strategies, and this prompts a practical question: when off-farm labor markets are incomplete, how do land constrained households in pursuit of welfare maximization respond to farm activities available to them?<sup>1</sup> Diminishing returns to land are likely to occur over a fixed landholding stock as initially small households expand over time resulting in high labor-to-land ratio. Further, land quality might decline over time in absence of soil fertility enhancing inputs. In this context, farm households may choose some or all of the following strategies (see Figure 1): Faced with diminishing or varying returns to land over time, farm households may

<sup>1</sup> Farm activities in this thesis are defined to include all activities in agricultural sector such as crop and livestock production, extraction of natural resource products such as forest products, fish and the like. *Off-farm* activities are often defined as all non-agricultural activities including agricultural wage labor, whereas *non-farm* activities are defined as non-agricultural wage labor including self-employment in non-agricultural activities. For easy reference, this thesis uses *off-farm* activities to include all activities except crop production, livestock production and extraction of natural resources.

undertake actions to improve land quality. The households may either choose to operate at the extensive margin if enough land is accessible or operate at intensive margin if the household is land constrained. For example, Byiringiro and Reardon (1996) find that land constrained households were associated with increased use of soil fertility enhancing technologies compared to those households holding larger stocks of land in Rwanda. However, decisions to produce at either extensive or intensive margin are influenced by population pressure and the degree at which rural markets operate (Boserup, 1965; Binswanger and McIntire, 1987; Pender, 1998).

As another option, smallholders may resort to extraction of natural resources such as forest products, which may be available as open (or at least easy to) access resources, e.g., through illegal encroachment on land owned by others. In the presence of active rural markets, including forest product markets, smallholders tend to engage in extraction of high return forest products (Fisher, 2004) to accumulate necessary income, which may provide incentives for participation in land (rental and sales) markets. At the same time, active rural markets encourage diversification in crop production such as a switch from subsistence to commercial crop production which raises household income while reducing forest dependence (Perz, 2004).

When population pressure is high and in presence of well-functioning rural markets, farm households tend to make agricultural production decisions based on the characteristics of these markets, rather than household assets and characteristics (Sadoulet and de Janvry, 1995). Even as production at extensive margin (e.g., expanding cultivated area) may imply large landholding, such production activities may also necessitate the presence of active land markets to enable households to acquire adequate land for extensive activities. The presence of active land markets may in turn influence large landholders to diversify their income portfolio into participation in land rental or sales markets. This can be expected to happen when the price for renting out land, sharecropping out land or selling land is greater than the marginal returns attained from own-operation. Similarly, if labor markets or other off-farm markets are active, households may rent out or sell land and allocate their labor time to off-farm activities<sup>2</sup>.

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<sup>2</sup> Note that even though I occasionally refer to household labor allocation, labor utilization is not a center of focus in this thesis, but the focus is on landholding.

In contrast, when the population pressure is high and farm households are unable to participate in land markets or participation is impeded by imperfections in land (rental and sales) markets, households may adopt production practices that involve intensification of input use. In absence of active output markets, intensified input use may be an alternative option for subsistence production rather than commercially oriented production. But in the presence of active rural markets and high population pressure, households switch from subsistence production to commercial production for which high crop returns are an incentive for investment in soil conservation (Pender, 1998; Lapar and Pandey, 1999; Tiwari et al., 2008).

The shift from subsistence to commercial production may also be possible where population pressure is low and rural markets are active. In this case, the development of rural markets, especially markets for crops, provides an incentive for adoption of or extensification of cash crop production. However, such a shift in production systems is conditioned on the stock of landholding among other factors. Access to large landholding is essential for cash production (Collins, 1995; Heltberg and Tarp, 2002; Challies and Murray, 2011) and high cash crop returns are associated with the use of soil conservation technologies (Pender et al., 2001; Pender et al., 2004a; Place et al., 2006).

In sum, in rural economies of developing countries, small landholding may be a major cause of low income, which makes it difficult for rural households to accumulate cultivable land. These households may be induced to respond in different ways. First, they may trade current consumption for higher participation in land markets (sales and rental) and thereby higher income in the future. Second, they may engage in extraction of natural resources such as forest products.

Conversely, with sufficient landholding, there are incentives to invest in landholding toward a desired level (that is, the landholding stock that enables a household to meet its subsistence target). All these processes evolve due to changes in population pressure, improvement and development of input and output markets, improvement in institutional policies such as land tenure, prices, property rights, and agricultural technological changes, as illustrated in Figure 1. These factors feed into local village conditions within which the rural farm households live. The village level factors such as natural resource endowment and distribution, development of infrastructure, and

population pressure are interdependent on the development of rural input and output markets, which in turn influence household level factors. These factors and their interrelationships strongly affect agricultural productivity, which again impacts on farm income and hence household welfare.

### **3 Data sources**

The data used in this thesis come from four different datasets of household surveys in Uganda. Table 1 reports how different datasets are used in different papers. The first dataset comes from two nationally representative surveys: The 1992 Integrated Household Survey (IHS) and the 1999/2000 Uganda National Household Survey (UNHS). Details of sampling procedure can be obtained from GOU (1993) and UBOS (2001). The IHS contains a random sample of 9,921 households, while UNHS collected data from 10,700 randomly selected households. The UNHS included more than 1,000 households that were surveyed in the IHS in 1992. This thesis uses a sub-sample of 532 panel households that lived in coffee producing districts.

The second dataset comes from panel household surveys carried out by Foundation for Advanced Studies on International Development (FASID), Graduate Institute for Policy Studies (GRIPS) and Makerere University (MU). The first round included 940 households in 2003, 894 households were re-surveyed in 2005, and 819 households in 2009. The sampling procedure of these panel surveys involved 94 communities from more densely populated areas in the southwest, central, eastern and parts of northern Uganda and representing seven of the nine major farming systems of the country (Figure 2). The sample excludes communities from the north and northeastern part of the country because of the insurgence at the time of the surveys. Details of the sampling procedure can be found in Yamano et al. (2004) and Kijima et al. (2006).

### Selected villages for community resource survey and mapping

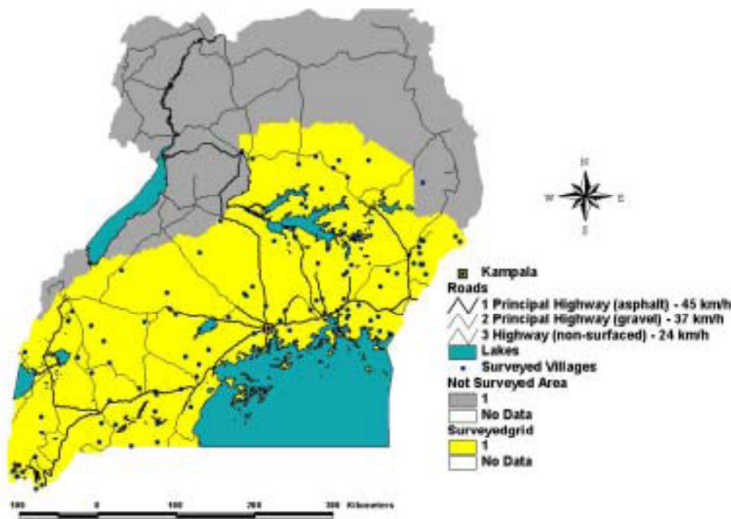


Figure 2. Sampled Communities in Uganda by FASID, GRIPS and Makerere University (Yamano et al., 2004)

The third dataset is from three districts of Uganda; Masindi, Nakasongola, and Hoima collected by the project on Natural Capital and Poverty Reduction (NCPR) funded by BASIS Assets and Market Access (AMA) Collaborative Research Support Program. These three districts are among the districts surveyed by FASID/GRIPS/MU. The districts represent some of the major producers and suppliers of charcoal for a population of more than four million people in the capital city Kampala and neighboring towns, whose majority depends on charcoal as a source of energy. A large share of these districts is covered by state owned natural forests and forest reserves. Agricultural production is the main livelihood strategy for the majority of the population, although some households engage in forest extraction for both subsistence and commercial purposes. The survey involved a purposive random sample of 300 households from 12 representative villages in the three districts.

The fourth dataset is from two districts (Kiboga and Hoima) of Uganda in the same location in which NCPR carried out surveys. The dataset comes from the study I carried out supported by International Foundation for Science (IFS). The IFS study collected household data aimed at evaluating the effects of decentralization policy of management of forest reserves from central to local government on conservation of forest reserves. The study involved 300 randomly selected households from 30 villages adjacent

to forest reserves where a government policy initiative aimed at supporting forest plantations is being applied. The policy encourages establishment of private commercial forest plantations on degraded forest reserves. Details of the policy component and sampling procedure are provided in paper IV.

The diversity of these datasets is matched with the diversity of analytical approaches to test the stated hypotheses. Paper I uses a switching regression on panel data, Paper II uses generalized linear models, fixed effects estimation and simulation models, Paper III uses quantile regression decomposition approach that does not require exclusion restrictions to control for confounding unobserved heterogeneity, and Paper IV uses difference-in-difference and decomposition approaches. Table 1 gives a summary of data sources, hypotheses, methods and key results of the papers.

Table 1: A snapshot of the thesis

<i>Key research question</i>	<i>Hypotheses</i>	<i>Data source</i>	<i>Approach and methods</i>	<i>Key results</i>
<b>Paper I: Is land inheritance an outcome of incomplete or missing land markets? How does land inheritance influence land disposal and acquisition decisions?</b>	<ul style="list-style-type: none"> <li>- The presence of active land markets limits the probability of land transfers through land inheritance.</li> <li>- Households that inherit land are less likely to involve in land purchases and more likely to sell land</li> </ul>	FASID/ GRIPS/MU	Theoretical and empirical analyses. <u>Econometric approach</u> - Tobit model - Switching regression model	<ul style="list-style-type: none"> <li>- Land inheritance is associated with the presence of imperfect land markets</li> <li>- The initially land-rich, especially those inheriting land, dispose more land than the initially land-poor</li> <li>- Land markets have equalizing effect on land distribution over time among sampled households.</li> </ul>
<b>Paper II: Does liberalization of coffee marketing lead to increased participation in coffee production?</b>	Participation in coffee production is related to distance to market centers, but liberalization has changed the specific pattern observed	UNHS/ IHS, FASID/ GRIPS/MU	Theoretical and empirical analyses. <u>Econometric approach</u> - Bivariate predictions - Generalized linear model - Fixed effects estimation - Simulation models	<ul style="list-style-type: none"> <li>- Before liberalization a pattern of primarily declining participation with distance is observed, while a bell shaped relationship is observed after liberalization</li> </ul>
<b>Paper III: Does the conjecture in literature that forest utilization is a major livelihood strategy for the rural poor in developing countries hold?</b>	Extraction of commercial non-timber forest products can lift poor rural households out of poverty	NCPR	Empirical analysis. <u>Econometric approach</u> - Semi-parametric model - Quantile regression decomposition	<ul style="list-style-type: none"> <li>- Households with few productive assets are more likely to engage in charcoal production</li> <li>- Charcoal producers are better-off than non-charcoal producers in terms of income, but worse-off in terms of resource endowments</li> </ul>
<b>Paper IV: Do commercial forest plantations reduce pressure on natural forests?</b>	Forest plantations reduce pressure on natural forests, but the effect is conditional on household resource endowments.	IFS	Empirical analysis. <u>Econometric approach</u> - Difference-in-difference model - Decomposition	<ul style="list-style-type: none"> <li>- Commercial forest plantations are weakly effective in conserving natural forests.</li> <li>- The reduction in forest use is unevenly distributed across households due to differences in location and resource endowments.</li> </ul>

## 4 Summary of key findings

The thesis consists of four papers, which cover related themes and within an overall conceptual framework as outlined above. All papers combine a more explicit theoretical approach with empirical investigation, using the four different datasets. Different methods and statistical techniques are used to test the sensitivity and robustness of the results.

The topics of the four papers are as follows: Paper I analyses the dynamics of land acquisition and in particular the impact of land inheritance on land purchases, Paper II investigates the effect of market liberalization on participation in coffee production, Paper III characterizes the households that participate in extraction of charcoal from natural forests and forest reserves, and Paper IV evaluates the effect of private forest plantations on conservation of natural forests.

### **Paper I: Land acquisition, disposal, market and non-market transactions: Evidence from Uganda**

With an emerging literature on land markets in Sub-Saharan Africa emphasizing land inheritance as the main mode of land acquisition, Paper I investigates the role of land inheritance on landholding by answering two questions: First, is land inheritance an outcome of incomplete or missing land markets? Second, does land inheritance influence long-term decisions relating to land acquisition and disposal through land markets? Household and village level data are used. Household data trace information on historical mode of land acquisition from the time of household formation up to the time when the survey was carried out. Village data provide information on land purchase and rental price and other village factors likely to explain differences in household consumption decisions.

Land inheritance (both pre- and postmortem) is the predominant mode of land acquisition followed by acquisition through land purchases and lastly through land rentals. Households inheriting land at the time of household formation come mainly from



large families headed by mostly polygamous parents and endowed with large landholding.

The paper also shows that having a high proportion of households in a village acquiring land through markets reduces the incentive of inheriting land from parents at the time of household formation. In addition, high land prices – implying high demand for land and/or scarcity of land – significantly reduce the chances of an individual inheriting land from parents after a household has been formed. This suggests that we cannot reject the hypothesis that active land markets limit land acquisition through inheritance. That is, in presence of active land markets with full information flow about land sales transactions, land acquisition through land inheritance is less likely.

However, where land access occurs through inheritance, there is limited incentive for households to invest in land. As a result there is no significant difference in landholdings between households acquiring land through inheritance and those acquiring land through land sales markets. Land disposal through sales and bequests is slightly more common among households acquiring land through inheritance. Overall, there is sufficient evidence to suggest a process of land equalization is unfolding in the sample households through land markets.

## **Paper II: Does liberalization increase export-crop participation and reduce poverty? The case of coffee market reforms in Uganda**

Declining economic growth amidst hiking trade deficits in developing economies, particularly African countries, in the late 1980s and early 1990s led to liberalization of state controlled agricultural marketing boards. Liberalization was expected to increase aggregate supply of export crops which would lead to increased government revenue and reduced poverty levels among farmers. Evidence from existing studies show mixed impacts of liberalization particularly on aggregate crop supply and household poverty. Paper II adds to the literature by responding to the following question: Did liberalization of coffee marketing board in Uganda enhance participation in coffee production and reduce poverty? Participation into export crop production or a shift from food to export crop production is an initial step to increase export crop supply. The literature review in Paper II shows that most studies have concentrated on the effect of liberalization on

export crop production but not participation into export crop production, which this paper attempts to address.

The results show that before coffee marketing liberalization, participation in coffee production decreased as one moved away from marketing centers up to a certain point after which participation was seen to increase farther away from the market centers. This means that participation was high in remote areas relative to areas closer to market centers. This was possible as farmers in some areas had a privilege to access coffee trucks roaming villages collecting coffee. Further, large landholdings are expected in more remote areas compared to less remote areas due to associated high population pressure. However, the opposite pattern is observed in later years of liberalization: participation increases with distance from market centers but at decreasing rate.

Though the results indicate that participation in coffee production significantly increased household income, a significant number of coffee farmers fell into poverty upon entering into coffee production in both early and later years after the coffee marketing liberalization. The number of new coffee adopters falling into poverty following liberalization is significantly higher than the number exiting poverty. Farmers falling into poverty are mainly those located farther away from market centers.

### **Paper III: Charcoal production and household welfare in Uganda: a quantile regression approach**

Much of the empirical literature suggests that extraction of forest products is primarily for the poor and that forest dependence (measured as the share of income derived from forests) is a major livelihood strategy for the rural poor in developing countries. Paper III uses data from both charcoal and non-charcoal producers in Uganda to illustrate that the overall effects of income derived from forest products is likely to depend greatly on the differences in household characteristics. For some households, forest products can function as a means to escape poverty.

On one hand, the empirical results confirm previous findings that younger households and those with few productive assets are more likely to participate in charcoal production to generate income. On the other hand, using quantile treatment effects, the paper shows that participation in charcoal production has a positive effect on household

income. The results further show that the observed positive effects of participation in charcoal production are explained largely by household characteristics. However, the income distribution of non-charcoal producers dominates the income distribution of charcoal producers. This is because non-producers are better-off than charcoal-producing cohorts, given the observed returns to resource endowments. Overall, participation in charcoal production appears to be a temporary means to accumulate wealth, after which exit from forest product extraction is possible.

#### **Paper IV: Do commercial forest plantations reduce pressure on natural forests? Evidence from forest policy reforms in Uganda**

A review of literature in paper IV shows that studies investigating the impact of individual forest plantations that exclude local communities on conservation of natural forests are still limited. The paper evaluates a policy initiative that encourages establishment of commercially oriented individual forest plantations in deforested and degraded forest reserves in Uganda. The policy is premised on the basis that establishment of individual forest plantations will reduce pressure exerted by local users on remaining natural forest reserves. The paper examines this policy initiative by answering the following question: Has establishment of individual forest plantations by private investors reduced extraction of forest products by rural households and hence improved the forest quality of the remaining forest reserves?

The results show that establishment of private commercial plantations on forest reserves has weakly reduced the amount of forest products extracted by rural households, by about 15 percent for the households in the intervention villages. However, this reduction is unevenly distributed among households. The findings indicate that households with higher returns to observed characteristics are associated with a significant reduction in forest extraction, while lower returns to these observed characteristics are linked to increased extraction of forest products. The implication is that for this policy initiative to succeed in conserving natural forest reserves, complementary policies that change household characteristics that reduce forest use can enhance the conservation impacts.

## 5 Overall conclusions and implications

High poverty rates among rural farm households amidst declining land productivity in developing countries remain a challenge for policy makers. This thesis offers some important insights on how rural farm households in Uganda acquire land, *how* landholding influences the choice of on-farm activities including a shift from food to cash crop production, the extraction of mainly subsistence forest products, and the engagement in commercial forest use, and for *whom* forest use is high and *why*. The main conclusions drawn in this thesis regarding these aspects of landholding are as follows:

1. Land acquisition is predominantly through inheritance in areas where land markets are incomplete. Where land inheritance is limited, acquisition is through participation in land sales and rental markets. However, a key finding is that households with initially large landholding acquired especially through inheritance are more likely to dispose of land through sales or bequests than those initially landless or near-landless. The findings suggest land markets have an equalizing effect on land ownership distribution among the sample households over time. Thus, restriction on land transaction runs the risk of increasing land inequality.
2. Where large landholding is an incentive for households to diversify their production from food to cash crop production, large landholding can be treated as a ‘necessary liability’. The findings indicate that participation in high return cash crops exacerbates poverty rates where large landholding is an incentive for participation, and where participation is a response to emergence of an output market following a trade policy change such as market (price) liberalization. In addition, large landholding is an incentive to produce at the extensive margin rather than at the intensive one (e.g., using inorganic fertilizers). This implies that while large landholding is important for income diversification, it discourages the use of soil conservation inputs which worsens land productivity and hence increased poverty levels.
3. When households are unable to acquire desired landholding and when returns to land (and other assets) are low, then households are pushed into forest extraction to

supplement their farm strategies to meet subsistence needs. Households that are poor in productive assets like landholding and livestock extract high return forest products such as charcoal from forest reserves until they have accumulated cash income to acquire productive assets, after which exit options are possible. While attaining the necessary productive assets is one option to reduce forest extraction, changing characteristics that reduce household forest use such as increasing returns to productive assets is another – often overlooked – option in policy debates. In general, policies designed to conserve forest reserves are likely to become more effective if accompanied by complementary interventions that change household assets and characteristics that reduce forest use.

Overall, access to large landholding is essential for household income diversification but not so much as the productivity of land and other productive assets. This thesis then draws two general policy implications:

- Land markets are good for both equity and efficiency. Although policies promoting active land markets can lead to land equalization, land distribution through such means without easy access to input-output markets may be a gateway to poverty for some rural farm households. Large landholding encourages a shift from subsistence to commercial crop production, but this shift can only alleviate poverty if easy access to input-output markets is guaranteed.
- Policies that affect the assets and characteristics of rural farm households that reduce forest use, such as interventions that lead to high returns to landholding or increased attainment of higher education, not only lead to improved household welfare, but are also essential for the effectiveness of policies targeting natural conservation (forests) and for more sustainable management of natural resources.

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# PAPER I



# Land acquisition, disposal, market and non-transactions: Evidence from Uganda\*

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John Herbert Ainembabazi and Arild Angelsen

## **Abstract**

A large body of theoretical and empirical literature investigates the role of land markets in land redistribution, but the attention given to the role played by non-market transactions remains limited. We approach the issue by addressing two questions: Is land inheritance an outcome of incomplete or missing land markets? How does land inheritance influence land disposal and acquisition decisions? We use a switching regression model on a balanced panel dataset of 786 households from Uganda. We find that initially landless or near landless households, due to little or no land inheritance at the time of household formation, pursue investment in landholding through land markets, while those that are land-rich dispose of land through land sales and bequests. The results suggest that a process of land equalization is unfolding within the sample.

Key words: Land access, land markets, distribution, Uganda

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## 1 Introduction

Agriculture continues to form the backbone of rural economies in sub-Saharan African countries. Farm land is a key resource and access to land determines the particular choice of livelihood strategies (Winter et al., 2009). This warrants a study on whether initial mode of land acquisition evolves into land equalization (convergence) or higher inequality over time. While the predominant mode of land access is through land markets in Asia (Deininger and Feder, 2001), land access through both market and non-market transactions is common in sub-Saharan African countries (Holden et al. 2009). Rural land markets have been extensively studied and found to play several roles which include: transferring land from large landholders to smallholders (or landless) (Baland et al., 2007; Deininger and Jin, 2008; Deininger et al., 2008b; Deininger et al., 2009), minimizing risk in exchange for less risky assets (Rosenzweig and Binswanger, 1993), overcoming credit market imperfections (Carter and Salgado, 2001), and mitigating negative shocks (Binswanger et al., 1995; André and Platteau, 1998; Deininger and Jin, 2008).

However, the empirical evidence documenting the role of land markets on land transfers through non-market transactions – such as inheritance – and how the initial mode of land access influences future landholding accumulation is relatively thin. Two research questions remain relevant and are addressed in this paper. First, is land inheritance an outcome of incomplete or missing land markets? Second, how does land inheritance influence households' later decisions on land disposal (sale) and acquisition (purchase) through markets?

An attempt to answer the first question is largely absent in the existing literature. Yet understanding how land inheritance emerges not only helps in formulating policies for active land markets and land redistribution, but the mode of land acquisition plays a significant role in soil quality conservation (Nkonya et al., 2009). An attempt to answer the second question has been made – in part – by Baland et al. (2007), who conclude that households inheriting smaller landholding accumulate land through land sales market. In addition to exploring how land inheritance emerges, our study complements the Baland et al.'s study by showing how land inheritance influences the household's decisions to acquire or dispose of land. Further, unlike Baland et al., who use cross-sectional data from rural households in central and eastern Uganda, we use panel data from rural

households sampled from all regions of Uganda, which enable us to examine how household characteristics influence land disposal and acquisition decisions over time.

Non-market land transfers are common in rural Uganda. Pre-mortem and postmortem land inheritance is the main mode of land acquisition for the majority of rural farm households (Baland et al., 2007; Deininger and Mpuga, 2009; Nkonya et al., 2009). Pre-mortem land inheritance often occurs at the time of household formation where parents hand over land to their newly married children in form of a gift. Postmortem land inheritance occurs when, following the death of household head or head and spouse, land is divided among children especially male children. The amount of land inherited often depends on the land owned by parents and number of children in the family. Thus, there is a possibility that some individuals form households without landholding (farmland), although they can gain access to land through land (sales and rental) markets.

Inequality in land distribution has remained high in Uganda. The landholding Gini coefficient during the period from 1971 to 1980 was as high as 0.59 (Okidegbe, 2001), and had slightly reduced to 0.57 by 1999 (Deininger and Okidi, 2001). The uneven land distribution in Uganda is partly due to poor land policies before mid 1990s that have since been reformed and led to emergence of active land markets (Baland et al., 2007; Deininger and Mpuga, 2009). Before 1975, a few individuals such as clan leaders or chiefs owned large tracts of land with exclusive rights granted by the British colonial administration. In 1975, a land reform decree declared all land in Uganda public and sought to reduce land fragmentation (which implied increased inequality in land distribution), promoted development of large tracts of land that were previously undeveloped, leased land to occupants up to 99 years among other functions. The 1995 Constitution abolished the 1975 land reform decree and reinstated the traditional tenure systems that had been abolished under the 1975 decree, namely: customary, leasehold, freehold and *mailo* (see Nkonya et al. (2004) and Deininger et al. (2008a) for details).

Although the 1995 Constitution reinstated the traditional tenure systems and relaxed some of the exclusive rights enjoyed by the large landholders, limitations in land transfer rights persisted under some tenure systems until 1998. For instance, holders under customary tenure system had secure tenure and the right to bequeath land to their children, but they were not allowed to sell land without approval from clan leaders and



family members. Limitations also existed under *mailo* tenure system. The *mailo* tenure is land under the king (*Kabaka*) in the central region of Uganda. There are *mailo* tenants and *mailo* owners under this tenure system. *Mailo* tenants are not allowed to put up any permanent investments without the consent of *mailo* owner. Before the 1998 Land Act, the *mailo* owner had a right to sell or bequeath land without approval of the tenant. These rules are different in the other tenure systems. Under leasehold, the owner grants the tenant exclusive possession of land for a specific period of time. The leaseholders are allowed to bequeath land or transfer the lease. Holders under freehold tenure hold registered land indefinitely and are allowed to use land in any way consistent with the laws governing land use in Uganda.

In 1998, the parliament of Uganda passed a Land Act that provides tenure security to all land users. Under this Land Act, the formerly customary land users and occupants can now obtain certificate of customary ownership with rights to sell, rent, and give away as gift or mortgage. Similarly, the Act allows *mailo* tenants to obtain certificate of occupancy that grants them right to give away, sublet, mortgage or inherit land. Unlike the colonial period of early 1900s and the 1975 land reform decree, the land reforms preserved in the 1995 constitution and the 1998 Land Act have led to land redistribution through both land market and non-market transactions. As a result, participation in land markets has increased since the 1990s, although land acquisition through non-market transactions remains predominant (Deininger and Mpuga, 2009). And, land size is shrinking for the formerly large land owners through land bequests and sales to overcome consumption expenditure (MFPED, 2002; Nayenga, 2003).

In this paper, we use an endogenous switching regression on three rounds of panel data from farm households in rural Uganda. The switching function is the probability to inherit land from parents. We find that land inheritance is more likely to occur where land markets are limited. However, households acquiring land through inheritance in the initial period are more likely to dispose of land through markets or bequests compared to other households. Related to that, the initially landless or near landless households gain access to land through active land markets, and active land markets thereby contribute to land equalization in the sample.

The outline of this paper is as follows. Section two outlines the theoretical model. Section three describes the estimation strategy. Section four presents data sources and descriptive statistics. Estimation of main results and discussion are presented in section five. Section six concludes.

## 2 Theoretical model

The theoretical model analyses the farm household's decision to buy or sell land, given the amount of land inherited at the time of household formation (THF) and other household and market characteristics. We develop a static model, implying that the model relates to the second question asked in this paper, and that we do not model the first choice of parents, namely determining how much land to bequeath to their children. Further, it might have been relevant to split the land sale/purchasing decisions of the households into several periods. However, given the non-separability (of consumption and production decisions) in the model, i.e., the shadow wages are endogenous, this would complicate the analysis, and the simple model is sufficient to theoretically establish the link between key variables that are to be tested in the empirical analysis.

We use a Chayanovian model approach, which assumes that farm households maximize utility with a choice between consumption and leisure in a setting where markets are imperfect (e.g., Chayanov, 1966; Singh et al., 1986; Sadoulet and de Janvry, 1995). Of particular relevance in our model is the imperfection in the labor market. The effects of missing or imperfect rural markets (for labor, land and capital) on land and labor transactions have been studied extensively in development economics (e.g., Eswaran and Kotwal, 1986; Singh et al., 1986; Carter and Wiebe, 1990; Sadoulet and de Janvry, 1995; Bhalotra and Heady, 2003; Takasaki, 2007). In this paper, we focus on how imperfections in land and labor markets influence investment decisions in land accumulation conditional on land inheritance. The household seeks to maximize utility given by:

$$U(c, l^l) \tag{1}$$

where  $c$  is consumption and  $l^l$  is leisure time of the household. We assume that:

$$U_c, U_l > 0; U_{cc}, U_{ll} < 0; U_{cl} = U_{lc} = 0$$

where subscripts denote partial derivatives. To simplify comparative statics, and without any loss of generality, we have assumed that the utility function is additive.

The household uses its resource endowments of labor and land to generate agriculture income. The household has an initial inherited landholding, and can augment the land through land purchases, but this comes at a cost. Alternatively, the household can sell a proportion of the land inherited and get an additional income that can be spent on higher consumption and/or more leisure. Finally, the household can engage in off-farm work and earn wage income. We assume that all income earned is used for consumption (since this is a one period static model, no savings or borrowing are included). Consumption is then given by:

$$c = pf(l^a, h^l + h^p) - h^p v + w l^o \quad (2)$$

where  $p$  is agricultural output price,  $l^a$  is family labor used in agriculture,  $h^l$  is land inherited,  $h^p$  is net land purchased that can be either positive or negative,  $v$  is the land price,  $w$  is the wage for off-farm work, and  $l^o$  is the amount of off-farm work. For later use, we also define total land as:

$$h = h^l + h^p \quad (3)$$

We assume that the labor market is imperfect such that  $l^o$  is fixed. This is a fundamental assumption that changes the logic of the model as it makes the shadow wage of the household endogenous (see Angelsen, 1999 for an elaboration, or the general references cited above).<sup>3</sup>

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<sup>3</sup> To focus on the key problem of the paper, equation (2) also excludes use of hired labor and other incomes such as remittances (which would be simple extensions of the model). It also assumes away credit income. We assume that credit markets are imperfect such that the household cannot borrow. Although we attempt to relax this assumption in empirical analysis, it is based on the fact that rural farm households are often rationed out of capital markets due to lack of collateralizable assets (Boucher et al., 2008), and indeed rural farmers in Uganda have limited access to credit markets (Mpuga, 2010).

The production function is assumed to have standard properties, in particular we make the reasonable assumption that land and labor are complementary inputs:  $f_b, f_h > 0$ ;  $f_{lb}, f_{hh} < 0$ ;  $f_{lh} = f_{hl} > 0$ ;  $f_{ll}f_{hh} - f_{lh}^2 > 0$ .<sup>4</sup>

The labor constraint is given by:

$$L = l^l + l^a + l^o \quad (4)$$

with  $L$  as the total labor time available to allocate on the three activities.

Substituting (2) and (4) into (1), and maximizing utility, the familiar first order conditions are:

$$pf_l - z = 0 \quad (5)$$

$$pf_h - v = 0 \quad (6)$$

$$z = \frac{U_l}{U_c} \quad (7)$$

Condition (5) states that the marginal productivity of agricultural labor equals the shadow wage rate ( $z$ ), which is the marginal rate of substitution between consumption and labor time (7). We also assume that the off-farm labor market constraint is binding for the household, that is,  $w > z$  (Angelsen, 1999). Condition (6) states that a household will purchase (sell) land until the value of the marginal productivity of land equals the land price.

The model is given by equations (1) to (7), and has the following endogenous variables:  $U, c, l^l, l^a, h^p, h, z$ . Exogenous variables are:  $h^l, L, l^o, p, v, w$ . For the purpose of the paper, we focus on changes in land inherited ( $h^l$ ) and off-farm labor opportunities ( $l^o$ ), and their impact on land purchases or sales ( $h^p$ ), and put forward the following propositions (proofs are provided in Appendix A):

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<sup>4</sup> The assumption of decreasing returns to scale in the production function ( $f_b, f_h > 0$  and  $f_{lb}, f_{hh} < 0$ ) implies that there is an optimal landholding size attained through sales and purchases, that is, there exists a single equilibrium and there is no 'land-poverty' trap. While we recognize the effects of this assumption in our model, we relax this assumption in the empirical analysis by testing whether there exists multiple equilibria in landholding in the sample households.

**Proposition 1:** *Higher land inheritance ( $h^l$ ) reduces land purchase ( $h^p$ ). Further, the reduction in  $h^p$  is larger than the increase in  $h^l$ , implying that higher  $h^l$  reduces the optimal landholding ( $h^*$ ).*

**Proposition 2:** *Increased availability of off-farm work ( $l^o$ ) reduces land purchases ( $h^p$ ).*

Regarding the first proposition, contrast our model to one with fixed  $z$  (unconstrained in the labor market, such that  $z = w$ ), where the impact of land inheritance on the optimal land holding would have been zero, that is, for every acre of more land inherited, the household would have bought one acre less. In this model, there is however a consumption (income) effect of land inherited: higher consumption raises the shadow wage rate ( $z_c > 0$ ). This results in less labor supplied to the family farm, and given complementarity,  $h^*$  is reduced. Thus, as an interesting result of the model is that land inheritance not only reduces land purchases, but the land purchases are reduced by more than the land inherited, thus the optimal land size declines.

Regarding the second proposition, better off farm labor opportunities ( $l^o$ ) (or a higher wage rate) will lower the land purchases for much of the same reasons: higher income and consumption will raise  $z$  and thereby lower  $l^a$  and  $h^*$ . For  $l^o$  we get an additional effect via the labor market constraint.

Finally, for the other exogenous variables, higher stock of family labor ( $L$ ) increases the land purchases. As more labor becomes available, more labor will be applied on the farm, and since labor and land are complementary inputs this provides an incentive to buy more (sell less) land. Higher price of agricultural produce provides incentives for higher agricultural production, and increases the optimal land size (and  $h^p$ ), while higher land price has the opposite effect.

By considering the first order conditions, we see that the model also gives a negative relationship between  $z$  and  $h^p$ , for any given level of  $h^l$ : factors that give a higher shadow wage will also yield lower land purchases.

The model is based on a number of assumptions, for example, we assume that land inheritance does not affect family size. Farm households inheriting large farm size

may have an incentive to increase their labor force by increasing the number of children (e.g., Cain, 1985). If that is the case, the first proposition may become invalid.

### 3 Estimation strategy

This section outlines the estimation strategy to test our hypotheses. We first describe the probability to inherit land and then focus on the estimation of a model that jointly controls for both decisions of land acquisition and disposal.

#### 3.1 The probability to inherit land

At the time of household of formation, we hypothesize that the probability ( $\rho \in [0,1]$ ) to inherit land depends on the amount of land owned by parents, the degree to which land markets are functional in his locality ( $\kappa \in [0,1]$ ), and other characteristics such as number of siblings. The probability to acquire land through land inheritance is specified with a tobit model (Tobin, 1958) as follows:

$$\rho(h^{lirt}) = \begin{cases} 0 & \text{if } h^{lirt*} = t^{\kappa} \kappa^{rt} + t^x x^{irt} + \mu^{irt} \leq \Upsilon \\ t^{\kappa} \kappa^{rt} + t^x x^{irt} & \text{if } h^{lirt*} = t^{\kappa} \kappa^{rt} + t^x x^{irt} + \mu^{irt} > \Upsilon \end{cases} \quad (8)$$

Where  $h^{lirt}$  is a binary variable coded 1 if household  $i$  living in village  $r$  at the time of household formation ( $t = 0$ ) (THF) inherited land from parents and 0 otherwise,  $h^{lirt*}$  is the latent variable that determines whether an individual inherited land at THF,  $\kappa^{rt}$  measures the extent to which land sales markets were active in village  $r$  at THF,  $x^{irt}$  are household characteristics at THF,  $t^{\kappa}$  and  $t^x$  are parameters to be estimated,  $\mu^{irt}$  is the error term and  $\Upsilon$  is unobserved threshold level. Equation (8) measures not only the probability that a household would inherit land at THF, but also the intensity of stock of land inherited. If the unobserved latent variable ( $h^{lirt*}$ ) is greater than  $\Upsilon$ , then the observed stock of land that indexes the probability of land inheritance,  $\rho(h^{lirt})$ , becomes a continuous function of the explanatory variables, and 0 otherwise (that is, no land inheritance at THF). Equation (8) is used to determine whether land inheritance is an outcome of incomplete or missing land markets. If the presence of active land markets influences the decision by parents to pass on land to their children at THF, then we fail to

reject the hypothesis that active land markets limit land transfer through inheritance only if  $t^k < 0$ , otherwise  $t^k = 0$ .

### 3.2 Challenges and strategy to estimate land acquisition and disposal

To identify the effect of land inheritance at THF on future land purchase and disposal, we face several challenges. The threshold of landholding that allows households to bequeath land to their children or sell land is unknown to us. Based on the theoretical model in section 2, we define this threshold of landholding as the ‘desired landholding’ ( $h^{dir}$ ), which enables the household to meet consumption needs given resource endowments and off-farm livelihood options. Further, denote current landholding as  $h^{irt}$ . If  $h^{irt} > h^{dir}$ , then the household may decide to dispose of excess land through either markets or sub-dividing it among children. If  $h^{irt} < h^{dir}$ , then investment in land occurs until the land stock approaches  $h^{dir}$ . Investment or disinvestment in landholding is, therefore, measured as the change in landholding stock over time expressed as:

$$\Delta h^{irt} = h^{irt} - h^{dir} \begin{cases} < 0, \text{ Net land purchases} \\ = 0, \text{ No transaction (or land purchases equal to disposal)} \\ > 0, \text{ Net land disposals} \end{cases} \quad (9)$$

The key issue is how to estimate (9) when  $h^{dir}$  is unknown and to identify which households invest in land purchases or dispose of land. Are they the households that acquired land through inheritance at THF or those with no land inheritance? To overcome these challenges we use an endogenous switching regression approach (Lokshin and Sajaia, 2004; Wooldridge, 2010) that allows us to identify the effects of land inheritance on land disposal and acquisition when the threshold of landholding is unknown. To proceed, we partition the sample into two groups: households with land inheritance at THF and those without land inheritance at THF. This partitioning is justifiable since about 60% of rural farm households in Uganda acquire land through inheritance (Deininger and Mpuga, 2009; Nkonya et al. 2009). Next, we assume that a household may make two sequential decisions over time: first, a decision to invest in land if the household inherited insufficient land or no land at all at THF, and second, a decision to dispose of accumulated land through either bequests or sales. The reverse decision-

making process holds for households inheriting larger landholdings at THF. That is, over time a household inheriting large landholdings at THF may, first disinvest landholdings through land bequests or sales, and second, invest in land accumulation if earlier land disinvestment resulted in landholding falling below  $h^{dir}$ , due to changes in, for example, the family labor force or off-farm labor opportunities, both of which affect the desired landholding (cf. section 2). With these assumptions, we use the amount of landholding in the previous (initial) period, as an alternative to  $h^{dir}$ , and subtract it from the current landholding which yields an estimate of  $\Delta h^{irt}$ . Even though this approach does not necessarily tell us which households are in deficit or excess of landholding as land disposal in one period may occur as a result of negative shocks<sup>5</sup>, we are able to determine whether the decision to invest in or dispose of land is associated with land inheritance at THF.

The other challenge we face is that we do not observe variables that determine household shadow wages, and even if shadow wages were observed, they are potentially endogenous as indicated in theoretical model in section two. We attempt to overcome these challenges by directly estimating shadow wages from a production function (Jacoby, 1993; Skoufias, 1994; Shively and Fisher, 2004) in the previous period. In addition to using shadow wages in the previous period, which minimizes the effects of endogeneity as such observations are predetermined and hence less likely to directly affect current decisions of land acquisition or disposal, we also use the instrumental variable estimation approach. Details of this approach are described in the results section.

With the outlined estimation challenges and the ways to overcome them, to determine how land inheritance at THF conditional on other factors influences the decisions of land acquisition and disposal, we use a switching regression to estimate a modified version of equation (9) as follows:

$$\Delta h_j^{irt} = \sigma_{jsb} \ln h_j^{sbirt-1} + \sigma_{jlp} \ln h_j^{lpirt-1} + \sigma_{jg} \sum_g \ln \hat{z}_j^{girt-1} + \sigma_{jx} X_j^{irt} + \varepsilon_j^{irt} \text{ if } \Pr\left(h^{lirt-0} \leq 0 \mid x^{irt-0}\right) \quad (10)$$

---

<sup>5</sup> Carter *et al.* (2007) find evidence that land disposal due to negative shocks leads to increased investment in land in later periods.



where  $\Delta h_j^{irt}$  is a change in land investment for household  $i$  in group  $j$ , where  $j = 0$  are households with no land inheritance at THF and  $j = 1$  are households that acquired land through inheritance at THF.  $h_j^{sbirt-1}$  is a quantity of land disposal through either sales or bequests in previous period,  $h_j^{lpirt-1}$  is amount of land acquired through either inheritance or purchases in previous period,  $X_j^{irt}$  is vector of both village and household characteristics,  $\varepsilon_j^{irt}$  is composite error term capturing household and village unobserved effects over time.  $\sigma_{jsb} - \sigma_{jx}$  are parameters to be estimated.  $\Pr\left(h^{lirt=0} \leq 0 \mid x^{irt=0}\right)$  is the switching regression that determines the ‘desired landholding’ and is estimated as a probability of acquiring land through land inheritance at THF.  $h^{lirt=0}$  and  $x^{irt=0}$  are as defined in (8).

Lastly,  $\hat{z}_j^{girt-1}$  is the household shadow wage disaggregated by labor source ( $g$ ): adult male (M), adult female (W) and child (C) labor. Disaggregating shadow wages by sex and age groups plays a key role in explaining how unobserved heterogeneity across households are associated with land inheritance and labor supply on family farm (Bhalotra and Heady, 2003; Basu et al., 2010). Shadow wages are derived using the following expression (Jacoby, 1993):

$$\hat{z}_j^{girt-1} = \frac{\hat{f}^{irt-1}}{l^{agirt-1}} \hat{\beta}_{girt-1} \quad (11)$$

where  $\hat{f}^{irt-1}$  denotes the predicted value of agricultural output based on the coefficient estimate  $\hat{\beta}_{girt-1}$  and  $l^{agirt-1}$  is the amount of labor units supplied by the labor source  $g$ .

#### 4 Data sources and descriptive statistics

The data come from three rounds of repeated household surveys in Uganda carried out by Foundation for Advanced Studies on International Development (FASID), Graduate Institute for Policy Studies (GRIPS) and Makerere University. The first round in 2003 included 940 households, while 894 and 819 households were re-surveyed in 2005 and 2009 respectively. Details of the sampling procedure can be found in Kijima et al. (2006).

With attrition and after dropping households with inconsistent data, we use a balanced panel of 786 households in the analysis.

#### 4.1 Household characteristics at the time of household formation

Table 1 reports household characteristics by land inheritance at THF. In general, the average age of the sample households in 2003 was about 21 years, that is, the average number of years of a household from THF to 2003. More than half (57%) of the sample households inherited (pre- or post-mortem), on average, 3.7 acres of land at THF. As a result, households inheriting land had large landholdings at THF (4.6 acres) compared to 2.7 acres for those that did not inherit land. Households inheriting land at THF come from mainly polygamous families with large landholding stock. Parents appear to favor children born later in giving out land compared to first or second born children. The percentage difference between the first born children inheriting land and those inheriting no land at THF is larger than the difference for second born children; 23 – 30% for the former and 19 – 20% for the latter. Figure 1 below further supports this relationship.

Table 1: Household characteristics at the time of household formation

	Inherited no land (42.8%)	Inherited land (57.2%)
Number of biological male siblings of head and spouse	5.7	6.3
Number of biological female siblings of head and spouse	6.1	6.7
Birth order of household head – 1 <sup>st</sup> born (%)	29.8	22.9
Birth order of household head – 2 <sup>nd</sup> born (%)	20.2	19.3
Birth order of household head – 3 <sup>rd</sup> born (%)	15.5	17.1
Household head had parents in polygamous marriage (%)	58.6	63.3
Land owned by parents (acres)	15.8 (29.2)	20.9 (46.5)
Initial land (owned) (acres)	2.7 (9.2)	4.6 (8.2)
Land acquired (inherited) from parents (acres)		3.7 (6.6)
Value of capital (cash, livestock, assets) ('000 Ush.) <sup>a</sup>	475 (3994)	370 (1317)
Average years of the household before 2003 <sup>b</sup>	20.8 (12.8)	20.4 (13.8)
Number of observations	336	450

<sup>a</sup> Ush. refers to Uganda shillings, the local currency. Figures in parentheses are standard deviations.

<sup>b</sup> Some households had missing data on when the household was formed. The number of observations for households with no land inheritance is 316 and 433 for those with inheritance.

Figure 1 shows that the amount of land inherited increases with the number of siblings (both male and female siblings) of both household head and spouse at THF. Similarly, the amount of land owned by parents is associated with large families. The

relationships in Figure 1 are strong for the large part of the sample: 66.7% of the sample households had 10-20 siblings, 27.8% had 0-9 siblings, and only 5.5% of households had more than 20 siblings. The correlation coefficient between parent’s landholding and the total number of siblings to head and spouse is positive (0.117) and significant ( $p < 0.001$ ). Likewise, the correlation coefficient between land owned by parents and the number of wives is positive and as high as 0.163 and significant ( $p < 0.001$ ). These results appear to suggest that parents may pass on nothing or small stocks of land to the first born child while saving for the young children and possibly future family size expansion. In turn, the children born later may benefit by acquiring larger stocks of land from their aging parents.

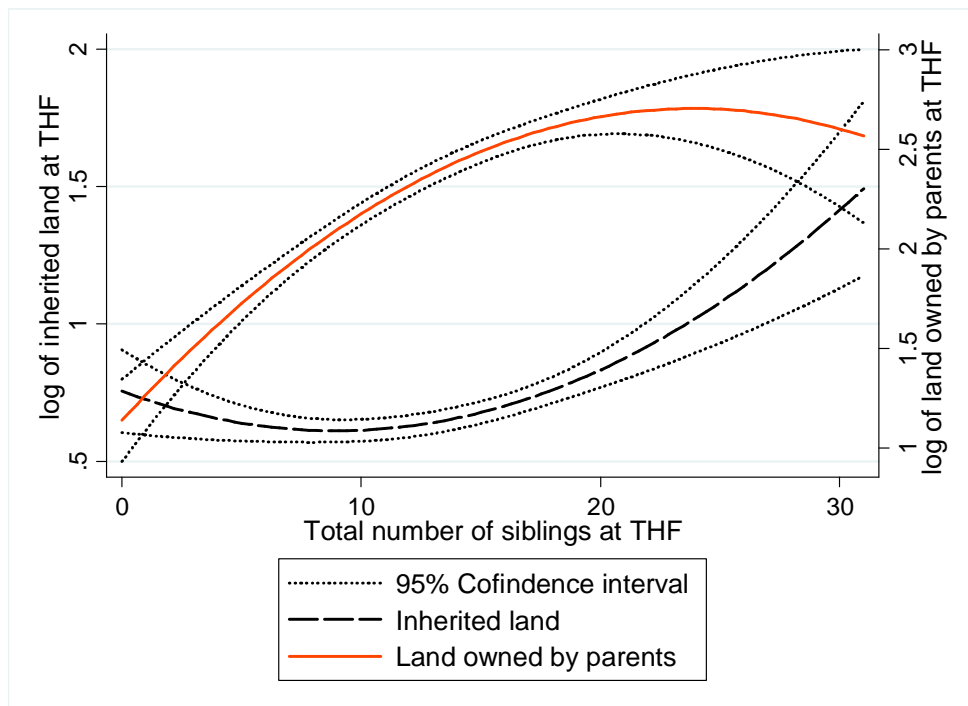


Figure 1. Quadratic prediction of inherited land and parents’ landholding on number of siblings.  
*Note: We obtain similar relationships when we use the nonparametric approach using locally weighted regression.*

#### 4.2 Household characteristics at the time of the survey

Table 2 reports household characteristics classified by land inheritance at THF. We observe no significant differences in demographic characteristics between households that inherited land and those that did not at THF, but the differences in landholding appear to influence land acquisition over time. The proportion of households acquiring

land through inheritance over time is higher for those that had inherited land at THF than for those households that did not inherit land at THF. That is, among the 57% of the sample households that inherited land at THF, 78% in 2003 and 74% in 2009 still had access to inherited land or had inherited more land over time. This implies that 22% and 26% of households that inherited land at THF had given away or sold off the inherited land by 2003 and 2009 respectively. On the other hand, lack of land inheritance at THF appears to be an incentive for households to work harder and acquire land through purchases. Land acquisition is significantly more common among households that did not inherit land at THF than it is for those that inherited land, as we will investigate further below.

Table 2. Household characteristics by land inheritance at THF

	2003		2005		2009	
	Inherited land =0	Inherited land >0	Inherited land =0	Inherited land >0	Inherited land =0	Inherited land >0
Age of household head	46.8 (14.7)	44.5 (15.0)	48.2 (14.6)	46.8 (15.1)	52.0 (14.1)	50.1 (14.1)
Education of head (years in school)	5.7 (3.8)	5.7 (3.9)	5.6 (3.8)	5.8 (3.9)	6.0 (4.0)	5.8 (3.9)
Household size	7.9 (3.9)	7.7 (3.6)	9.2 (4.1)	8.8 (4.1)	8.9 (4.0)	8.6 (3.7)
# of male members aged 15 – 65 years	2.1 (1.6)	1.8 (1.4)	2.5 (1.8)	2.1 (1.6)	2.6 (2.1)	2.3 (1.7)
# of female members aged 15 – 65 years	2.0 (1.4)	1.8 (1.2)	2.4 (1.6)	2.2 (1.5)	2.3 (1.5)	2.1 (1.4)
# of members (excluding head) with primary education	3.7 (2.6)	3.6 (2.5)	4.7 (2.8)	4.7 (2.8)	4.7 (2.6)	4.7 (2.6)
# of members (excluding head) with post-primary education	1.2 (1.8)	0.8 (1.4)	1.5 (2.0)	1.0 (1.7)	1.6 (2.2)	1.2 (1.7)
# of members in off-farm employment	0.7 (0.8)	0.7 (0.8)	0.8 (0.9)	0.9 (0.9)	0.6 (0.7)	0.7 (0.8)
Gross crop income (Ush. *1000)	670 (1229)	723 (1150)	771 (1427)	727 (1211)	1026 (1059)	1104 (1092)
Land owned (acres)	5.0 (5.8)	4.7 (6.0)	5.9 (6.9)	5.5 (7.1)	6.5 (10.8)	5.4 (7.4)
Households acquiring land through purchase (%)	66.7	50.7	-	-	74.1	60.2
Households acquiring land through inheritance (after THF) (%)	48.8	78.2	-	-	50.0	74.2
Households renting in land (%)	23.5	23.3	31.0	36.2	35.4	37.8
Households disposing of land through sales or giving away to children (%)	-	-	4.5	6.9	22.6	26.2
Households renting out land (%)	-	-	16.1	14.4	16.4	16.0

Figures in parentheses are standard deviations. Note that information on land disposal was only captured in 2005 and 2009 surveys but not in 2003 survey, while information on land acquisition was captured in 2003 and 2009 surveys but not in 2005.

We further estimate Gini coefficients to study land distribution among households after household formation. The Gini coefficients in Figure 2 show that inequality in land ownership was significantly reduced between the time the household was formed and in the later survey years, although we also see that land inequality slightly increased between 2003 and 2009.

Also important in Figure 2 is the distribution of operated land and owned land. The Gini coefficients for owned land for both households that inherited land and those that did not are relatively close, but significantly higher than the Gini coefficients for operated land for both groups. This implies that land rental markets play a considerable role in equalizing the distribution of operated land between households that did not inherit land and those that inherited land at THF. In other words, land rental markets enable households with no land inheritance at THF to accumulate landholding to the same operational landholding level as those households that inherited land at THF.

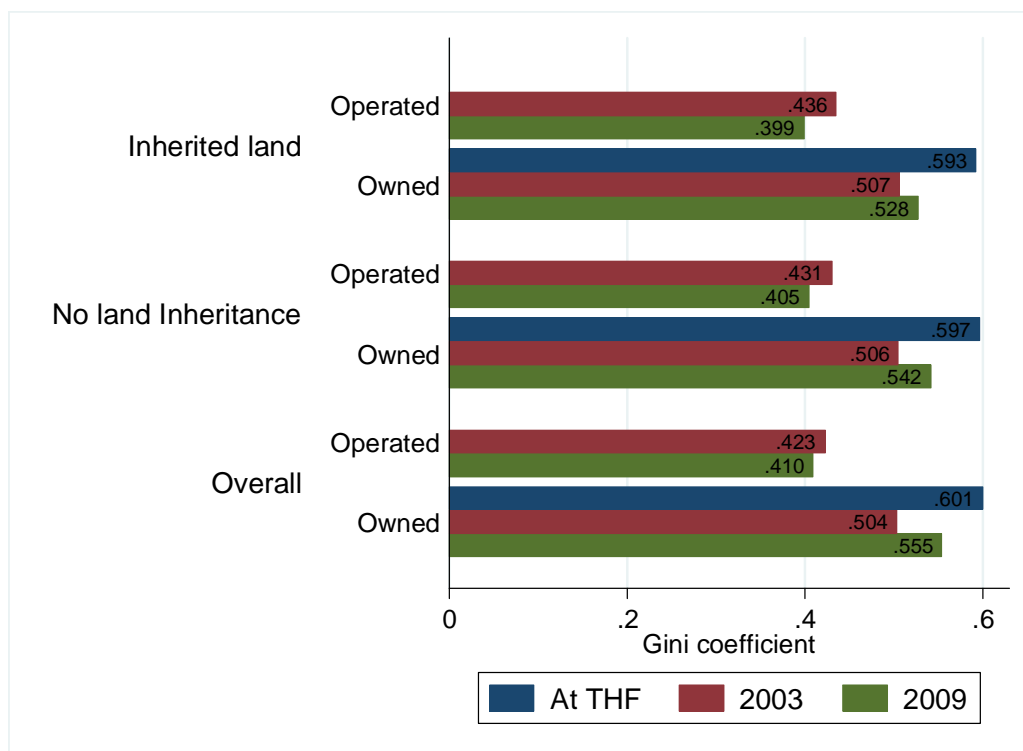


Figure 2. Gini coefficients for owned and operated land

## 5 Results

This section presents the econometric estimation results of the procedure described in section 3. We begin by reporting and discussing the results to establish whether land inheritance is an outcome of incomplete land markets. This is followed by the results describing how land inheritance at the time of household formation (THF) influences long-term decisions of land disposal and acquisition through land markets.

### 5.1 Land markets and land inheritance

Table 3 reports results estimated from equation (8). The results show the intensity of land inheritance at THF (models 1 – 2) and total land inheritance over time (models 3 – 6). Model (1) does not control for any household characteristics at THF, whereas model (2) controls for characteristics of the household head and head’s parents. We measure the extent of land market activity using the share of land acquired through land sales market in a given village. Using characteristics of land markets at the *village* level helps to control for unobserved effects at the *household* level that would endogenously determine the decision to participate in land markets.

The results indicate that the likelihood to inherit land at THF reduces significantly with increased share of land acquired through land markets in the village. We notice that the point estimate reduces from 1.56 to 1.49 when we control for observed demographic characteristics of the household at THF. The likelihood to inherit land is, for example, significantly and positively associated with large landholdings owned by the parents. Perhaps more surprisingly, household heads born fourth in the birth order or higher are more likely to inherit more land at THF compared to first born household heads. In general, these findings support the earlier descriptive evidence in Table 1 and Figure 1 suggesting that we cannot reject the hypothesis that active land markets limit land transfer through inheritance.

We further check the robustness of our results by estimating the accumulated land inheritance over time, that is, acquisition of (more) land from parents in later years after household formation. Models (3) and (4) yield similar results to those of models (1) and (2). However, model (5) shows that including ‘current’ household characteristics strengthens the relationship between land markets and accumulated land inheritance. In particular, as the household head grows older, the likelihood to inherit land from parents

reduces significantly, which may simply reflect the fact that their parents have disposed all land or have passed away. When land inheritance occurs over time, it discriminates against female headed households. This finding is supported by the anecdotal evidence in Uganda that parents tend to favor their sons compared to daughters when bequeathing land.

Model (6) shows that although the inclusion of other village and regional (fixed) characteristics reduces the point estimate on the land market from 1.88 to 1.80, the results provide further evidence that the existence of active land markets reduces land transfers through land inheritance. An increase in the land purchase price and the proportion of households renting in land in the village significantly reduces the likelihood of inheriting land from parents. High land prices are indicative of high demand for land, which backs up the hypothesis that land inheritance is a consequence of missing or incomplete land markets, and not only an informal obligation for parents to pass on land to their children. Land sales can also be a way for the older generation to get their 'pension', i.e., to cash in assets when they have become too old for farming or other income generating activities.

Table 3. Relationship between land inheritance and active land markets

Tobit dependent variable = land inheritance	Inheritance at THF		Total land inheritance (over time)			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Household characteristics at THF</i>						
log of capital owned by head (Ushs.)		0.013 (0.017)		0.018 (0.011)	0.010 (0.009)	0.012 (0.010)
Head was 2 <sup>nd</sup> born relative 1 <sup>st</sup> born =1, 0 otherwise		0.103 (0.105)		0.050 (0.230)	0.020 (0.211)	0.006 (0.204)
Head was 3 <sup>rd</sup> born relative 1 <sup>st</sup> born =1, 0 otherwise		0.137 (0.110)		-0.074 (0.243)	-0.104 (0.240)	-0.110 (0.262)
Head was 4 <sup>th</sup> born or beyond relative 1 <sup>st</sup> born =1, 0 otherwise		0.079*** (0.021)		0.126 (0.131)	0.074 (0.122)	0.060 (0.148)
Number of male siblings		-0.011 (0.014)		-0.020 (0.014)	-0.027* (0.015)	-0.027** (0.013)
log of land owned by household head's parents (acres)		0.263*** (0.031)		0.170*** (0.026)	0.161*** (0.031)	0.144*** (0.028)
Household head's parents polygamous =1, 0 otherwise		-0.062 (0.090)		0.100* (0.058)	0.076* (0.043)	0.057 (0.037)
<i>Household characteristics after THF</i>						
Age of household head (years)					-0.009** (0.004)	-0.008** (0.004)
Male headed household =1, 0 otherwise					0.200*** (0.025)	0.181*** (0.031)
Number of members employed in off-farm activities					-0.125 (0.087)	-0.120 (0.082)
Number of male members aged 15 – 65 years					0.060 (0.044)	0.059 (0.045)
Number of female members aged 15 – 65 year					-0.038 (0.047)	-0.027 (0.046)
<i>Village and regional characteristics</i>						
Share of land acquired through land sales market in the village	-1.559*** (0.193)	-1.485** (0.678)	-1.883*** (0.208)	-1.845*** (0.218)	-1.919*** (0.247)	-1.800*** (0.333)
log of lagged land purchase price per acre (Ush.) (2005)						-0.292*** (0.062)
Share of households participating in renting in land						-0.089* (0.048)
Population density (number of households per square mile)						-0.026 (0.031)
Eastern Uganda region relative to central region						0.094*** (0.011)
Western Uganda region relative to central region						0.231*** (0.026)
Constant	0.940*** (0.084)	0.228 (0.345)	1.382*** (0.093)	0.826** (0.327)	1.375** (0.586)	5.312*** (0.734)
Number of observations	786	786	786	786	786	786

Figures in parentheses are robust standard errors. \*\*\*, \*\*, \* are significance levels at 1%, 5%, 10% respectively



## 5.2 Investment and disinvestment in landholding given land inheritance

The second issue raised in this paper concerns how land investment behavior of households inheriting land change over time. Table 4 reports results estimated from an endogenous switching function (equation (10)) to test our second hypothesis, namely: Initial land inheritance discourages land purchases but encourages future land disinvestment. Models (1) through (3) show estimates for the households without land inheritance at THF, whereas models (4) through (6) show estimates for the households with land inheritance at THF. Table B.1 reports results from the switching function. We report results with shadow wages derived from different specifications of the production function (see, for example, Jacoby, 1993). Models (1) and (4) use shadow wages derived from the Cobb-Douglas (CD) production function. Models (2) and (5) use shadow wages derived from the translog production function. Models (3) and (6) use shadow wages estimated from instrumental variable estimation of the Cobb-Douglas (IV-CD) production function. Table B.2 reports estimates of these production functions. Appendix C describes the procedure for testing whether shadow wages are endogenously determined in equation (10).

The correlation coefficients across shadow wages derived from different specifications were significant and large. The correlation coefficients ranged from 0.911 to 0.972, with the exception of the correlation coefficient of female shadow wages (0.841) derived from translog and IV-CD production functions. Shadow wage estimates derived from IV-CD and translog production functions do not differ appreciably, but to some extent differ from those derived from ordinary CD production function. The rest of the discussion is based on models (2) and (5) that use shadow wages derived from the translog function that nests the possibility of perfect substitutability of inputs.

Table 4. Investment in landholding conditional on land acquisition from parents at THF

Dependent: $\Delta h_{irt} = H_{ir2009} - H_{ir2003}$	No land inheritance at THF			Land inheritance at THF		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Household characteristics</i>						
log of land disposed (sales or bequests) in 2005	-1.270** (0.613)	-1.199** (0.576)	-1.600*** (0.608)	0.746 (1.314)	0.819 (1.315)	0.756 (1.300)
log of land acquired through inheritance or purchases in 2003	3.048*** (1.003)	3.071*** (1.018)	3.119*** (1.142)	-2.190*** (0.806)	-2.222*** (0.812)	-2.203*** (0.807)
log of shadow wage of adult males' labor in 2003	0.357** (0.173)	0.194 (0.144)	0.187 (0.186)	0.128 (0.138)	0.172 (0.143)	0.059 (0.147)
log of shadow wage of adult females' labor in 2003	0.722 (0.495)	0.366 (0.379)	0.430 (0.477)	-0.093 (0.217)	0.019 (0.227)	-0.227 (0.230)
log of shadow wage of child labor in 2003	0.604*** (0.163)	0.498*** (0.139)	0.407** (0.157)	0.059 (0.128)	0.090 (0.121)	0.017 (0.139)
log of lagged land owned (2003) (acres)	-8.017*** (2.048)	-7.633*** (1.867)	-7.524*** (1.922)	-3.062*** (0.625)	-3.107*** (0.616)	-2.976*** (0.629)
Number of members employed in off-farm activities	-0.881** (0.354)	-0.869** (0.392)	-0.899** (0.364)	-0.054 (0.265)	-0.042 (0.269)	-0.043 (0.265)
Number of members (excl. head) with primary education	0.418** (0.141)	0.424** (0.177)	0.395*** (0.148)	-0.027 (0.153)	-0.024 (0.151)	-0.035 (0.154)
Number of members (excl. head) with post-primary education	0.327*** (0.124)	0.396** (0.153)	0.351** (0.140)	0.383** (0.193)	0.379** (0.192)	0.385** (0.193)
Education of household head (years in school)	0.043 (0.072)	0.047 (0.091)	0.053 (0.087)	0.237*** (0.077)	0.235*** (0.076)	0.241*** (0.077)
Age of household head (years)	0.111*** (0.035)	0.110** (0.035)	0.106*** (0.032)	0.032 (0.020)	0.034* (0.020)	0.031 (0.020)
log of average distance from home to owned parcels (km)	0.387 (0.348)	0.320 (0.344)	0.349 (0.296)	0.632** (0.271)	0.613** (0.267)	0.646** (0.273)
log of value of farm related assets (Ush.)	0.411** (0.135)	0.380** (0.157)	0.318* (0.170)	0.669*** (0.184)	0.664*** (0.183)	0.678*** (0.184)
<i>Village characteristics</i>						
log of land purchase price per acre (Ush.)	-1.550** (0.684)	-1.491** (0.651)	-1.341** (0.606)	-2.145*** (0.583)	-2.165*** (0.587)	-2.161*** (0.579)
log of land rental rate/acre/season (Ush.)	-0.031 (0.692)	0.058 (0.711)	-0.235 (0.738)	0.793 (0.599)	0.789 (0.595)	0.782 (0.599)
Household population density	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)
Number of output markets accessed (2003)	0.390* (0.203)	0.429* (0.248)	0.388** (0.194)	-0.056 (0.150)	-0.063 (0.152)	-0.051 (0.149)
Share of households that received credit (2003)	3.037* (1.592)	2.843 (1.826)	2.520* (1.438)	-4.037** (1.978)	-4.074** (1.980)	-3.985** (1.968)
Share of landless households	-2.436* (1.466)	-3.265* (1.750)	-2.675* (1.518)	0.365 (1.628)	0.348 (1.635)	0.371 (1.616)
Dummy for Eastern Uganda relative to central region	-0.494 (1.545)	-0.293 (1.496)	-0.352 (1.512)	-0.189 (0.887)	-0.226 (0.878)	-0.132 (0.906)
Dummy for Western Uganda relative to central region	0.875 (1.447)	1.206 (1.283)	1.603 (1.541)	1.949** (0.955)	1.947** (0.949)	1.996** (0.968)
Constant	-1.689 (9.260)	-1.208 (9.627)	1.298 (9.035)	12.853* (7.587)	11.970 (7.748)	14.395* (8.084)
F-test for shadow wages	14.39***	1.07	15.44***	1.84	9.25**	1.15
Wald test of independent equations				48.128***	50.509***	50.737***
Number of observations	737	737	737	737	737	737

Figures in parentheses are robust standard errors. \*\*\*, \*\*, \* are significance levels at 1%, 5%, 10% respectively.

Note that the number of observations reduces from 786 to 737 due missing information on labor variables.

The results show that land disposal encourages land purchases among households with no land inheritance at THF, but this relationship is not significant among households with land inheritance at THF. On the other hand, positive changes in landholding are significantly associated with land purchase for households that did not inherit land, but land purchase is significantly associated with negative changes in landholding among households that inherited land at THF<sup>6</sup>. The implication of these results is that inheriting land discourages land purchases, whereas lack of land inherited at THF is an incentive to invest in land through land purchases.

The findings also show that the household labor endowment is significantly associated with land investments for households with no land inheritance, but less so for those who inherited land at THF.

The F-test of joint significance shows that the shadow wages of child labor, adult female and male labor jointly cause a significant variation in land investment among households inheriting no land at THF compared to their counterparts. In particular, an increase in shadow wage of child labor significantly increases investment in land among households without land inheritance at THF. Similar correlations are observed, but insignificant among households inheriting land at THF. These results are contrary to our theoretical prediction of a negative association between shadow wages and land purchase. A possible explanation is that the estimated shadow wages reflect the labor productivity in crop production, ignoring consumption decisions. We were unable to include consumption decisions due to data limitations. Despite this limitation, our empirical results reflect the reality in rural Uganda (and possibly other developing countries) where labor markets are missing or imperfect and households use agricultural income from their small landholdings or borrowed (rented) in land to make land purchases. This means that the supply of labor on family farm plays a key role in generating agricultural income. With this in mind, our empirical results suggest that the initially landless or near landless households employ more child labor on their farms rather than supplying it to off-farm

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<sup>6</sup> We obtain similar results qualitatively when we use the share of land acquired through land markets in the village – a proxy for active land markets – instead of land purchase at household level. These results are not reported here but available upon request. Active land markets encourage land disposal among households acquiring land through land inheritance, but the reverse is true for households with no land inheritance. Active land markets are an incentive for investment in land among households without access to land through inheritance.

market work. This finding is in contrast with the notion that the land poor households over-supply labor to off-farm work (Rosenzweig, 1978, 1980; Akram-Lodhi, 2005), but supports the inverse-farm size productivity relationship due to high labor-to-land ratio (Carter, 1984; Newell et al., 1997). On the other hand, the large landholders can achieve allocative efficiency by disposing of a share of their landholding (Barrett et al., 2008). In other words, as our theoretical model predicts, in an imperfect labor market environment there is an optimal land size and the land poor may buy land, if they can, and the land rich will sell or bequeath

In addition to shadow wages, land disposal and acquisition, there are other household and village factors that influence the decision to invest in land. As predicted by the theory in section 2, having more household members employed in off-farm work is negatively and significantly associated with land accumulation among households with no land inheritance, while we observe an insignificant relationship among households inheriting land at THF. The negative and significant coefficient on the lagged land owned indicates that investment in land is reduced by previous large landholding stock. Earlier investment in both human and physical capital enhances investment in land, that is, having more household members with high levels of education and ownership of farm related assets are associated with increased investment in land. Land accumulation is significantly associated with older household heads with no land inheritance but weakly linked to those with land inheritance at THF<sup>7</sup>. This suggests that with no land inheritance at THF, it takes some time for households to attain the desired landholding as they normally are capital constrained (Winter et al., 2009).

Village level factors that cause significant variation in investing in landholding included land purchase price, and access to output and credit markets. The negative coefficient on land purchase price is consistent with the theoretical model in the way that an increase in purchase price encourages land sales, but discourages the use of land for agricultural production. Good access to output markets encourages engaging in agricultural production and is an incentive to invest in land. Interestingly, an increase in share of households receiving credit significantly reduces the investment in land among

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<sup>7</sup> The squared term of age of household head to capture the life-cycle effects did not yield any statistical significance besides having substantially small coefficient, and thus was excluded in the reported results.

households inheriting land but weakly increases land accumulation among households with no land inheritance at THF. Several interpretations are possible: The availability of credit services encourages the initially land poor to apply inputs to improve their land productivity, and use the higher land returns to acquire more land. Alternatively, the initially land rich use their landholdings as collateral to access credit for other off-farm income generating activities, hence they are more likely to dispose of a share of their landholding.

### 5.3 General discussion of results

Putting together the descriptive results and parametric estimation results, the evidence suggests that land equalization has been occurring over time within the sample. Land markets contribute to the process. However, the question is whether this implied land equalization translates into convergence in size of landholding over time, as predicted in the theoretical model (although the ‘desired’ land holding depends on household and market characteristics, e.g., family labor supply). While we have information on landholding at THF and in the later years after household formation, the three survey periods do not provide enough information to fully answer this question. We attempt, however, to respond to the issue of land equalization using simple non-parametric estimations using locally weighted least squares as shown in Figures 3 and 4.

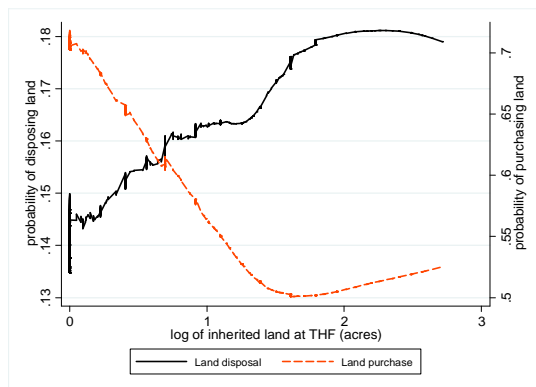


Figure 3. Land inheritance and the probability to purchase or dispose of land

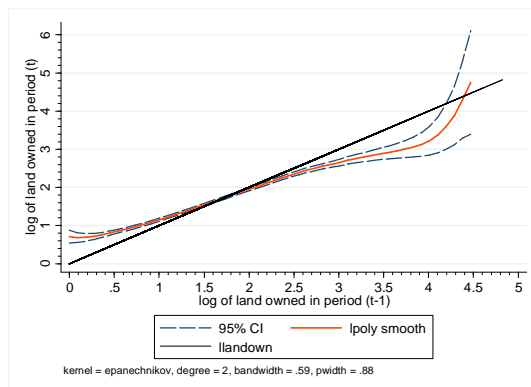


Figure 4. Landholding dynamics

Figure 3 shows how land inheritance at THF varies with the probability to dispose of or purchase land in later periods after household formation. The results show that the likelihood to dispose of land through bequeathing or sales increases with the area inherited at THF. Baland et al. (2007) find a similar result in central and eastern Uganda. The reverse is true for land purchase, with lack of inheritance or inheritance of small stocks significantly increasing the probability of land purchases in future.

Figure 4 explores the dynamics in landholding by estimating the relationship between current stock of landholding ( $t$ ) and the initial land stock ( $t-1$ ). The current period is 2009. The initial period is represented by lagged landholdings for 2005 and 2003. The 45-degree line represents the dynamic equilibria where landholding is equal across the periods. The results show two equilibria points: a low, stable equilibrium that lies within a 95% confidence interval, and a high, unstable equilibrium that almost falls out of the 95% confidence interval. Only three households in the sample owned land greater than the high equilibrium (log of 4.4 or 81.5 acres). This means that in practice, we only have one equilibrium within our sample, which suggests that the hypothesis of multiple equilibria that implies existence of “land-poverty” traps is not supported by our results (Carter and Barrett, 2006). We consider only the lower equilibrium point, which suggests potential convergence in landholding where households with initially large landholding stock disinvest towards the desired landholding size while those with initially small landholding invest toward the same desired level. Overall, the implication is that land markets facilitate redistribution toward land equalization in our sample households.

## **6 Conclusion**

A large number of studies indicate that the main mode of land access is through land inheritance in Sub-Saharan Africa, but few studies have investigated how land inheritance emerges and how it influences investment decisions relating to land acquisition and disposal. In this paper, we develop a theoretical model to examine the relationship between land inheritance at the time of household formation and the decision to acquire or dispose of land over time. We empirically test this relationship using panel data collected from rural farm households in Uganda.

We find evidence to suggest that land inheritance is influenced by missing or incomplete land sales markets, and not only as a traditional obligation for parents to bequeath land to their children. Empirical results are consistent with our theoretical predictions, and show that households inheriting large landholdings are more likely to disinvest through land sales and bequests, while those with no inheritance or inheriting small landholdings have an incentive to accumulate land through land purchases in the market.

We did not find evidence to support the hypothesis of multiple equilibria that implies existence of “land-poverty” traps in our sample households. Instead, we find that there is a convergence in landholding within our sample, where households with initially large landholdings dispose of land toward the desired landholding size while those with initially small landholding invest in land toward the more similar desired level of land holdings. Hence land markets seem to restore an imbalance created through inheritance, and contribute to a more equal distribution of land across the households.

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## Appendix A

### *Proof of propositions*

Define the impact on the shadow wage rate ( $z$ ) of changes in consumption and leisure as:

$$z_c = -\frac{U_{cc}U_{ll}}{U_c^2} > 0, \quad z_l = \frac{U_{ll}}{U_c} < 0$$

Total differentiation of the first order conditions (FOC) in (5) and (6), taking into account (2)-(4), using the FOC to simplify, and considering only the exogenous variables of interest ( $h^I$  and  $l^o$ ), we obtain:

$$\begin{pmatrix} pf_{lh} & pf_{ll} - z_c pf_l + z_l \\ pf_{hh} & pf_{hl} \end{pmatrix} \begin{pmatrix} dh^p \\ dl^a \end{pmatrix} = \begin{pmatrix} -pf_{lh} + z_c pf_h & z_c w - z_l \\ -pf_{hh} & pf_{hl} \end{pmatrix} \begin{pmatrix} dh^I \\ dl^o \end{pmatrix}$$

Given the assumptions of the production function and the definitions above, the determinant of the Hessian matrix is:

$$p^2 (f_{l_a h}^2 - f_{l_a l_a} f_{hh}) + (z_c pf_{l_a} - z_l) pf_{hh} < 0 \quad (\text{A.1})$$

The effect of land inheritance on land purchase, with simplifications, is given as:

$$\frac{\partial h^p}{\partial h^I} = \frac{p(f_{ll} f_{hh} - f_{lh}^2) + z_c p(f_h f_{hl} - f_l f_{hh}) + z_l f_{hh}}{p(f_{l_a h}^2 - f_{l_a l_a} f_{hh}) + (z_c pf_{l_a} - z_l) f_{hh}} < 0 \quad (\text{A.2})$$

The effect of land inheritance on optimal landholding ( $h^*$ ) is given as:

$$\frac{dh^*}{dh^I} = \frac{dh^p}{dh^I} + \frac{dh^I}{dh^I} = \frac{z_c pf_h f_{h l_a}}{p(f_{l_a h}^2 - f_{l_a l_a} f_{hh}) + (z_c pf_{l_a} - z_l) f_{hh}} < 0 \quad (\text{A.3})$$

Lastly, the effect of supplying labor to the market on the land purchase is:

$$\frac{dh^p}{dl^o} = \frac{f_{hl} (z_c (w + pf_l) - pf_{ll} - 2z_l)}{p(f_{l_a h}^2 - f_{l_a l_a} f_{hh}) + (z_c pf_{l_a} - z_l) f_{hh}} < 0 \quad (\text{A.4})$$

## Appendix B

Table B.1. Switching functions using land inheritance at THF

Selection variable – land inheritance at THF	Model 1	Model 2	Model 3
log of land acquired through land sales market at THF	-0.055 (0.039)	-0.062 (0.039)	-0.064 (0.043)
log of capital (livestock, other assets, cash) owned by head at THF (Ushs.)	0.014*** (0.004)	0.013*** (0.004)	0.014*** (0.004)
Head was 2 <sup>nd</sup> born relative 1 <sup>st</sup> born =1, 0 otherwise	0.115* (0.069)	0.125* (0.069)	0.121* (0.065)
Head was 3 <sup>rd</sup> born relative 1 <sup>st</sup> born =1, 0 otherwise	-0.072 (0.119)	-0.068 (0.126)	-0.074 (0.120)
Head was 4 <sup>th</sup> born or beyond relative 1 <sup>st</sup> born =1, 0 otherwise	0.015 (0.050)	0.032 (0.044)	0.039 (0.039)
Number of male siblings	0.007 (0.007)	0.004 (0.006)	0.003 (0.006)
log of land owned by household head's parents (acres)	0.019 (0.022)	0.023 (0.024)	0.022 (0.023)
Household head's parents polygamous =1, 0 otherwise	0.007 (0.040)	0.013 (0.045)	0.011 (0.041)
Constant	0.007 (0.091)	0.016 (0.096)	0.027 (0.093)
Number of observations	737	737	737

Figures in parentheses are robust standard errors. \*\*\*, \*\*, \* are significance levels at 1%, 5%, 10% respectively. Models (1) through (3) correspond to models (1) and (4), (2) and (5), (3) and (6) in Table 4 respectively.

Table B.2. Estimates of Cobb-Douglas (CD) production function

	Ordinary CD	Instrumental Variable CD	Translog
log of plot area cultivated (acres)	0.522*** (0.069)	0.316*** (0.095)	0.981*** (0.357)
log of seed used (kg)	0.201*** (0.073)	0.178* (0.093)	-0.128 (0.380)
log of organic manure (kg)	-0.002 (0.055)	-0.450 (0.466)	0.787 (0.621)
log inorganic fertilizers (kg)	0.039 (0.058)	0.303 (0.452)	-0.605 (0.603)
log of household refuse (kg)	-0.063 (0.054)	-0.312 (0.387)	1.250** (0.622)
log of number of total labor hours for adult males	0.153*** (0.026)	0.247** (0.096)	0.495*** (0.171)
log of number of total labor hours for adult females	0.220*** (0.072)	0.324** (0.156)	0.152 (0.247)
log of number of total labor hours for children	0.088*** (0.023)	0.131** (0.050)	0.330** (0.155)
log of number of total labor hours for oxen	0.087* (0.045)	-0.012 (0.323)	-0.080 (0.274)
log of total expenditure on hired labor (Ush.)	0.049*** (0.009)	0.055*** (0.013)	-0.005 (0.069)
Constant	8.652*** (0.385)	7.884*** (0.790)	7.509*** (0.996)
Quadratic terms			yes
Own variable second derivative terms			yes
Cross variable second derivative terms			yes
R <sup>2</sup>	0.395	0.308	0.479
F-value	31.60****	28.32***	56.93***
Number of observations	737	737	737

Figures in parentheses are robust standard errors. \*\*\*, \*\*, \* are significance levels at 1%, 5%, 10% respectively.

*Notes about Table B.2.* We use the value of production for maize, beans and coffee using farmer reported prices before aggregating them. We use these three crops to generate shadow wages for the following reasons: Detailed labor supply information on crop production was collected on maize, beans and coffee and this information was only collected in the 2003 survey. These three crops are the most important cash and food

crops in all study areas. Each of the sampled households produced at least one of the three crops.

Estimating the Cobb-Douglas production function using inputs like fertilizers may lead to biased estimates due to possible correlation with error term. As a result, organic manure, inorganic fertilizers, household refuse and family labor were instrumented using: presence of a dispensary or clinic in the village, presence of a primary school in the village, share of households affected seriously by malaria in the last twelve months preceding the survey, share of households having at least two meals a day between harvests, share of households having at least two meals a day at the time of the survey, village experienced drought or floods, distance from centre of the village to the nearest accessed input/output market, household population density, total number of male headed households, total number of female headed households, total number of landless households, land rental rate per acre in the village, number of credit sources in the village, share of households renting in land in the village, age and educational level of household head, household dependence ratio, number of members engaged in off-farm employment, number of household members (excluding head) with primary education, number of members (excluding head) with post-primary education, number of male members aged 15 – 65 years and number of female members aged 15 – 65 years.

In addition to estimating a Cobb-Douglas production using instrumental variables, we also use translog production function that nests the possibility that hired and family labor are perfect substitutes.

## Appendix C

### *Test for endogeneity of shadow wages*

We follow Papke and Wooldridge (2008) to test whether shadow wages are endogenous in equation (10) in a two-stage approach. The first stage involves regressing  $\hat{z}_{jgirt-1}$  on some variables that directly affect labor market supply but not necessarily affecting investment in land or disposal. These were mainly village level variables: share of adult males and females aged 18 years and above who are able to read and write in the village, presence of a dispensary or clinic in the village, presence of a primary school in the village, share of households affected seriously by malaria in the last twelve months preceding the survey, share of households having at least two meals a day between harvests, share of households having at least two meals a day at the time of the survey, and whether a village experienced drought or floods. These variables were also included in estimating equation (10) but did not attain any acceptable statistical significance level. Other variables included are: distance from centre of the village to the nearest accessed input/output market, household population density, share of landless households, age and educational level of household head, household dependence ratio, number of members engaged in off-farm employment, number of members (excluding head) with primary education, number of members (excluding head) with post-primary education, number of male members aged 15 – 65 years and number of female members aged 15 – 65 years. We then predict residuals from this specification.

In the second stage, the switching function is estimated with the residuals from first stage as an additional covariate. The test for endogeneity of  $\hat{z}_j^{girt-1}$  is obtained as a t-test on residuals generated from each of the shadow wages in  $\hat{z}_j^{girt-1}$  vector and a joint F-test on all elements in  $\hat{z}_j^{girt-1}$ . The test results showed that individually and jointly, the residuals were statistically not different from zero suggesting that shadow wages are not endogenously determined in the switching function of investment in land and disposal. We thus estimated the switching function ignoring the first stage estimation.





# PAPER II



# Does Liberalization Increase Export-Crop Participation and Reduce Poverty? The Case of Coffee Marketing Reforms in Uganda\*

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John Herbert Ainembabazi

## **Abstract**

The effects of liberalization of export-crop marketing boards on supply response and poverty remain mixed in existing studies. This paper investigates the impacts of the abandonment of the Coffee Marketing Board in Uganda, using data collected from four rounds of household surveys between 1992 and 2009. Participation rates in coffee production decreased significantly in early years of liberalization, but have picked up in later years. Higher participation is mainly found among farmers located farther away from central markets, even though the same farmers obtain lower coffee incomes than those in central locations. Descriptive analysis indicates that a considerable number of new coffee farmers following liberalization fell into poverty, particularly those located farther away from central markets. Policies directed toward improving market access such as improving rural road networks can help in lifting coffee producers out of poverty.

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## 1 Introduction

State controlled marketing of agricultural produce – a major contributor of economic growth – led to a decline in supply of agricultural exports in most of the Sub-Saharan African countries in the late 1980s and early 1990s. As a result, economic growth declined amidst hiking trade deficits (Lele and Christiansen, 1989; Meerman, 1997; Shepherd and Farolfi, 1999; Kherallah et al., 2000; Baffes, 2005a). This led to liberalization of agricultural markets that saw abolition of state marketing boards through which governments practiced pan-territorial pricing policy, a pricing policy that – in theory – provides all producers with the same farm gate price regardless of their location (Gersovitz, 1989). These price controls were far more effective on export crops than food crops (Kherallah et al., 2000). The liberalization was expected to result in higher aggregate supply for exports and higher producer prices, with the former boosting government revenue and the latter reducing poverty among farmers.

Nearly three decades later, the realization of these expectations remains mixed. Brambilla and Porto (2009) and Gergely and Poulton (2009) find that cotton yields in Zambia initially declined immediately after the liberalization of cotton marketing boards, before increasing in later years. In Tanzania, cotton production fell sharply, while in Uganda production remained low after liberalization of cotton marketing (Poulton et al., 2004; Gergely and Poulton, 2009). In Zimbabwe, on the other hand, cotton production increased considerably after liberalization (Poulton et al., 2004). Cocoa production in Cameroon and Nigeria increased significantly soon after liberalization but later declined due to fluctuating prices (Shepherd and Farolfi, 1999). In Tanzania, liberalization of cashew-nut marketing led to higher overall production, but inefficiencies in production were observed as well (Rweyemamu, 2002).

Although studies on price response to liberalization remain limited, available studies show mixed effects too. Gemech and Struthers (2007) find that coffee market liberalization resulted in high producer price volatility in Ethiopia, although the mean coffee price rose by 400% after liberalization. In Tanzania, transaction costs decreased significantly following liberalization of coffee marketing, but with no significant supply response due to higher input prices (Winter-Nelson and Temu, 2002, 2005; Baffes,

2005b). Ultimately, the effects of liberalization on government revenue and poverty were indefinite (Winters, 2000; Winters et al., 2004).

The mixed impacts of export-crop trade liberalization on supply response and output pricing are partly explained by the inefficiencies in marketing systems among firms that replaced state marketing boards. In most of the countries discussed above, state marketing boards were taken over by large oligopsonistic firms. The economies of scale in export-crop marketing enjoyed by these firms might have discouraged easy entry of individual traders or small firms. This might have limited farmers' market access to similar marketing conditions experienced pre-liberalization. As a result, the pricing system imposed by oligopsonistic firms in some countries is more or less the same as that practiced pre-liberalization by state marketing boards. However, this was not the case for the liberalization of the coffee marketing board in Uganda. Similar to other countries, coffee marketing boards in Uganda applied fixed and uniform coffee prices before liberalization. However, liberalization enabled new players to enter the market at varying scales of operation ranging from individual traders to large export companies, thus allowing coffee prices to be determined by demand and supply in a relatively competitive domestic market.

This paper takes an approach that is missing in most studies reviewed on liberalization of export-crop marketing boards in Sub-Saharan Africa. I examine how liberalization of coffee marketing boards influenced the decision to participate in coffee production in Uganda, and then determine the effect of participation in coffee production on household poverty. The paper uses market access to measure the effect of liberalization on participation in coffee production because farmers' improved access to market is a key outcome of liberalization. Based on a simple theoretical framework, the paper examines empirically the relationship between distance to market and participation in coffee production in early stages of market liberalization and in the later years after liberalization. Farmers' participation in export crop production is a first step in determining the supply response following liberalization.

Marred by corruption and inefficiencies in service delivery, the state controlled Coffee Marketing Board (CMB) formed in 1929 was abolished in 1992, and the Uganda Coffee Development Authority (UCDA) was formed and became responsible for

monitoring and regulating the industry activities (for details see World Bank, 1999; Akiyama, 2001; Sayer, 2002). Prior to liberalization, CMB through official cooperative unions and societies offered a number of services to farmers including: providing input credit and coffee processing facilities, organizing blanket spraying of coffee trees, and most importantly providing easy access to the coffee market – where in some cases coffee stores were established in central places and in other cases cooperative trucks roamed around villages collecting coffee. Exclusively, however, CMB controlled coffee exports and fixed producer prices. Farmers received uniform coffee prices regardless of their location. This uniform pricing was, however, theoretical. In practice, farmers had to transport (or head load) their coffee to the collection centers or turning points for trucks. In other words, a farmer located at the coffee collection center received the same price as the farmer located a few kilometers away from the center. That is, distant farmers from the center had to incur the cost of transporting coffee to the center that was not accounted for in the price received.

After liberalization of CMB, several new players in coffee marketing emerged. These include large scale coffee processors that double as coffee exporters. These processors depend on agents and middlemen to supply coffee, who in turn depend on individual traders and brokers. Today, farmers receive prompt payment upon delivery of coffee beans to traders, which often delayed under the CMB system. Farmers are free to choose where and to whom to sell their coffee. This kind of market structure transition helps to identify the effect of market liberalization on entry into and exit from participation in coffee production as well as on household poverty.

The paper is outlined as follows. The next section develops the analytical framework. Section three describes the econometric estimation strategy. Section four presents data sources and simple statistics. Section five reports and discusses the main results and section six concludes.

## 2 Analytical framework of participation in coffee production

The analytical framework describes how farmers' decision to participate in coffee production is influenced by location, and how this changes with market liberalization. I present a stylized model of the situation before and after the policy, sufficient to capture the key features and generate testable predictions, while acknowledging that reality is more diverse. The set-up of the model draws on the work of Jacoby (2000), while the application to coffee liberalization is inspired by the particular situation in Uganda and the general literature on impact of economic liberalization, discussed above.

Denote the distance from the farm to the coffee collection center as  $h_d$  for  $d = a, b$ , where  $a$  and  $b$  identify the distance *after* and *before* liberalization, respectively. Transport costs, i.e., the per unit (kg) and per km costs to transport coffee or inputs for coffee production, are denoted by  $\tau_d$ .

The coffee price ( $p$ ) is determined by the household's location and the cost of transport, such that the effective (farm gate) price is:  $p - \tau_d h_d$ . Similarly, the effective unit input cost ( $v$ ) is:  $v + \tau_d h_d$ .

The opportunity costs of labor ( $w$ ) is assumed to depend on location, in the way that it decreases with the total distance from the collection center, as well as a vector of household specific and village location factors ( $z$ ), such as family labor and land, which make wage vary among households:  $w'_{h_d}(h_d, z) < 0$ . This declining  $w$  with distance is justified both by declining off-farm employment opportunities as one moves away from the center, and lower returns in alternative forms of self-employment, e.g., due to lower market prices. This assumption is also consistent with empirical evidence that rural wages decrease with distance from rural market centers (Sumner, 1981; Newman and Gertler, 1994; Abdulai and Delgado, 1999; Jacoby, 2000). The decline in the wage rate is also assumed to diminish with distance:  $w''_{h_d h_d}(h_d, z) > 0$ .

Coffee yield ( $q$ ) (output per acre) is a function of per-acre inputs of labor ( $l$ ) (both hired and family labor) and purchased inputs ( $x$ ) (e.g., fertilizers and pesticides):



$q = (x, l)$ , with standard neoclassical properties<sup>8</sup>. The farm profit at a particular location before and after liberalization is given as:

$$\pi_d = (p - \tau_d h_d)q - (v + \tau_d h_d)x - w(h_d, z)l \quad (1)$$

Equation (1) shows how coffee profits change with distance, before and after market liberalization. The lower effective output price and higher effective input price reduce profit as one moves away from the collection center, while a declining wage rate pulls in the opposite direction. Assuming the first order conditions<sup>9</sup> for profit maximization are met and given the assumption that  $w$  is convex in  $h_d$ , an interior solution is assumed to exist where these effects just cancel out each other, i.e., an optimal distance for coffee production where the profit is at its maximum:  $h_d^*$ . Using the envelope theorem, the impact of distance on farm profit is:

$$\frac{\partial \pi_d}{\partial h_d} = -\tau_d (q + x) - w'_{h_d} l \begin{cases} > 0 \text{ for } h_d < h_d^* \\ = 0 \text{ for } h_d = h_d^* \\ < 0 \text{ for } h_d > h_d^* \end{cases} \quad (2)$$

Empirical studies support the importance of location in affecting wages, input use and sales (profitability). Jacoby (2000) finds that both agricultural wages and fertilizer purchases decrease with distance from market centers in Nepal. Fafchamps and Hill (2005) show that coffee sales to the market decrease with increasing distance from market centers in Uganda. This may suggest that although labor costs are declining in market distance, the high marketing costs and less use of inputs like fertilizers associated with increasing market distance eventually lead to lower coffee returns.

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<sup>8</sup> The following properties are assumed to hold:  $f'_x, f'_l > 0$ ;  $f''_{xx}, f''_{ll} < 0$ ;  $f''_{xl} = f''_{lx} > 0$ .

<sup>9</sup> The first order conditions are:  $(p - \tau_d h_d) f'_x - (v + \tau_d h_d) = 0$ ;  $(p - \tau_d h_d) f'_l - w'_{h_d} = 0$

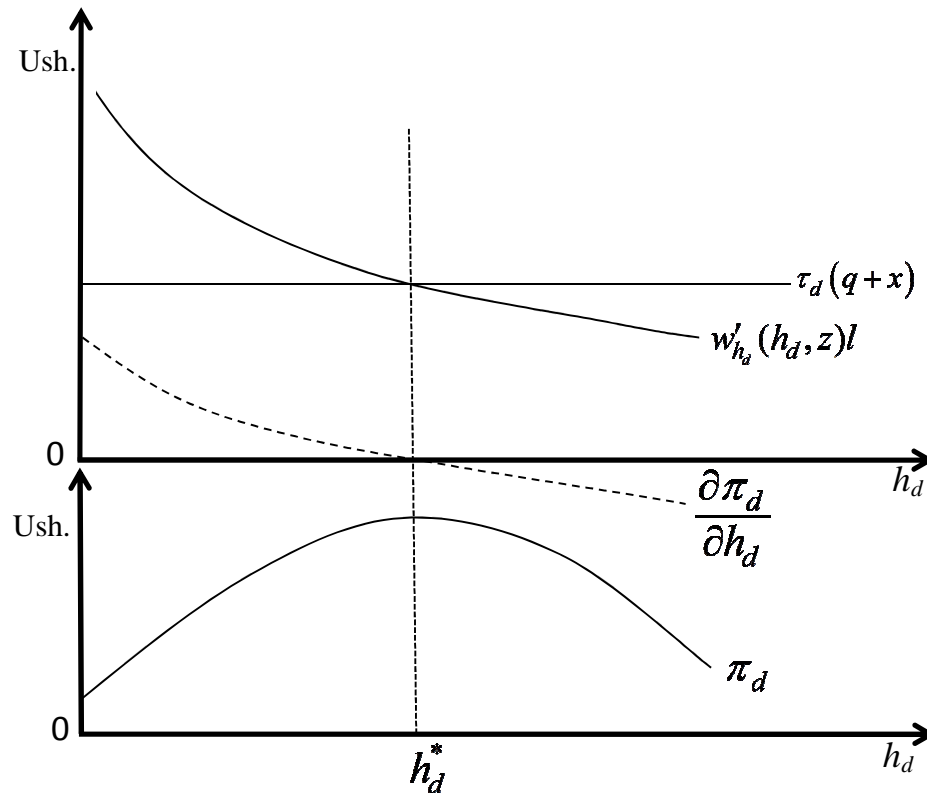


Figure 1. Coffee returns and distance to market (Ush. = Uganda shillings)

Within this simple modeling framework, market liberalization can be seen as a change in two factors. First, liberalization implied that a number of new coffee buying centers have been established in the villages or in smaller district markets, while before liberalization farmers delivered coffee to one central point.<sup>10</sup> The establishment of such centers can be analyzed as an exogenous shift in the distance from the farm household to the center. I pursue this in the empirical analysis, where distance to the nearest center is a key variable. Following liberalization, this distance has been reduced for some households.

Second, the transport costs per km have been lowered. The establishment of coffee buying centers, the increase in the number of traders and the resulting higher competition has had a major impact on the prices of coffee and inputs farmers face

<sup>10</sup> As noted, this is a stylized model, and in reality some of the newly established centers are also coffee factories. In other cases the new centers have emerged with itinerant traders that drive to the farms and buy coffee at the farm gate.

through changes in the transport costs. The farmers and itinerant traders are able to transport coffee to the collection centers at a much lower costs:  $\tau_a < \tau_b$ .<sup>11</sup>

Figure 1 shows that lower transport costs will move the distance that maximizes profit to the right ( $h_a^* > h_b^*$ ). Further, some households have ‘moved’ closer to the center as a result of the new centers being established (in reality: the centers moved closer to them, but in the model the center is fixed).

The model gives the relationship between distance and profit in coffee production, and not participation. The profitability is, however, dependent on household and village characteristics ( $z$ ). Given that households at a particular distance have different characteristics (and live in villages with different characteristics), the higher the profitability, the higher the share of households will find it profitable to participate in coffee production. We can therefore interpret the profit curve in Figure 1 to describe the pattern of participation in coffee production.

Depending on the location of the curves in the figure, and the location of the households along the x-axis, we can expect different relationships between coffee participation (profit) and distance to the centers. One possibility is a bell-shaped relationship between participation and distance to the market, as displayed in Figure 1: profit is first increasing as the effect of falling opportunity costs of labor outweighs transport costs for coffee inputs and outputs, reaches a maximum, and then declines as the transport costs component starts to dominate.

A second possibility is that most households are located to the left of  $h_d^*$ , thus we get a pattern of increasing participation with distance. A final and third possibility is that most households are located to the right of  $h_d^*$ , thus we get a pattern of a negative relationship between participation and distance.

While I cannot, based on the theory, identify which patterns to observe before and after liberalization, the claim is that liberalization made  $h_d^*$  move to the right and some households moved to the left in the figure. Thus, the four possible hypotheses are:

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<sup>11</sup> There have also been other changes between the time periods, i.e., both the central coffee market and inputs prices might have shifted, and so might the  $w(h_d, z)$  function. I choose to focus, however, on the two shifts as discussed in the main text.

1. Before liberalization a pattern of declining participation with distance is observed, while after liberalization a bell shaped relationship is observed.
2. Before liberalization a bell shaped relationship between participation and distance is observed, while after liberalization a pattern of increasing participation with distance is observed.
3. Before liberalization a pattern of declining participation with distance is observed, while after liberalization a pattern of increasing participation with distance is observed.
4. The same pattern is observed both before and after liberalization (declining, increasing, or bell-shaped).

The empirical analyses will identify the actual patterns before and after liberalization.

### 3 Econometric estimation strategy

#### 3.1 Participation in coffee production and market access

I estimate the probability to participate in coffee production as the function of market distance and other household and village characteristics as follows:

$$P_{ivt} = \rho_t + \beta_h h_{vt} + \beta_c c_{ivt} + \beta_v Z_{vt} + \beta_i Z_{ivt} + \beta_p Z_{ipvt} + \varepsilon_{ivt} \quad (3)$$

where  $P_{ivt}$  is the participation variable, coded 1 if household  $i$  in village  $v$  participates in coffee production in period  $t$  and 0 if the household does not participate.  $\rho_t$  is the time dummy picking up aggregate policy effects over time.  $h$  is, as defined above, the distance to the market center.  $c$  is the crop commercialization index (computed using the Herfindahl index) to control for household specific crop marketing heterogeneity.  $Z_{vt}$  and  $Z_{ivt}$  are vectors of other village and household characteristics.  $Z_{ipvt}$  is a vector of asset holding at the time of household formation and characteristics of parents to the household head, which will be used to control for selection bias into coffee production.  $\varepsilon_{ivt}$  is the composite error term for both household and village unobserved effects.

The main interest is to estimate parameter  $\beta_h$ . According to the theoretical predictions above, a nonlinear relationship between the likelihood to participate in coffee

production and  $h_{vt}$  is possible. To test the non-linearity between  $P_{ivt}$  and  $h_{vt}$ , the quadratic term of  $h_{vt}$  is included as an explanatory variable.

The challenge faced, however, is the consistent estimation of equation (3). The use of simple probit or logit estimation would be inappropriate since such estimation may not control for unobserved heterogeneity and capture important nonlinearities among some explanatory variables (Papke and Wooldridge, 2008). In particular, the use of ordinary probit or logit to estimate participation rates in coffee production may not adequately capture the diminishing effects of market distance in presence of unobservable heterogeneity that might be correlated with the error term. To overcome this challenge, Papke and Wooldridge (1996, 2008) recommend the use of quasi-maximum likelihood estimation (QMLE) with a probit link function and time averages of observed characteristics instead of using a fixed effects logit to achieve robust estimates with satisfactory efficiency properties. This is because the fixed effects logit estimation does not account for serial correlation (Papke and Wooldridge, 2008; Wooldridge, 2010). The variant of equation (3) estimated is:

$$P_{ivt} = \rho_t + \beta_h h_{vt} + \beta_c c_{ivt} + \beta_v Z_{vt} + \beta_i Z_{ivt} + \beta_p Z_{ipvt} + \beta_c \bar{c}_{iv} + \beta_v \bar{Z}_v + \beta_i \bar{Z}_{iv} + \varepsilon_{ivt} \quad (4)$$

where  $\bar{c}_{iv}$ ,  $\bar{Z}_v$  and  $\bar{Z}_{iv}$  are time averages of  $c_{ivt}$ ,  $Z_{vt}$  and  $Z_{ivt}$  respectively to control for unobserved village and household level heterogeneity and any possible correlation between  $\varepsilon_{ivt}$  and covariates.

### 3.2 Effect of participation in coffee production and market access on poverty

In the next step of the estimation, I attempt to measure the effect of participation in coffee production and market distance on household consumption expenditure and hence poverty level. There are several approaches to measure this impact. One approach uses a counterfactual framework to estimate the average treatment effect as the difference in consumption expenditure between coffee farmers and non-coffee farmers (Rosebaum and Rubin, 1983; Abadie *et al.*, 2004). Another approach uses the difference-in-difference to estimate before-after difference in the mean consumption of coffee farmers

(that is, before and after participation in coffee production) compared with the before-after difference in the mean consumption expenditure of non-coffee farmers in a defined period of time (Wooldridge, 2010). However, these approaches require data on consumption expenditure and other variables before and after participation in coffee production. Because of data limitations, I chose to use a simple two-step approach to estimate the impact of participation in coffee production and market distance on consumption expenditure.

In the first step, consumption expenditure is regressed on participation in coffee production and market distance while controlling for other variables. This estimation has, however, some specification problems. First, the difference in consumption expenditure between coffee and non-coffee households is expected to vary since coffee income is observed only for farmers who choose to participate in coffee production, and participation is possibly correlated with unobserved changes in coffee returns and village effects. Second, since coffee is a perennial and cash crop, coffee farmers tend to have extra land for annual food crops. This suggests that farmers with small landholdings are less likely to participate in coffee production. Thus, identifying the effects of participation in coffee production on household poverty requires controlling for potential selection bias into coffee production. I follow the Semykina and Wooldridge (2010) procedure, which controls for combined problems of unobserved village and household effects and selection bias. The procedure involves estimating equation (4), for each time period and obtaining the inverse Mills ratio ( $\hat{\lambda}_{ivt}$ ). Then for each farmer, the observed consumption expenditure ( $E_{ivt}$ ) is estimated by fixed (or random) effects regression with  $\hat{\lambda}_{ivt}$  as one of the explanatory variables as follows:

$$E_{ivt} = \gamma_c P_{ivt} + \gamma_h h_{ivt} + \gamma_L L_{ivt} + \hat{\lambda}_{ivt} + \xi_{ivt} \quad (5)$$

where  $L_{ivt}$  is a vector of village and household factors.  $\gamma_c$  and  $\gamma_h$  are parameters of interest to be estimated.  $\gamma_L$  is the vector of parameters corresponding to  $L_{ivt}$  to be estimated.  $\xi_{ivt}$  is a composite error term. The rest of the terms are as defined earlier. Note

also that consistent estimation of (5) requires some exclusionary restrictions into participation in coffee production. These exclusion restriction variables are included in (4). I however use different exclusion restriction variables due to different datasets used in analysis.

In one dataset, farming as a major occupation of parents is used as an exclusion restriction variable. It is reasonable to believe that children whose parents are largely dependent on farming are more likely to engage in farming as well, that is, the decision taken by children to choose which crop to produce may be influenced by the parents' crop production decisions, but these parents' decisions may not have direct effect on their current children's (current household's) consumption expenditure. In another dataset, I use household land stock owned by parents of both head and spouse at the time of household formation. The evidence in Paper I of this thesis shows that land accumulation of 'current' household is significantly influenced by land stock owned by parents. It is, thus, more likely that parents' landholding stock may influence the current household's decision to choose which crop to produce, but the parents' landholding may not have direct effect on the current household's consumption expenditure. Overall, these exclusion restriction variables are expected to explain the variation in the probability to participate in coffee production but may not affect the current level of household consumption expenditure (beyond the impact through participation in coffee production).

In the second step, estimates obtained from (5) are used to estimate the impact of participation in coffee production and market distance on household poverty using the simple simulation approach. The approach closely follows the Datt and Jolliffe (2005) simulation procedure. Using estimates from (5), consumption expenditure for household  $i$  is estimated as:

$$\hat{E}_{ivt} = e^{\hat{\alpha}'x_{ivt} + \hat{\sigma}^2/2} \quad (6)$$

where  $\hat{E}_{ivt}$  denotes predicted consumption expenditure in logarithmic form,  $\hat{\alpha}'x_{ivt}$  are parameter estimates from (5),  $\hat{\sigma}$  is root mean square estimate, and  $\hat{\sigma}^2/2$  is needed for

lognormal transformation (Greene, 2003) of consumption expenditure. Then the corresponding probability ( $\hat{\omega}_{ivt}$ ) of household  $i$  being poor is given by:

$$\hat{\omega}_{ivt} = \Pr\left(\ln \hat{E}_{ivt} < \ln L_p\right) = \Phi\left[\left(\ln L_p - \hat{\alpha}'x_{ivt}\right)/\hat{\sigma}\right] \quad (7)$$

where  $L_p$  is the poverty line,  $\Phi$  is the cumulative distribution function and the rest of the variables are as defined earlier. The estimate in (7) gives the probability that the consumption expenditure of household  $i$  given the probability distribution has a value below the poverty line.

To determine the impact of participation in coffee production and market distance on consumption expenditure (and hence household poverty), I run a set of policy simulation experiments using estimates from (5) to predict consumption expenditure in (6) and poverty level in (7). Details of these policy experiments are described later in the results section. The purpose of simulation experiments is to examine how policy changes aimed at increasing participation in export crop production impact on household poverty levels, i.e., the impact of simultaneous changes in market access and the opportunity for farmers to participate in coffee production. To perform these experiments, I make changes in market distance, participation in coffee production and access to landholding. Given the uncertainty around the predicted consumption expenditure or poverty level, it would be inappropriate to compare simulated consumption expenditure and poverty levels against actual levels, hence I use predicted mean consumption expenditure and poverty levels from equations (6) and (7) as the base simulation estimates.

#### **4 Data sources and descriptive statistics**

To test hypotheses stated in section 2, I use two different datasets collected over different time periods. The first dataset includes panel surveys in 1992 and 1999/2000, which capture the gradual process of liberalization of coffee marketing, and the second dataset includes surveys in 2003 and 2009, which capture the post liberalization effects. As earlier mentioned, the functions of CMB were abolished in 1992 but CMB continued to export coffee while operating as a limited enterprise renamed as CMB limited. In the



same year a tax on coffee exports was removed, and in 1995, a mandatory floor-export price was abolished. While in 1994/95 a coffee stabilization tax was introduced and abolished in 1996. In 1997/98 CMB limited withdrew completely after its export shares declined considerably (for details, see World Bank, 1999; Akiyama, 2001; Sayer, 2002).

The first panel dataset consists of two nationally representative surveys, the 1992 Integrated Household Survey (IHS) and the 1999/2000 Uganda National Household Survey (UNHS). IHS had a random sample of 9,921 households and UNHS collected data from 10,700 households between August 1999 and September 2000. UNHS included more than 1,000 households that were surveyed in the 1992 IHS. The analysis only uses the sub-sample of panel households that lived in coffee producing districts. I use a sample of 532 households that participated in each of IHS and UNHS rounds. These panel households come from 16 districts. Both surveys included community (village) level questionnaires that collected information on access to social services. The household surveys collected detailed information on socio-economic activities and household expenditure. Details of sampling procedure are given in GOU (1993) and UBOS (2001).

The second panel dataset comes from household surveys carried out by Foundation for Advanced Studies on International Development (FASID), Graduate Institute for Policy Studies (GRIPS) and Makerere University. The first round included 940 households in 2003 and 819 households were re-surveyed in 2009. Also community level surveys accompanied household surveys. I use 603 households from 19 coffee producing districts that participated in each survey round. Kijima, Matsumoto and Yamano (2006) provide details of the sampling procedure.

Although the two different panel datasets come from different sampling procedures, a large number of households come from same districts covered by all surveys. Out of the 16 districts covered by both IHS and UNHS, 12 districts are among the 19 where FASID, GRIPS and Makerere University sampled households. The homogeneity of district characteristics and the fact that sample households and communities were randomly selected helped in making some comparisons of the results from the two different datasets. As described earlier, the household surveys of 1992 – 2000 cover well the early stages of liberalization of the coffee marketing board. I refer to this period in subsequent discussions as “early years of coffee market liberalization

(CML)”, and the 2003 – 2009 panel survey period as “later years of CML”. Also for simple presentation, I refer to IHS and UNHS surveys as “UNHS”, and FASID, GRIPS and Makerere University surveys as “FASID”. Table 1 reports descriptive statistics.

Table 1 shows some of the key variables used in analysis. The results show a substantial increase in the proportion of households producing coffee over time. However, this increase is not matched with easy access to output markets in early years of CML. The average distance to the main market accessed by the village remained fairly the same, about 9 km between the two periods but with low standard deviation of 10.9 in 2000 compared to 14.8 in 1992, suggesting that some communities gained access to market. This is reflected in the increased availability of transport trucks up from about 10% in 1992 to 21% in 2000. Also important from Table 1 is the monthly consumption expenditure, computed as the sum of monthly food expenditure, non-food expenditure and food consumption from own production. Consumption expenditure values for 1992 and 2003 were adjusted to 1999/2000 and 2009 values, respectively, using the consumer price index. Consumption expenditure is further normalized by adult equivalents (AE) to account for different age-gender requirements in the household (Appleton, 2001). However, I was unable to compute to total household income due to data limitations, but consumption expenditure can act as good proxy, and is indeed often the preferred variable to measure (changes in) poverty.

Table 1. Descriptive statistics (averages) of key variables

	1992 (N=532)	2000 (N=532)	2003 (N=603)	2009 (N=603)
Participation in coffee production	.29	0.49	0.44	0.55
Monthly expenditure per adult equivalent (PAE) (US\$)	17.70	20.20	18.80	22.50
<i>Village characteristics</i>				
Distance from village center to market (km)	8.82	8.88	3.02	.79
Average coffee price (Ush. per kg)**	204	542	1347	1244
Availability of transport trucks	.10	.21		
Share of villages that experienced drought	.10	.44		
Number of local farmer organizations			1.11	3.34
Size of the village (sq. km)			9.74	8.65
Share of households having at least two meals a day at time of survey			.73	0.54
Share of households having at least two meals a day between harvests			.56	.58
<i>Household characteristics</i>				
Commercialization index (Herfindahl index)	.97	.80	0.89	.89
Farmland (acres)	3.21	3.44	6.57	7.92
Tropical livestock units (TLU)			2.70	3.00
Number of members employed in off-farm activities	.24	.16	.70	.69
Number of male members aged 15-65 years	1.22	1.21	1.91	2.48
Number of female members aged 15-65 years	1.33	1.41	1.93	2.23
Number of members with primary education	2.55	3.27	4.27	4.28
Number of members with post-primary education	.38	.48	1.26	1.10
Age of household head	43	49.9	45.2	50.7
Share of male headed households	.80	.74	.89	.88
<i>Initial assets and characteristics of parents</i>				
Landholding of parents at the time of household formation (acres)				20.70
Household assets excluding land at the time of household formation (US\$)				229
Share of fathers with formal education		.36		
Share of mothers with formal education		.19		
Share of fathers with farming as major activity		.80		
Share of mothers with farming as major activity		.87		

Expenditure values are expressed in 1999/2000 and 2008/09 prices for UNHS and FASID respectively. Average official exchange rates in 1992, 2000, 2003 and 2009 were: 1,134; 1,644; 1,964 and 2,030 Uganda Shillings (Ushs). per US\$, respectively. \*\* Coffee prices are in 2000 and 2009 values adjusted from 1992 and 2003, respectively, using producer price index

## 5 Results

The first part of the results examines the relationship between participation in coffee production and market access. The second part reports the results of how participation in coffee production influences household expenditure. This is followed by simulation experiments to determine the impact of participation in coffee production and market access on household poverty. The last part is a robustness check of the simulation results.

### 5.1 Participation in coffee production and market access

I begin by reporting the bivariate relationship between participation in coffee production and distance to the market. Figure 2 shows evidence corresponding to the theoretical predictions. The results show approximately both U-shaped and bell-shaped (inverted U) relationships between the probability to participate in coffee production and market distance in early and later years of CML, respectively. Table 2 reports similar results after controlling for other household and village effects. As a robustness check, Figure 3 uses the expected value of participation in coffee production estimated using estimates in Table 2. Figure 3 reports relationships similar to those observed in Figure 2.

In Figure 2, about 21% of sample households in the 1992/2000 dataset have a distance to the market greater than the turning point of about 5.5 km (i.e., the logarithm of 1.7). Note that this turning point is not the one discussed in Figure 1, as this is for a U-shaped relationship. The majority of the sample households (79%) fall on the declining part of the curve, that is, the probability to participate in coffee production largely declined with distance from the market center in early years of CML. A declining relationship is compatible with the theoretical framework developed in section 2, while a U-shaped relationship was not a prediction. Two explanations are possible for this relationship in the early years of CML.

One, off-farm wage rates are expected to decrease with distance from markets, as argued in section 2. The bivariate relationships in Figures 4 and 5 confirm this relationship. However, the UNHS model does not include the wage variable because a large number of communities had missing data on wage. In the sub-sample estimations where wage data were available, I did not observe any significant relationship between wage and participation in coffee production. A similar insignificant relationship is observed in the FASID data. If the off-farm labor market is largely missing in remote

areas, then a weak relationship between wage and participation in coffee production can be expected. On the other hand, the results show that having more household members engaged in off-farm activities is associated with less participation in coffee production. Simple correlation results (not shown) from UNHS data show a negative and significant ( $p < 0.05$ ) relationship between the number of household members employed in off-farm activities and market distance. FASID data shows similar results albeit insignificant. These results suggest that farmers farther away from markets have lower opportunity cost of labor compared to farmers nearer to markets whose members are more likely to engage in off-farm activities and to receive higher wage rates.

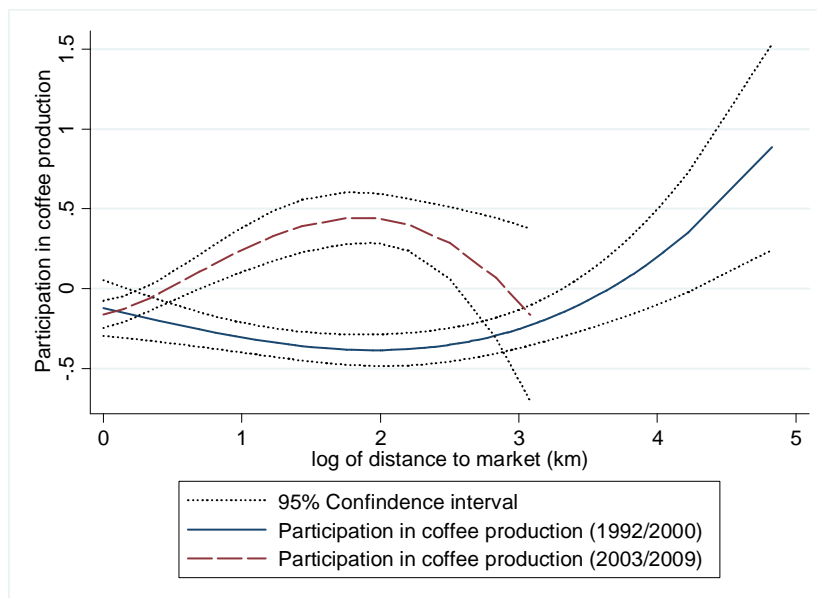


Figure 2. Fractional-polynomial prediction with probit estimation of participation in coffee production and distance to the market. *Note: About 21% and 55% of observations in 1992/2000 and 2003/2009 data, respectively, have the log of distance to market greater than the corresponding turning points of about 1.7 and 1.75.*

Two, it is also possible that landholding size and accumulation among farmers nearer to markets is limited compared to farmers farther away from markets. This would suggest that farmers nearer to the market produce at an intensive margin while those farther away produce at an extensive margin, with opportunities to produce non-perishable cash crops like coffee.

Turning to results from FASID data collected more than a decade after market liberalization in Uganda, Figure 2 shows that 55% of sample households in the 2003/2009 dataset have a distance to market greater than the turning point of 5.8 km (i.e., the logarithm of 1.75)<sup>12</sup>. This means that nearly half of the sample households (45%) fall on the rising part of the curve, that is, in later years of CML the probability to participate in coffee production increases from the market center at a decreasing rate up to 5.8 km before declining at greater distances.

These findings are generally consistent with the theoretical prediction in section 2, and in particular the first hypothesis: a generally declining relationship between coffee participation and distance before and in early years after liberalization, and a bell-shaped relationship after liberalization. This finding is also consistent with earlier work of Fafchamps and Hill (2005), although they do not explicitly discuss the bell-shaped relationship. They observe that most coffee sales occur at farm gate in Uganda. Farmers located at a low to medium distance from the market center are easily accessed by the itinerant traders, and they receive quite good farm gate prices. The itinerant traders have limited chances of cheating the farmer by offering lower prices. First, unlike other crops, coffee price information is easily obtainable by farmers through radio programs by UCDA, newspapers, availability of traders and itinerant traders in rural areas. Second, during the peak season there is a large number of itinerant traders, which keeps the demand and the price for coffee high. In effect, the transport costs have been lowered significantly in the new marketing regime, and – at least for a large segment of the households, the probability to participate in coffee production can be expected to increase as one moves away from market centers. However, the probability to participate in coffee production decreases for farmers located in more distant villages, which are inaccessible by itinerant traders or the volumes to be traded are too small to defend sending their trucks to these areas.

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<sup>12</sup> Note that the turning points of participation in coffee production with distance in early and later years of CML are nearly the same: 5.5 and 5.8 km respectively. This should not be interpreted as if the average distance to the market increased after liberalization; instead these results reflect how liberalization has changed the pattern of participation in coffee production along the market distance. Results in Table 1 show that the average distance to the market significantly decreased after liberalization.

Table 2. Participation in coffee production and distance to the market

	UNHS (1992-2000)	FASID (2003-2009)
	Coffee producer (0/1)	Coffee producer (0/1)
Distance to market (km)	-.024*** (.008)	.090*** (.026)
Distance to market squared *10 <sup>-2</sup>	.030*** (.011)	-.281* (.150)
Crop commercialization index	-1.960*** (.427)	-.872*** (.329)
log of operational land (acres)	.308*** (.106)	.268*** (.080)
Year dummy	.181 (.185)	.344*** (.122)
log of coffee price at community level (Ush. per kg)	.303** (.145)	.462*** (.106)
Number of members employed in off- farm activities	-.322*** (.125)	.038 (.058)
Share of males aged 15-65 years	.665** (.308)	-.371 (.298)
Share of females aged 15-65 years	-.271 (.417)	-.180 (.385)
Tropical livestock units		-.043*** (.012)
log of farm labor wage per day		-.031 (.117)
Other village controls	yes	yes
Other household controls	yes	yes
Characteristics of parents	yes	yes
Household and village fixed effects	yes	yes
Constant	5.724*** (1.278)	-4.720*** (1.708)
Chi square value	214.16***	173.55***
Number of observations	1064	1206

Figures in parentheses are robust standard errors. \*\*\*, \*\*, \* denote estimated parameter is significantly different from zero at the 1%, 5% and 10% test levels, respectively.

*Notes: Other village controls included in the UNHS model are: dummies for availability of transport trucks and for whether a village experienced drought during the cropping seasons prior to the survey. Village controls included in the FASID model are: number of local farmers' organizations, share of households having at least two meals a day at the time of survey and share of households having at least two meals a day between harvests. Other household controls included in both models are: age of household head, sex of the household head, number of household members with primary education and number of household members with post-primary education. Characteristics of parents in the UNHS model included education and occupation dummies for both father and mother of household head. The FASID model also included the value of household assets owned at the time of household formation, and land owned by parents at the time of household formation.*

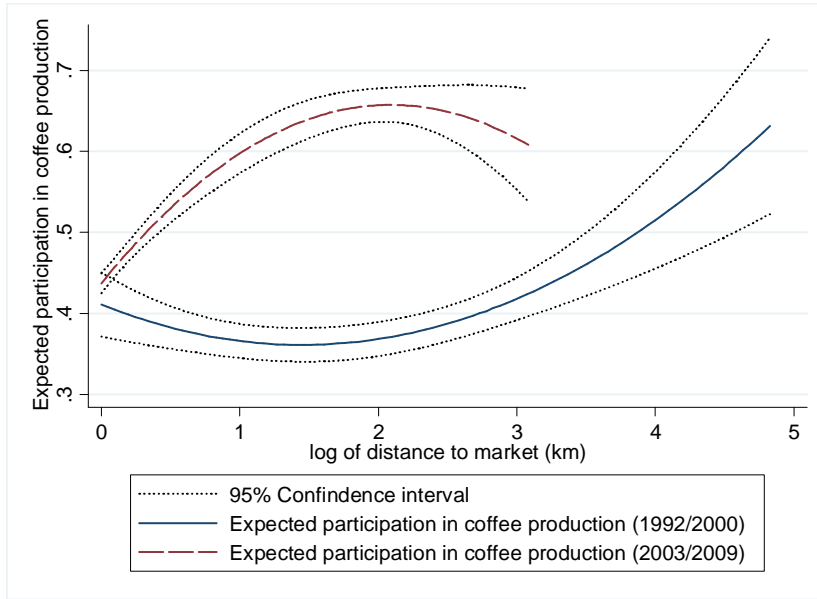


Figure 3. Quadratic prediction of expected value of participation in coffee production, generated from models in Table 2 and distance to the market.

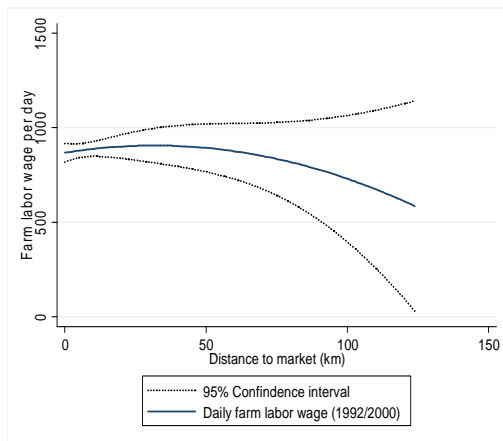


Figure 4. Quadratic prediction of farm labor wage on distance to market (UNHS data)

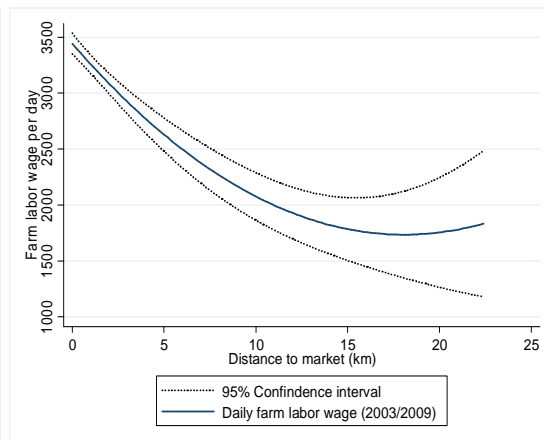


Figure 5. Quadratic prediction of farm labor wage on distance to market (FASID data)



An important result in both UNHS and FASID data is the role of farm size holding. The results show a positive and significant relationship between participation in coffee production and farm size in both early CML and later years of CML. This means that irrespective of market constraints, farm size is a key factor for income diversification through a shift from subsistence production to a crop mix of food and cash crop production.

## 5.2 Effect of participation in coffee production on household expenditure

As mentioned in the first section, one of the main objectives of market liberalization was to increase aggregate supply of export crops by improving market access coupled with better output prices that would eventually reduce poverty among farmers. The analysis that follows explores whether indeed participation in coffee production following market liberalization reduced household poverty. Before presenting estimation results from (5), Figures 6a and 6b show how annual *gross* coffee income per adult equivalent varies with market distance for the sub-sample of coffee farmers. Net coffee income could not be used because of data limitations, thus the interpretation of the figures below should be treated with care. Although the figures show widening confidence intervals, there is *prima facie* evidence consistent with theoretical expectations reported in Figure 1. The results show that coffee income increases with market distance at a decreasing rate before declining at farther distances from market centers.

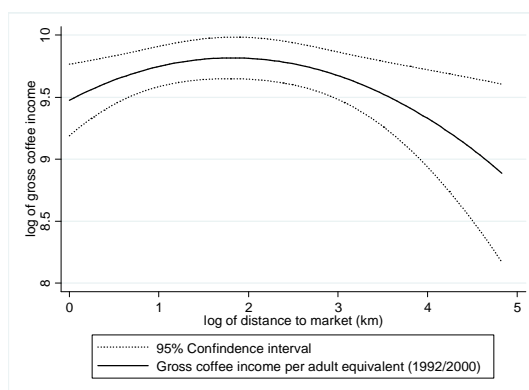


Figure 6a. Quadratic prediction of annual gross coffee income per adult equivalent on distance to market (UNHS data)

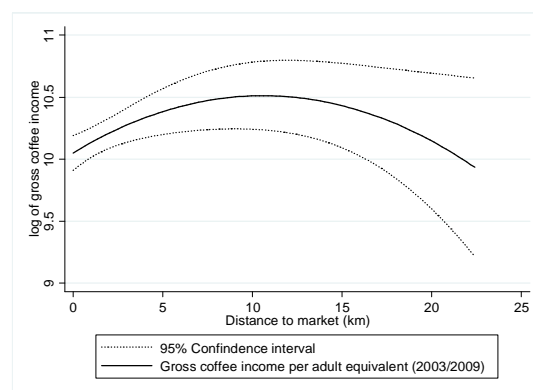


Figure 6b. Quadratic prediction of annual gross coffee income per adult equivalent on distance to market (FASID data)

Table 3 reports estimates from equation (5). In addition to controlling for selection bias described in section 3, I also test for endogeneity between consumption expenditure and participation in coffee production. As mentioned earlier, the exclusion restriction variables used to instrument for participation in coffee production are: farming as the main occupation of parents of the household head in UNHS data, and land stock owned by parents at the time of the household formation in FASID data. The Wu-Hausman test for endogeneity rejects the hypothesis that participation in coffee production is endogenously determined in the consumption expenditure model. But selection bias into participation in coffee production exists as shown by the significant coefficient for the inverse Mills ratio. Estimation of inverse Mills ratio follows the procedure described in section 3.2. The first stage results to generate inverse Mills ratio are not shown, but similar variables used in Table 2 were used (excluding time averages of explanatory variables). Equation (5) is estimated by including individual household dummies to control for household fixed effects and estimated inverse Mills ratio to control for selection bias (Semykina and Wooldridge, 2010).

Models 1 and 3 in Table 3 report results without controlling for possible non-linear relationships associated with market distance. Compared to Model 1, Model 2 shows that in early years of CML market distance was non-linearly related to consumption expenditure. That is, farmers nearer to markets had better consumption expenditure levels compared to those farther from the markets. On the other hand, in later years of CML, Model 4 shows negative but insignificant coefficients on both linear and quadratic terms of market distance. Without a quadratic term, Model 3 shows a weak significance of this linear relationship. I consider estimates in Models 2 and 3 to be the main estimates.

As expected, holding productive assets like land and livestock significantly raises consumption expenditure. Most importantly, there is a positive and significant relationship between consumption expenditure and participation in coffee production. This means that farmers engaged in coffee production have higher expenditure levels than non-coffee farmers. Whether this improvement is evenly distributed among coffee farmers with respect to market distance is the question I turn to using simulation results.

Table 3. Determinants of consumption expenditure

	UNHS (1992 – 2000)		FASID (2003 – 2009)	
	Model 1	Model 2	Model 3	Model 4
Participation in coffee production (0/1)	.138** (.066)	0.128** (.065)	.187** (.073)	.187*** (.070)
Distance to market (km)	-.0004 (.002)	.011*** (.004)	-.011* (.006)	-.010 (.017)
Distance to market squared (km) * 100 <sup>-2</sup>		-.015*** (.005)		-.004 (.099)
log of farm size (acres)	.138*** (.048)	.143*** (.048)	.199*** (.046)	.199*** (.050)
Household size	-.068*** (.013)	-.067*** (.013)	-.055*** (.011)	-.055*** (.012)
Number of household members employed in off-farm activities	-.101* (.055)	-.094* (.054)	.011 (.035)	.011 (.035)
Share of household members with primary education	.284** (.128)	.273** (.126)	-.177 (.170)	-.178 (.151)
Share of household members with post primary education	.686*** (.250)	.717*** (.248)	-.368 (.330)	-.367 (.282)
Age of household head	.017*** (.005)	.017*** (.005)	.013*** (.005)	.013*** (.004)
Male headed household (0/1)	-.270** (.133)	-.254* (.130)	.127 (.201)	.127 (.143)
Tropical livestock units			.019*** (.007)	.019*** (.007)
Inverse mills ratio	-.174** (.068)	-.193*** (.068)	-.167* (.093)	-.167* (.097)
Constant	9.297*** (.355)	9.308*** (.344)	10.778*** (.426)	10.777*** (.512)
R <sup>2</sup>	.607***	.614***	.693***	.693***
Standard error of regression	.556	.551	.584	.585
Wu-Hausman F-test (F-value)	.005	.920	1.894	1.856
Number of observations	1064	1064	1206	1206

Figures in parentheses are robust standard errors. \*\*\*, \*\*, \* denote estimated parameter is significantly different from zero at the 1%, 5% and 10% test levels, respectively.

### 5.3 Effect of participation in coffee production and market distance on poverty

To test the effect of participation in coffee production and distance to the market on household poverty, I use estimates from Models (2) and (3) in Table 3 to run a set of policy simulation experiments. The inference drawn from policy experiments depends on normally distributed residuals (Greene, 2003). The test for the normality of residuals from Models (2) and (3) is done using both the Shapiro-Wilk test for normality and kernel density plot. The Shapiro-Wilk test for normality fails to reject the hypothesis that Model (2) residuals are normally distributed, but the test rejects normality of Model (3) residuals. Although Kernel plots in Figures 7a and 7b show that residuals are fairly normally distributed, simulation results from Model (3) should be interpreted with caution.

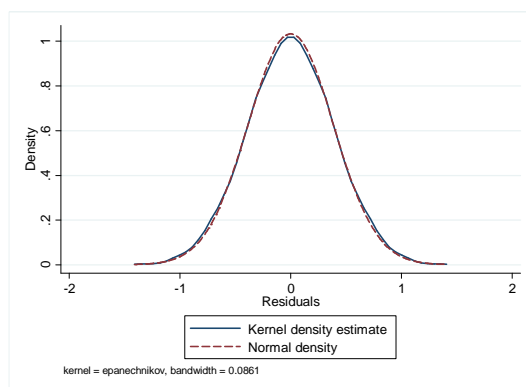


Figure 7a. Distribution of residuals from Model (2) in Table 3

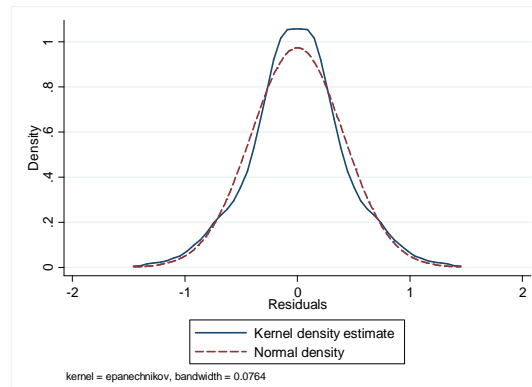


Figure 7b. Distribution of residuals from Model (3) in Table 3

Given the uncertainty around the predicted consumption expenditure or poverty level, it would be inappropriate to compare simulated consumption expenditure and poverty levels against actual levels. As the base simulation, I use the predicted consumption expenditure and poverty level obtained using actual levels of variables in Models (2) and (3). Table 4 reports base simulation estimates for each survey period for comparison with actual values to test the validity of the simulation results.

Table 4. Base simulation of consumption expenditure and poverty

	UNHS		FASID	
	1992	2000	2003	2009
Mean of consumption expenditure per adult equivalent (US\$ per month)	22.4	19.4	21.3	24.4
Poverty headcount (%)	51.1	31.4	34.0	26.4

Expenditure values are expressed in 1999/2000 and 2008/09 prices for UNHS and FASID data respectively.

Table 4 reports both simulated mean monthly consumption expenditure per adult equivalent and poverty levels. Poverty levels are computed using an updated poverty line of Appleton (2001).<sup>13</sup> The results show that the simulated mean monthly consumption expenditures are close to the actual mean values reported in Table 1. The sub-sample poverty estimates are fairly close to earlier estimates using the same poverty line. Appleton (2003), using the full sample of the same UNHS datasets used in this paper, found that 56% of Ugandans were categorized as poor in 1992, dropping to 35% in 1999-2000. UBOS (2010), using national household surveys, classified 39% of Ugandans as poor in 2002-2003, falling to 25% in 2009-2010.

#### 5.4 Policy simulation experiments

*Policy experiment I:* The first policy experiment is run as a two-stage procedure. In each stage, I observe changes in households' monthly consumption expenditure and poverty levels. In stage one, non-coffee farmers are granted an opportunity to begin producing coffee. In stage two, in addition to stage one, marketing opportunities are brought nearer to farmers by reducing the market distance by 30%, 60%, 90% and 99%. I only report results for the affected sub-sample, that is, the households directly targeted by the policy intervention. The percentage change in consumption expenditure and poverty levels is measured against the base simulation results from respective targeted groups of farmers. The results for the full sample follow similar patterns, reported in Table 5 and Figures 8a and 8b.

<sup>13</sup> Uganda does not have an official poverty line. The poverty line commonly used by government statistical department was derived by Appleton (2001) using household survey data of 1993/94. Appleton's monthly poverty line for rural areas is Ush. 15,548 per adult equivalent in 1993 prices. I adjust this poverty line using consumer price index.

Table 5. Simulation results: changes in mean consumption expenditure and poverty levels

Description of simulation	UNHS (1992 – 2000)		FASID (2003 – 2009)			
	% of full sample affected	Overall % change in mean consumption	Overall % change in headcount poverty	% of full sample affected	Overall % change in mean consumption	Overall % change in headcount poverty
Allow non-coffee farmers to produce coffee	45.9	16.2	-15.1	37.6	20.6	-20.3
Allow non-coffee farmers to produce coffee with land redistribution	26.5	22.5	-18.8	19.7	58.6	-38.6
Allocate more land to coffee farmers with less 60 <sup>th</sup> percentile of land distribution	17.3	18.8	-12.9	26.3	11.9	-10.4

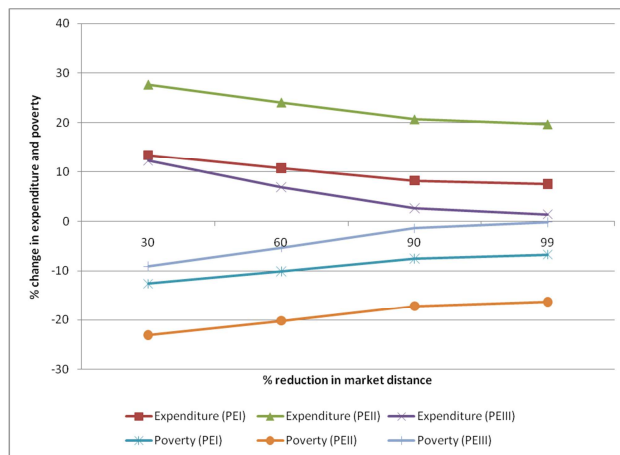


Figure 8a. Changes in poverty headcount and market distance (UNHS data).  
 Note: PE = Policy Experiment.

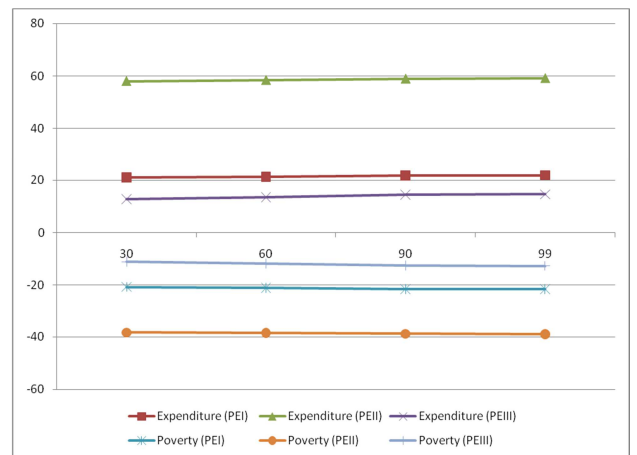


Figure 8b. Changes in poverty headcount and market distance (FASID data).  
 Note: PE = Policy Experiment .

Experiment I involves 46% and 38% of the full sample in early and late years of CML respectively. The results from stage one show that allowing non-coffee farmers to begin producing coffee would increase the overall monthly consumption expenditure by 16% in early years of CML and by 21% in later years of CML, and reduce the proportion of the poor households by 15% and 20%, respectively. Figures 8a and 8b report stage two results with curves labeled (PEI). Allowing non-coffee farmers to begin producing coffee and simultaneously increasing their market access benefits farmers farther away from market centers relative to those nearer to the market center in early years of CML. Despite the policy to reduce market distance having large and favorable impacts on

expenditure and poverty levels in early years of CML, these policy impacts appear to be the same for both households nearer and those farther away from the market centers in later years of CML.

*Policy experiment II:* Like in experiment I, non-coffee farmers are targeted but this time with land redistribution. Land is redistributed from large landholders to the landless and small landholders. In each district, eligible households for farmland giveaways are those holding land in excess of the 60<sup>th</sup> percentile regardless of whether they are coffee producers or not. All farmland above the 60<sup>th</sup> percentile is available for redistribution to eligible households within the same district. However, for this experiment, only 75% of excess farmland is available for redistribution, the remaining 25% is considered in experiment III below. Eligible farmers are: (i) non-coffee farmers at time period  $t$ , that is, if a farmer was not a coffee producer, say in 1992 but a producer in 2000, he/she would only be eligible in 1992 but not in 2000; (ii) non-coffee farmers holding farmland less than 60<sup>th</sup> percentile at time period  $t$ ; (iii) non-coffee farmers without any household members who had attained post-primary education at time period  $t$ . This last condition is necessary to capture family labor availability. Simple correlation coefficients show a positive and significant ( $p < .0001$ ) relationship between off-farm employment and post-primary education in both early (0.283) and later (0.116) years of CML. Any farmer fulfilling all the above three conditions was eligible to a share of land available for redistribution depending on how much farmland the farmer had. The land redistribution formula is given by:

$$R_{emt} = \omega_{emt} * \left( \sum_{e=1}^n \omega_{emt} \right)^{-1} * \theta x land_{mt}; \quad \omega_{emt} = \frac{1}{A_{emt}} \quad (8)$$

where  $R_{emt}$  is the amount of land given to an eligible farmer  $e$  in district  $m$  at time period  $t$ .  $A_{emt}$  is the farm area owned by the farmer. If the farmer is landless, then  $\omega_{emt} = 1$ . Giving the landless farmer a weight of 1 means that such a farmer gets a larger share of available land for redistribution relative to those farmers with some land. For example,

for a farmer holding 2 acres,  $\omega_{emt} = .5$ , while for the one holding 1 acre,  $\omega_{emt} = .75$ .  $xland_m$  is the sum of all excess land above the 60<sup>th</sup> percentile in the district.  $\theta$  equals to 0.75 for this experiment as mentioned earlier. Table 5 reports overall effects on targeted farmers, comprised of 27% and 20% of full sample in early and later years of CML respectively. The effects of improving market access to these farmers are reported by curves labeled (PEII) in Figures 8a and 8b.

Compared to experiment I, large welfare impacts are observed when participation in coffee production is considered simultaneously with an opportunity of land redistribution. The overall mean expenditure of targeted households would increase by 23% in early years and by 59% in later years of CML, and reduce poverty levels by 19% and 39% respectively. Similar to the experiment I effects, improving market access would mainly benefit farmers distant from market centers in early years of CML, but would not affect the distribution of welfare benefits in later years of CML.

*Policy experiment III:* The third experiment targets coffee farmers with land constraints. In this experiment, I distribute the remaining 25% of excess land available for redistribution in each district to a group of eligible coffee farmers. Specifically, eligible coffee farmers are those holding farmland less than the 60<sup>th</sup> percentile in the district at time period  $t$ . I use the same formula as in (8). This group of farmers included 17% and 26% of the full sample in early and later years of CML respectively. Table 5 reports the overall results. Figures 8a and 8b report associated results of market access represented by curves labeled (PEIII). Unlike experiments I and II, the results show that the welfare of coffee farmers would not improve as much as that of non-coffee farmers. In general, the policy initiative would improve the mean consumption expenditure by 19% in early years and by 12% in later years of CML, and reduce poverty levels by 13% and 10% respectively. Consistent with experiments I and II, improvement in market access would benefit farmers distant from markets centers in early years of CML, but with nearly uniform effects in later years of CML.

The simulation results paint a picture that is consistent with the theoretical model. If farmers are assured of market access, then one would expect increasing participation in coffee production in places farther away from market centers where land is abundant and



with relatively cheap labor. However, the flipside of the simulation results is that while improved market access would be an incentive for non-coffee farmers to engage in coffee production, such a shift to export crop production may lead to increased poverty levels. As simulation results imply, high welfare gains from coffee participation accrue to those farmers with larger landholding or those able to acquire more land. To substantiate these interpretations, I carry out a sensitivity analysis on participation in coffee production and headcount poverty using transition matrix based actual data.

### **5.5 Participation in coffee production and poverty dynamics**

I use consumption expenditure per adult equivalent described in Table 1 to construct poverty classes using the Appleton (2001) poverty line. The results are reported in Table 6, and are meant to provide supportive evidence for simulation results, and thus descriptive in nature. Caution should therefore be exercised in interpreting the results since the analysis focuses on consumption expenditure and participation in coffee production without controlling for other observed and unobserved heterogeneity across households. In general, the percentage of households falling into poverty is substantially higher than the percentage exiting poverty across all study periods. The sample results show that participation in coffee production exacerbated this problem during early years of CML compared to later years of CML. During the early years of CML, the majority of coffee farmers (70%) fell into poverty compared to only 54% of non-coffee farmers. Correspondingly, the percentage exiting poverty was higher among non-coffee farmers (34%) than it was among coffee farmers (28%) in the same period. However, the proportion of chronically poor non-coffee farmers was 16 percentage points higher than that of coffee farmers, 46-30 percent during early years of CML.

On the other hand, participation or non-participation in coffee production seems to make no difference in poverty dynamics in later years of CML. In later years of CML, I observe only a five-percentage point difference between coffee farmers and non-coffee farmers falling into poverty: 57% for the former and 62% for the latter. Further, I find a two-percentage point difference for those exiting poverty: 24% for coffee farmers and 22% for non-coffee farmers. A four-percentage gap was observed between the chronically poor: non-coffee farmers (39%) and coffee farmers (43%).

Despite the high poverty levels associated with participation in coffee production, the rate of participation in coffee production continued to increase over time (Table 1), especially among farmers farther away from market centers (Table 2). Did CML turn participation in coffee production into a risky venture? I do not have necessary data to answer this question. The question would be better answered by data collected much earlier prior to CML. Instead, the sample results show that entry into coffee participation leads to a potentially high risk of falling into poverty. During both early and later years of CML, the sample shows that a fairly large percentage of new coffee farmers fell into poverty, 65% initially non-poor fell into poverty after entry into coffee production in the early years of CML compared to 63% in later years after CML. In contrast, only 27% and 11% of farmers exited poverty upon entry into participation in coffee production in early and later years of CML, respectively.

Table 6. Transition matrix of poverty dynamics

Per capita expenditure classes for 2000			Per capita expenditure classes for 2009				
<i>Overall per capita expenditure classes</i>			<i>Overall per capita expenditure classes</i>				
163	Never poor (69.94%)	Out of poverty (30.1%)	305	Never poor (78.0%)	Out of poverty (22.0%)		
369	Into poverty (60.7%)	Chronically poor (39.3%)	298	Into poverty (58.3%)	Chronically poor (41.6%)		
	338	194		412	191		
<b>Per capita expenditure classes for 1992</b>	<i>Non-coffee farmers</i>		<b>Per capita expenditure classes for 2003</b>	<i>Non-coffee farmers</i>			
	79	Never poor (65.8%)		Out of poverty (34.2%)	131	Never poor (77.9%)	Out of poverty (22.1%)
	165	Into poverty (53.9%)		Chronically poor (46.1%)	96	Into poverty (61.5%)	Chronically poor (38.5%)
		141		103		161	66
	<i>Coffee farmers</i>			<i>Coffee farmers</i>			
	32	Never poor (71.9%)		Out of poverty (28.1%)	112	Never poor (75.9%)	Out of poverty (24.1%)
97	Into poverty (70.1%)	Chronically poor (29.9%)	113	Into poverty (56.6%)	Chronically poor (43.4%)		
	91	38		149	76		
<i>Non-coffee producers in 1992 to producers in 2000</i>			<i>Non-coffee producers in 2003 to producers in 2009</i>				
44	Never poor (72.7%)	Out of poverty (27.3%)	46	Never poor (89.1%)	Out of poverty (10.9%)		
89	Into poverty (65.2%)	Chronically poor (34.8%)	62	Into poverty (62.9%)	Chronically poor (37.1%)		
	90	43		80	28		

Note: Figures in the first column and bottom row of each panel are row and column total numbers of observations respectively.

## **6 Conclusion**

Liberalization of export-crop marketing boards in a number of Sub-Saharan African countries was a common phenomenon in the late 1980s and early 1990s. The effects of the liberalization policy on export crop supply response and household poverty remain mixed in existing studies. This is partly due to the fact that marketing boards were replaced by oligopsonistic firms that provided more or less the same marketing conditions after liberalization. Liberalization of the coffee marketing board (CMB) in Uganda provides, however, a somewhat unique example. Liberalization of the CMB led to emergence of several market intermediaries ranging from individual itinerant traders to large scale exporters. Instead of analyzing the supply response, I examine the effect of liberalization on participation in coffee production, and then the effect of participation on household poverty. The data used were collected at the time when liberalization was still in the initial stages and in the later years after liberalization. The effect of liberalization on coffee participation is measured conditioned on market access.

Liberalization of CMB led to more farmers participating in coffee production, especially among those located farther away from market centers. This is an indication of coffee production taking place at the extensive margin for farmers with initially limited market access. Although participation in coffee production was found to have positive and significant effects on consumption expenditure, these positive effects are not sufficient to meet the household consumption expenditure target, in particular for farmers farther away from market centers. The descriptive analysis indicated that a significant number of coffee farmers fell into poverty in both early and later years after coffee market liberalization. A similar situation is observed for new farmers participating in coffee production. The number of new coffee farmers falling into poverty following liberalization is significantly higher than the number exiting poverty. The farmers falling into poverty are mainly those living farther away from market centers. The results suggest that efforts to reverse this pattern of falling into poverty should not only be directed toward improving market access, but also increased land access. Investment in improving village road network and establishment of coffee stores in villages

accompanied with land redistribution policies can help to increase coffee income and hence reduce poverty.

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# PAPER III





# Charcoal Production and Household Welfare in Uganda: A Quantile Regression Approach<sup>\*</sup>

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## Abstract

Previous research suggests that the forest-dependent tend to be poorer than other groups, and that extreme reliance on forest resources might constitute a poverty trap. We provide an example in which a non-timber forest product (NTFP) appears to be providing a pathway out of poverty for some rural households in Uganda. Data come from households living adjacent to natural forests, some of whom engage in charcoal production. We use a semi-parametric method to identify the determinants of participation in charcoal production, and a quantile regression decomposition to measure the heterogeneous effect of participation on household income. We find that younger households and those with few productive assets are more likely to engage in charcoal production. We also show that, as a result of their participation, charcoal producers are better-off than non-charcoal producers in terms of income, but worse-off conditional on resource endowments.

Key words: Africa, non-timber forest products, poverty

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## 1 Introduction

In this paper we examine the extent to which the use of non-timber forest product (NTFP) by low-income households might provide a path out of poverty. Faced with a limited set of livelihood strategies and low stocks of productive assets, the rural poor in developing countries often rely on natural resource extraction for sustenance, cash income, and insurance against unforeseen events. NTFPs are especially attractive to rural households because they are often available as *de facto* open-access resources and typically require only unskilled labor and a modest set of inputs to collect or process (Neumann and Hirsch, 2000; Cavendish, 2000; Belcher et al., 2005; Fu et al., 2009). Although most NTFPs are of low value (Ambrose-Oji, 2003; Paumgarten and Shackleton, 2009), they sometimes provide natural insurance against crop shortfalls and other idiosyncratic shocks (Campbell et al., 2002; McSweeney, 2005; Debela et al., 2012). Where NTFPs function as a *safety net*, it may be argued that rural poverty exogenously drives forest-dependence (Angelsen and Wunder, 2003). Nevertheless, and despite empirical support for this perspective (e.g., McSweeney, 2004; 2005), some observers (e.g. Neumann and Hirsch, 2000; Campbell et al., 2002) have argued that due to their inherent low value, NTFPs rarely provide households with a means to escape poverty, and that forest reliance therefore serves as a kind of *poverty trap*, in which poverty and forest-dependence perpetuate each other. Indeed, rural households dependent on NTFPs are often found to be poor not just in terms of income, but also in terms of assets such as land, livestock and financial networks that might facilitate income growth (Boucher et al., 2008). External factors such as remoteness, poor infrastructure and limited market access also relegate NTFPs to the realm of subsistence consumption. Additionally, because markets for NTFPs are often thin and unpredictable, potentially valuable resources yield low returns (Belcher *et al.*, 2005). Casual observation suggests that these features serve to trap households in a situation in which forest products are extracted to sustain consumption rather than increase income, thereby undermining the investment in productive assets that would promote overall rural development.

Although the body of empirical studies on NTFPs is large and growing, findings regarding the link between forest dependence and poverty remain mixed. Pattanayak and Sills (2001) and Adhikari (2005) find that rich Amazonian households are more forest-

dependent than poor households, but Khan and Khan (2009) find no empirical link between poverty and forest-dependence in Pakistan. Fisher (2004) and Narain et al. (2008a; 2008b) argue that conclusions regarding forest dependence are highly sensitive to the definition of what constitutes an NTFP. Treating forest products as a homogenous bundle is problematic because some NTFPs may naturally lend themselves to subsistence while others may provide opportunities for cash income generation. For households that depend on forests primarily for subsistence consumption, NTFPs may look much like a safety net that prevents them from falling deeper into poverty, and such households may be more likely to remain poor. For those whose dependence rests on cash transactions, in contrast, NTFPs may – under the right conditions – provide an opportunity to escape poverty. Ultimately, however, whether a household enters into a more commercialized form of resource extraction will depend on household decisions as well as features of the natural and market environment in which they operate. Therefore, if one looks across any specific income distribution, the mapping from forest use to household welfare will depend on differences in household-specific resource endowments as well as household-specific returns to these endowments.

This potential sensitivity of observed patterns to heterogeneity within any particular rural population motivates us in this paper to attempt a somewhat nuanced investigation of how use of a particular NTFP may be contributing to the incomes of rural households. We focus on charcoal production, an activity which has relatively low barriers to entry, is scalable, and generates a relatively homogenous product that can be used by the producer or sold. Our empirical strategy is to compare differences in income distributions for charcoal producers and non-producers in two ways.<sup>14</sup> We first use an approach based on quantile treatment effects to examine heterogeneity in the way participation in charcoal production affects household income within the sample. This allows us to measure the impacts of participation across the income distribution and compare outcomes to the average effect observed in the sample. This casts some light on

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<sup>14</sup> Charcoal and firewood production are often seen as falling into a gray area between non-wood forest products and timber. Here we treat charcoal as an NTFP, largely because of the relatively small quantities and values observed. In addition to being a main source of energy in Africa, income from charcoal and fuel wood production supplements the incomes of many poor farmers (Arnold et al., 2003). Because of high urban demand and high energy content per unit weight, charcoal is highly marketable throughout much of Africa (Angelsen and Wunder, 2003).

whether participation is more important to some households than others, and is therefore suggestive of whether participation might provide the means to help some households move out of poverty. Our findings indicate that the income effects of charcoal production are somewhat small at the low end of the income distribution, but grow larger as one shifts attention to the upper end of the income distribution.

Second, we use a quantile regression decomposition approach that allows us to partition observed income differences across the sample into two parts: one attributable to differences in resource endowments and a second attributable to returns to these resource endowments. This decomposition enables us to ascertain whether non-charcoal producers would become better off if they participated in charcoal production, given the observed returns to their endowments, or whether such a strategy would fail to improve incomes. These results suggest that, controlling for observed differences in *levels* of resource endowments, charcoal producers have an income advantage vis-à-vis non-producers. However, once one adjusts for observed *returns* to these endowments, this same group appears to be at a disadvantage compared to non-charcoal producers. Our approach opens the way to new methods of assessing the importance of environmental income in low-income settings and also provides evidence that is consistent with the view that some forms of natural capital have the potential to go beyond seasonal gap-filling and income maintenance by helping to foster movements up the income ladder.

## **2 Analytical framework**

### **2.1 Quantile treatment effects (QTE) of participation in charcoal production**

Our primary point of departure for this study is the conjecture that using a measure of average effects may not be appropriate for understanding how the choice of an activity influences outcomes. For example, if the actual impacts of generated income from charcoal production differ between charcoal producing households and non-producers, then a standard regression approach that measures mean effects may mask the heterogeneous effects of participation. Following Firpo (2007) and Frölich and Melly (2010) we examine the distributional effects of participation using quantile treatment effects. To proceed, let  $C_i$  denote the binary decision to participate in charcoal

production, where 1 indicates participation and 0 indicates non-participation. Let  $H_{ij}$  be the income for household  $i$  if its participation status is equal to  $j$ . Given household characteristics  $x_{ij}$ , the conditional probability to participate is  $\Pr(C_i = j | x_{ij})$ ,  $j \in [0,1]$ . Because a household cannot simultaneously choose to participate and to not participate,  $H_{i1}$  and  $H_{i0}$  cannot be observed for the same household. Counterfactual income is, by definition, unobserved (Wooldridge, 2010). The difference of interest between  $H_{i1}$  and  $H_{i0}$  is the gain or loss in household income that household  $i$  would receive if it participated in charcoal production, compared to what it would receive by not participating. This causal difference associated with participation is just the average treatment or participation effect (Imbens and Angrist, 1994). However, this measure tells us nothing about the potential impacts of treatment or participation for specific households or groups of households in the data. For that, Frölich and Melly (2010) propose computing the unconditional quantile treatment effect (QTE), namely:<sup>15</sup>

$$QTE^\tau = q_{H_1}^\tau - q_{H_0}^\tau \tag{1}$$

where  $q_{H_1}^\tau$  is the  $\tau^{th}$  quantile of  $H_1$  and  $q_{H_0}^\tau$  is the  $\tau^{th}$  quantile of  $H_0$ . For example, suppose we are interested in how participation in charcoal production affects the income of a representative household at the 25<sup>th</sup> quantile of the household income distribution. The QTE at the 25<sup>th</sup> quantile is calculated as the difference between income at the 25<sup>th</sup> quantile of the income distribution for charcoal producers and income at the 25<sup>th</sup> quantile of the income distribution for non-charcoal producers. The resulting QTE reflects how the income distribution would change if participation in charcoal production were assigned randomly.

A methodological challenge arises, however, because the “true” effects of participation cannot be directly identified from the sample households. This is because a decision to participate is likely to be influenced by the poverty status of the household,

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<sup>15</sup> Conditional QTEs are defined conditionally on the value of covariates, and unconditional QTEs reflect the effects of treatment for the entire population (Frölich and Melly, 2010).

and hence the distributions of  $H_1$  and  $H_0$  are themselves contaminated by the underlying participation decisions. To overcome this problem, we use a two-step estimator proposed by Frölich and Melly (2008, 2010). In step one, the probability of participating in charcoal production (i.e., the propensity score) is estimated non-parametrically. Step two derives the participation effects, adjusting the differences between income quantiles (e.g.  $q_{H_1}^\tau$  and  $q_{H_0}^\tau$ ) using the propensity scores generated in step one. The joint estimation procedure relies on an instrumental-variable set-up (Frölich and Melly, 2008). However, the use of an instrumental variable approach is problematic for several reasons. First, we face a challenge in identifying a reasonably valid instrument for our sample. And second, even if one were available, its use would likely invalidate the final estimates due to the presence of heterogeneous participation effects (Imbens and Angrist, 1994; Klein and Vella, 2010) and the manner in which the error distribution depends on the explanatory variables (Klein and Vella, 2009). To circumvent these problems we utilize the control function estimator of Klein and Vella (2010). This approach does not rely on exclusion restrictions to control for the endogenous participation decision or heteroskedasticity in the error distribution. Under this approach the joint estimation procedure becomes:

$$C_i = c(x_i, u_i) \quad (2)$$

$$H_i = h(C_i, x_i, \varepsilon_i) \quad (3)$$

where  $C_i$  is household  $i$ 's participation decision,  $H_i$  is household  $i$ 's income, and  $x_i$  is a vector of exogenous control variables,  $\varepsilon_i$  and  $u_i$  are error terms.

Using (2) and (3), Frölich and Melly (2008, 2010) show that the estimated unconditional QTE in (1) can be obtained as:

$$(\hat{\varphi}_0, \hat{\varphi}_1^\tau) = \arg \min_{\varphi^0, \varphi^1} \sum \hat{w}_i \cdot \rho_\tau(H_i - \varphi_0 - C_i \varphi_1^\tau) \quad (4)$$

where  $\hat{\omega}_i$  are the propensity score weights estimated from the first-stage using the binary instrumental variable.  $\rho_\tau \equiv u \cdot \{\tau - 1(u < 0)\}$ , where  $u$  is the asymmetric absolute loss function of Koenker and Bassett (1978). The terms  $\hat{\phi}_0$  and  $\hat{\phi}_1^\tau$  are equivalent to  $\hat{\phi}_0 = \arg \min_{\phi^0} \sum_{C_i=0} \hat{\omega}_i \cdot \rho_\tau(H_i - q_{H_0})$  and  $\hat{\phi}_1^\tau = \arg \min_{\phi^1} \sum_{C_i=1} \hat{\omega}_i \cdot \rho_\tau(H_i - q_{H_1}) - \hat{\phi}_0$  respectively.<sup>16</sup> Alternatively, equation (1) can be estimated numerically, where:

$$q_{H_0}^\tau = \arg \min_{\phi^0} \sum_{C_i=0} \hat{\omega}_i \cdot \rho_\tau C_i (H_i - q_{H_0}) \text{ and } q_{H_1}^\tau = \arg \min_{\phi^1} \sum_{C_i=1} \hat{\omega}_i \cdot \rho_\tau (H_i - q_{H_1}) (1 - C_i).$$

Under the control function approach Millimet and Tchernis (2009, 2012) show that treatment effects arising from (2) and (3) can be consistently estimated by using the inverse probability estimator of Hirano and Imbens (2001) and Firpo (2007) as weights ( $\hat{\omega}_i$ ) in equation (4):

$$\hat{\omega}_i = \frac{C_i}{\hat{\Pr}(x_i)} + \frac{1 - C_i}{1 - \hat{\Pr}(x_i)} \quad (5)$$

where  $\hat{\Pr}(x_i)$  is the propensity score estimated from (2). In addition to using weights defined by (5) in estimating the QTE in (4), we use, as an additional explanatory variable, the control function (CF) estimator of Klein and Vella (2010). To see how the CF estimator of Klein and Vella (2010), hereafter KV, facilitates identification, let us assume the errors  $\varepsilon_i$  and  $v_i$  are heteroskedastic and that the conditional correlation between homoskedastic errors, say,  $\varepsilon_i^*$  and  $v_i^*$ , are constant. More specifically, let  $S_\varepsilon^2(x_i)$  and  $S_v^2(x_i)$  denote the conditional variance functions for  $\varepsilon_i$  and  $v_i$  respectively. We can rewrite the error terms, scaling each by their standard deviation to obtain  $\varepsilon_i = S_\varepsilon(x_i) \varepsilon_i^*$  and  $v_i = S_v(x_i) v_i^*$ . The correlation between them can be written as  $\rho = E(\varepsilon_i^* v_i^* | x_i)$ . With these definitions, Farré et al. (2010) and KV (2010) show that the key identifying restrictions rely on three assumptions. One, either or both  $S_\varepsilon(x_i)$  and  $S_v(x_i)$  must be non-constant. Two, the ratio  $S_\varepsilon(x_i)/S_v(x_i)$  must not be constant across observational

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<sup>16</sup> The covariates are required for identification and increased efficiency in the first stage (i.e., estimation of propensity scores) and are then integrated out (Frölich and Melly, 2008; 2010).



units, which implies that the form of heteroskedasticity varies across equations (2) and (3). And three,  $\varepsilon_i^*$  and  $v_i^*$  must be homoskedastic and the conditional correlation coefficient ( $\rho$ ) between them must be constant. If these conditions hold then  $\varepsilon_i^*$  and  $v_i^*$  may be interpreted as correlated measures of unobserved heterogeneity suggesting that the contribution of unobserved heterogeneity to household income and participation depends only on household characteristics ( $x_i$ ). With these assumptions, KV (2010) show that a generated control function,  $\rho[S_\varepsilon(x_i)/S_v(x_i)]v_i$ , can be used to consistently estimate (3):

$$H_i = h(C_i, x_i, \rho[S_\varepsilon(x_i)/S_v(x_i)]v_i, e_i) \quad (6)$$

where  $e_i$  is the zero mean error term and  $\rho$  is estimated along with other parameters.

The estimation of the control function follows two stages. First, the participation equation is estimated using an ordinary probit regression and the complete sample of households. This provides generalized residuals for identification of the outcome regression (Freedman and Sekhon, 2010; Wooldridge, 2011) regardless of the error structure (KV, 2010). We estimate  $v_i$  as the generalized residual from the probit regression of  $C_i$  on  $x_i$ . An estimate of the standard deviation of the reduced form error,  $S_v(x_i)$ , is obtained as the square root of the expected value from the regression of squared generalized residuals ( $v_i^2$ ) on  $x_i$ .<sup>17</sup> That is:

$$\hat{S}_v(x_i) = \sqrt{\hat{S}_v^2(x_i) \equiv \hat{E}(v_i^2 | x_i)} \quad (7)$$

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<sup>17</sup> Where negative values arise for the expected value of the squared generalized residual, we replace them using the smooth trimming function (KV, 2010) given as:  $trim = \left[ 1 + \exp\left(\ln(N)^2 \hat{E}(v_i^2 | x_i)\right) \right]^{-1}$ , where  $N$  is the total number of observations and  $\ln$  is the natural logarithm. This function tends to zero as  $(\hat{v}_i^2 | x_i)$  becomes negative and to unity otherwise. For our data, only two observations were replaced using this smooth trimming function.

To improve the efficiency of our estimates we follow KV (2010), and repeat the entire process using the estimated conditional variance in a procedure similar to generalized least squares (GLS). This is done by normalizing the explanatory variables by the estimated variance as  $x_i^* \equiv \frac{x_i}{\hat{S}_v(x_i)}$ , which provides the residuals of interest.

One empirical challenge we face, however, is obtaining consistent estimates of the parameters associated with equation (2) in order to learn which household characteristics influence the decision to participate in charcoal production. If unobserved heterogeneity influences the decision to participate in charcoal production, then the error variances will be large, and estimating (2) under the assumption of similar error variances for all households in the sample will produce incorrect standard errors and biased parameter estimates (Williams, 2009). Although we overcome this problem by using a procedure akin to GLS to estimate (2), Klein and Vella (2009) note that it is difficult to interpret the coefficients on explanatory variables that have been normalized by  $\hat{S}_v(x_i)$ . For the purposes of identifying the characteristics that influence the decision to participate in charcoal production, therefore, we use the semi-parametric estimator of Klein and Spady (1993) to estimate (2), which allows us to control for the unknown joint distribution of unobserved heterogeneity. An alternative is to use an ordinal generalized linear estimation that controls for heteroskedasticity (Williams, 2009; Wooldridge, 2010). This alternative has the advantage of isolating the explanatory variables that lead to non-constant error variance. In the empirical section below we report results from the Horowitz and Härdle (1994) specification test, which guides our choice of the model.

The second step in estimating the control function involves estimating  $S_\varepsilon(x_i)$ . We use an approach similar to that adopted for the first step, with slight modification. We regress  $H_i$  on  $C_i$  and  $x_i$  using ordinary least squares (OLS) to obtain an estimate of the residuals,  $\hat{\varepsilon}_i$ . The logarithm of the squared residuals,  $\ln(\hat{\varepsilon}_i^2)$ , is then regressed on  $x_i$  to obtain the standard deviation as:

$$\hat{S}_\varepsilon(x_i) = \sqrt{\hat{S}_\varepsilon^2(x_i) \equiv \hat{E}(\hat{\varepsilon}_i^2 | x_i)} \quad (8)$$

## 2.2 Counterfactual decomposition of changes in household income

Despite that charcoal is a high-value NTFP in Uganda, relatively few households produce it. For this reason, in addition to linking forest extraction to household income, we assume that forest extraction may differ across households both because market values translate differently for households and because households may differ in their abilities to access and extract charcoal. In other words, we may observe self-selection into charcoal production in the sample. Ignoring any underlying selection process has the potential to bias our estimate of the income gap between producers and non-producers. Our estimation strategy follows the counterfactual decomposition approach proposed by Newey et al. (1990) and Machado and Mata (2005) and later modified by Albrecht et al. (2009) to allow for selection correction. As before, let  $H_i$  denote income for household  $i$ .<sup>18</sup> The quantiles of  $H_i$  conditional on  $x_i$  are given by

$$Q_\tau(H_i | x_i) = x_i \beta(\tau), \quad \tau \in (0,1) \quad (9)$$

where  $Q_\tau(H_i | x_i)$  is the  $\tau^{\text{th}}$  quantile of the income distribution conditional on observed covariates  $x_i$ . The true value of the parameter of interest, correcting for selection, is  $\beta(\tau)$ <sup>19</sup>, and the quantiles of  $H_1$  (i.e. for producers) conditional  $x_i$  and the selection correction term is given by:

$$Q_\tau(H_1 | s_1) = x_1 \beta(\tau) + h_\tau(s_1 \gamma), \quad \tau \in (0,1) \quad (10)$$

where the vector  $s_1$  includes all variables in  $x_i$  plus the additional variables satisfying the exclusion restrictions and  $\gamma$  is a vector of parameters to be estimated. The selection

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<sup>18</sup> In the regressions reported below we work with the natural logarithm of income to facilitate interpretation of the estimated coefficients, which represent the income effect of each covariate at a particular quantile of the conditional income distribution.

<sup>19</sup> Koenker and Bassett (1978) show that  $\beta(\tau) = \hat{\beta}(\tau) = \arg \min n^{-1} \sum_{i=1}^n (H_i - x_i \beta)(\tau - 1(H_i \leq x_i \beta))$ , where  $n$  is the number of observations,  $1(\bullet)$  is the indicator function and  $\beta(\tau)$  is estimated separately for each quantile.

correction term for the  $\tau^{th}$  quantile is given by  $\hat{h}_\tau(s_1\gamma)$ , which can be approximated by the inverse Mills ratio obtained from (2). However, as indicated above, we are concerned not only with the lack of a valid instrument, but also with the possibility that both the participation decision and household income might depend on unobserved heterogeneity. This unobserved heterogeneity may be misspecified if  $\hat{h}_\tau(s_1\gamma)$  is incorrectly estimated, in which case quantile differences obtained from (10) will be inconsistent. For this reason, to obtain consistent quantiles when the joint distribution is unknown, we estimate (10) using the control function for the  $\tau^{th}$  quantile ( $CF_\tau$ ) instead of  $\hat{h}_\tau(s_1\gamma)$ , i.e.:

$$Q_\tau(H_1|s_1) = x_1\beta(\tau) + CF_\tau; \quad \tau \in (0,1), \quad CF_\tau \equiv \rho_\tau \frac{S_{\varepsilon\tau}(x_{i\tau})}{S_{v\tau}(x_{i\tau})} v_{i\tau} \quad (11)$$

where the subscript  $\tau$  identifies the  $\tau^{th}$  quantile.

We now turn briefly to our approach of decomposing differences in household income distribution between charcoal and non-charcoal producers. We follow the procedure outlined in Melly (2005) and discussed at length in Fortin et al. (2011). We estimate the counterfactual distribution of income that non-charcoal producers would have earned if the distribution of their household characteristics had been as those observed for charcoal producers. Given the distribution of household characteristics and the control function, Melly (2005) shows that a change in income distribution can be decomposed into the effects of changes in household characteristics ( $x_i$ ), coefficients ( $\hat{\beta}$ ) and residuals ( $r$ ). The final decomposition for, say, the  $\tau^{th}$  quantile can be written as:

$$\hat{Q}(\hat{\beta}_1, \bar{x}_1) - \hat{Q}(\hat{\beta}_0, \bar{x}_0) = \left[ \hat{Q}(\hat{\beta}_0, \bar{x}_1) - \hat{Q}(\hat{\beta}_0, \bar{x}_0) \right] + \left[ \hat{Q}(\hat{\beta}_{\tau_1, r_0}, \bar{x}_1) - \hat{Q}(\hat{\beta}_0, \bar{x}_1) \right] + \left[ \hat{Q}(\hat{\beta}_1, \bar{x}_1) - \hat{Q}(\hat{\beta}_{\tau_1, r_0}, \bar{x}_1) \right] \quad (12)$$

where the quantile identifier  $\tau$  has been suppressed for easy presentation except in the second and third square-bracketed terms to define the residual components. The terms

$(\hat{\beta}_j, \bar{x}_j)$ ,  $j=0,1$  define the parameter estimates and sample averages of characteristics used for non-charcoal producers ( $j=0$ ) or charcoal producers ( $j=1$ ) for the  $\tau^{th}$  quantile. The first square-bracketed term represents the effects of changes in the distribution of household characteristics, the second square-bracketed term represents the effects of changes in the  $\tau^{th}$  coefficients (interpreted as returns to household characteristics  $x_i$ ), and the third square-bracketed term represents the effect of changes in the residuals. We use equation (12) to generate our decomposition results. We estimate  $\hat{\beta}(\tau)$  for each of 99 quantiles,  $\tau = 0.01, \dots, 0.99$ , using a bootstrap procedure with 500 replications. Results are presented in graphical form.

### 3 Data and descriptive statistics

Our data come from three districts of Uganda: Masindi, Nakasongola, and Hoima. These are among the major charcoal producing districts that supply charcoal to a population of more than four million people in the capital city Kampala, as well as neighboring towns. A large proportion of each district is covered by state-owned natural forests and forest reserves. Agricultural production is the main livelihood strategy for the majority of the population. Khundi et al. (2011) provide a detailed overview of the charcoal producing districts included in the sample. Shively et al. (2010) describe the charcoal market and the supply chain that links these producing districts to Kampala. Data were collected in 2008 from 300 households in 12 representative villages. Purposive random sampling was used to obtain a balanced representation of households engaged in charcoal production and those not involved in this activity. Four villages were selected from each district, from which 25 households per village were randomly selected using village lists compiled by local leaders. Table 1 reports descriptive statistics for the sample used in the analysis. We see considerable variation in household resource endowments. Non-charcoal producing households have more productive assets, including larger farms and more livestock. They are headed by older members and exhibit longer residency, on average, than charcoal producers. Charcoal producers are more likely to belong to the dominant ethnic group in the district. They also cleared more forest land, on average, in the 12 months prior to the survey, and were more likely to report the intention to clear additional forest land in the

future. No significant differences are observed between the groups with respect to dependency ratios, educational levels, or access to all-season roads.

Table 1. Characteristics of sample households

Variable	Charcoal producers (n=170)	Non-producers (n=125)	t-values
Farm size owned (hectares)	3.2 (6.8)	6.7 (16.5)	2.461**
Tropical livestock units (TLU) <sup>a</sup> (number)	3.0 (8.3)	5.6 (17.0)	1.774*
Female-headed household (0/1)	0.08 (0.28)	0.28 (0.45)	4.655***
Age of household head (years)	36.6 (11.2)	41.0 (14.9)	2.853**
Household head's schooling (years)	4.7 (3.2)	4.7 (3.2)	0.173
Member of dominant ethnic group (0/1)	0.72 (0.45)	0.62 (0.49)	-1.703*
Dependency ratio (# under 15+ #over 65)/(# 16-64)	0.48 (0.21)	0.48 (0.22)	0.013
Household size (adult-equivalent consumers)	2.48 (0.72)	2.50 (0.72)	0.228
Household cleared forest/bush land (0/1)	0.78 (0.41)	0.63 (0.48)	-2.868**
Planning to clear forests in next 12 months (0/1)	0.78 (0.41)	0.50 (0.50)	-5.362***
Land size expected from clearing forests in next 12 months (hectares)	0.47 (0.45)	0.39 (1.95)	-0.784
Destruction of crops, e.g., by drought (0/1)	0.24 (0.43)	0.24 (0.43)	0.094
Distance from home to nearest all-season road (km)	2.3 (2.3)	1.9 (2.2)	-1.369
Distance from home to nearest accessible forest (km)	0.95 (1.28)	1.09 (1.08)	0.995
Duration of residence in village (years)	18.4 (15.3)	23.9 (18.2)	2.816**
Value of household assets e.g., hand hoes, bicycles, etc (1000 UgSh)	155 (572)	177 (315)	0.384
Annual income per adult equivalent (1000 UgSh)	832 (1,763)	535 (579)	-1.812*
Below Uganda poverty line (0/1)	0.31 (0.46)	0.44 (0.50)	2.271**

Figures in parentheses are standard deviations. \*, \*\*, \*\*\* refer to significance at 10%, 5%, and 1% test levels respectively. UgSh= Ugandan Shillings; at time of survey 1USD=1,624 UgSh.

<sup>a</sup> A TLU index was computed as: 1 TLU = 1 cattle = 0.1 goats or sheep = 0.5 donkeys = 0.05 chicken or turkeys or ducks (Jahnke, 1982).

Table 1 also compares annual household incomes for the two groups, normalized using an OECD–modified adult-equivalent scale (Haagenars et al., 1994). Charcoal producers appear to be slightly better-off in income terms than non-producers. This pattern is illustrated in Figure 1, which plots the kernel densities of household income per adult equivalent for charcoal producers and non-producers. Income differences are more pronounced in the middle and upper-tail of the distribution. Similarly, poverty incidence is significantly lower in the sub-sample of charcoal producers.<sup>20</sup>

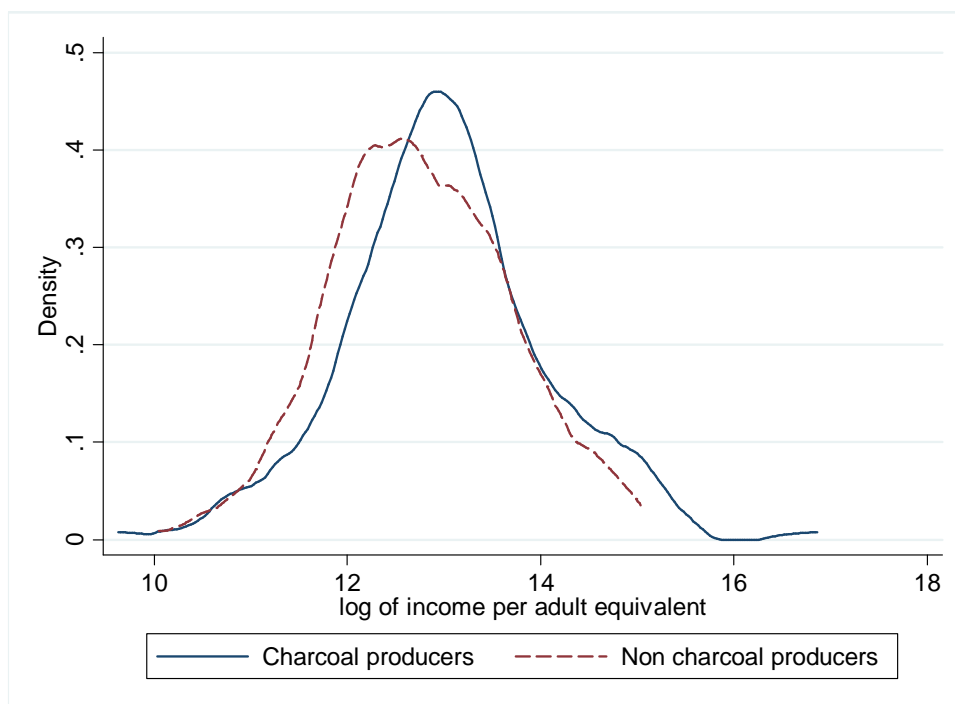


Fig. 1. Income densities for charcoal and non-charcoal producers

<sup>20</sup> We use the absolute poverty line derived by Appleton et al. (2001). It is widely used as the “official” poverty line by the Ugandan Government. We use the average rural poverty line for the Central and Western regions, where the districts in the sample are located. The average poverty line was adjusted from 1993 prices to 2008 prices using the consumer price index. The annual poverty line used in this study is UgSh. 281,904 per adult equivalent.

## 4 Results

### 4.1 Who produces charcoal?

We use equation (2) to identify the factors correlated with charcoal production. For comparison purposes, the first three columns of Table 2 report estimates from a probit model (Model 1), the ordinal generalized linear model with a probit link function (hereafter, OGLM probit) (Model 2) to provide a test of heteroskedasticity (Williams, 2010) and a Klein-Spady semi-parametric (KSS) specification (Model 3). For reasons mentioned in section 2.1, the discussion of results is based on Model 3. To control for problems associated with location and scaling in the semi-parametric specification (see Klein and Spady, 1993), we normalized the dependency ratio to unity. The kernel function was taken as the standard normal density function and we used a bandwidth of 0.4 (i.e.,  $0.4 = n^{-\frac{1}{6.5}}$  where  $n = 295$ ).<sup>21</sup> With only a few exceptions, most of the estimated coefficients for the three specifications (models 1-3) are similar in sign, magnitude and statistical significance. The Horowitz–Härdle (1994) specification test indicates that the ordinary probit function and the OGLM probit might not be appropriate for our data. The test statistic supports rejecting the null hypotheses at a 1% test level.

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<sup>21</sup> Klein and Spady (1993) show that the asymptotic properties of the semi-parametric maximum likelihood estimators require the bandwidth ( $b_n$ ) parameters to satisfy the restrictions  $n^{-\frac{1}{6}} < b_n < n^{-\frac{1}{8}}$  to achieve efficiency.



Table 2 Regression results for models of charcoal participation and household income

	Model 1	Model 2	Model 3	Model 4	Model 5
	Probit	OGLM <sup>a</sup>	KSS	OLS	CF-GLS
	Producer (0/1)	Producer (0/1)	Producer (0/1)	Total Income	Total Income
Constant	0.416 (0.901)			10.136*** (0.516)	10.210*** (0.512)
Farm size owned (hectares)	-0.021* (0.012)	-0.001** (0.000)	-0.030*** (0.008)	-0.008 (0.007)	-0.009 (0.008)
Tropical Livestock Units (#)	0.003 (0.011)	-0.002 (0.001)	-0.015* (0.008)	0.023*** (0.005)	0.023*** (0.007)
log of value of assets e.g., hand hoes, bicycle, etc (Ugshs)	-0.105 (0.075)	-0.010 (0.026)	-0.156** (0.065)	0.233*** (0.043)	0.233*** (0.041)
Education of household head (years)	-0.044* (0.025)	-0.007** (0.003)	-0.036 (0.025)	0.026 (0.017)	0.026* (0.016)
Age of household head (years)	0.072** (0.033)	0.026* (0.015)	0.303*** (0.060)	0.022 (0.020)	0.027 (0.021)
Age of household head squared (years)	-0.001** (0.000)	-0.000* (0.000)	-0.003*** (0.001)	-0.000 (0.000)	-0.000 (0.000)
Female household head (0/1)	-0.998*** (0.230)	-0.217 (0.162)	-2.085*** (0.395)	0.010 (0.151)	-0.033 (0.149)
Dominant ethnicity (0/1)	0.409** (0.176)	0.151 (0.107)	0.662** (0.259)	0.036 (0.113)	0.050 (0.109)
Destruction of crops, e.g., by drought (0/1)	0.108 (0.186)	-0.091 (0.057)	-0.181 (0.209)	-0.399*** (0.117)	-0.405*** (0.118)
Duration of residency in village (years)	-0.006 (0.005)	-0.001** (0.001)	-0.049*** (0.010)	-0.000 (0.003)	-0.000 (0.003)
Land expected from forest clearing in next 12 months (hectares)	0.138 (0.120)	0.009 (0.013)	0.736*** (0.138)	0.111 (0.086)	0.116 (0.131)
Distance to nearest all-season road (kms)	0.038 (0.036)	0.033 (0.056)	0.521*** (0.096)	-0.058** (0.024)	-0.056** (0.024)
Distance to forest (kms)	-0.097 (0.065)	-0.098 (0.070)	-0.135 (0.086)	0.018 (0.041)	0.021 (0.047)
Dependency ratio	-0.198 (0.392)	-0.005 (0.033)		-1.094*** (0.280)	-1.086*** (0.269)
Charcoal producer (0/1)				0.334*** (0.110)	0.242** (0.112)
CF with generalized least squares					-0.031** (0.014)
Wald chi square / F-value	44.696***	73.023***	48.819***	13.760***	135.117***
R <sup>2</sup> (Pseudo- R <sup>2</sup> for probit)	0.127	0.182		0.289	0.299
Horowitz and Härdle specification test	51.191***	19.166***			
White's test for heteroscedasticity				124.88	140.70
Number of observations	295	295	295	295	295

Figures in parentheses are standard errors. \*\*\*, \*\*, \* denote estimated parameter is significantly different from zero at the 1%, 5% and 10% test levels, respectively. *Note that estimates in Model 5 are obtained after bootstrapping with 500 replications to correct the standard errors for first stage estimation.*

<sup>a</sup> *Coefficients (standard errors) of variables included in variance function are: farm size -0.189\*\* (0.083), household assets -0.463\*\*\* (0.155), duration of residency in village 0.016 (0.021), land size expected from forest clearing 1.686\*\* (0.799), distance to nearest all-season road 2.647\*\* (1.192), and distance to forest 1.748\*\*\* (0.638). The choice of variables included in the variance function followed number of estimations; we first included all variables considered in the table above and the model failed to achieve convergence, then we experimented with a series of different combinations of variables to get a set of variables included in the variance function.*

We find that households located farther away from all-season road (and hence markets) are more likely to participate in charcoal production. Households poor in terms of landholdings, livestock and other physical assets are more likely to participate in charcoal production. Presumably, households with large stocks of livestock—particularly cattle—have access to cash and less incentive to participate in charcoal production. Similarly, larger farms provide greater opportunity for both food and cash generation, which also reduce incentives to produce charcoal. To test the life cycle hypothesis, we included age of the household head with its squared term. Younger household heads are more likely to produce charcoal, but as heads grow older, their likelihood of producing charcoal declines. This inverted-U relationship likely reflects that charcoal production requires physical strength that is most easily provided by relatively young individuals.

Columns 4 and 5 of Table 2 report results from two income regressions. Model 4 uses OLS and provides a test for heteroscedasticity. Using White's test for heteroskedasticity we fail to reject the null hypothesis of homoskedascity, but the variance function for the OGLM probit shows that farm size, household assets, amount of land expected from forest clearing in future, distance to the nearest all-season road and distance to the forest are all associated with nonconstant error variance in the participation model of charcoal production. As discussed in section 2.1, having nonconstant error variance in the participation model justifies the analytical strategy proposed for our sample data.

Model 5 employs the control function (CF) approach outlined in section 2.1. The main focus in models 4 and 5 is the difference in estimates of the participation coefficients and the CF estimate. The OLS estimate (0.334) is slightly larger than the CF estimate (0.242), but both estimates are significantly different from zero indicating that unobserved heterogeneity may account for the difference in magnitudes of these estimates. The correlation coefficient on the control function in Model 5 is negative and statistically significant, which indicates that participation in charcoal production is endogenous. Comparing estimates in models 4 and 5, the difference in participation estimates not only reflects unobserved heterogeneity, but the correlation coefficient of -0.031 suggests that the returns to this unobserved heterogeneity are negative. Put simply,

the unobserved household (and village) heterogeneity that increases the individual's probability to participate in charcoal production is negatively correlated with household income. The economic interpretation is that households that produce charcoal above a certain level (determined by observed characteristics) receive lower returns (due to unobserved heterogeneity) for every increment in charcoal production than households producing below this level. This further suggests that a household may continue to participate in charcoal production up to a certain level conditional on variation in observed characteristics beyond which exit options from charcoal production are likely to be driven by household (and village) unobserved heterogeneity. Results in the next subsection elaborate on this interpretation.

#### **4.2 The impact of participation in charcoal production on income**

We now turn to estimation of the main results using analytical procedure described in section 2.1. Figures 2a and 2b present the results obtained using equation (4). We omit confidence intervals to make the graphs more legible. Figure 2a compares two measures of the returns to participation in charcoal production. The dashed line is derived assuming participation is exogenously determined. The solid line with dots is derived by computing returns after controlling for endogeneous selection into participation, using the control function. The QTEs assuming exogeneity are relatively stable along the distribution up to 80<sup>th</sup> quantile, beyond which there is a slight increase in the treatment effect. However, when one controls for the endogeneity of participation, returns to participation in charcoal production are much higher and largely positive, but declining gradually along the income distribution, and negative and relatively steep beyond the 85<sup>th</sup> quantile. This means that returns to charcoal production are high among poor households, but fall as households become better-off.

Recalling that the efficiency of the estimates based on equation (4) depends on a set of covariates, Figure 2b shows how important it is to control for village-level fixed factors and physical assets. The vector of covariates used to achieve efficiency is shown in Table 2 (Model 5). We use the distribution obtained using all covariates (Model 5) as the base distribution. Figure 2b shows that controlling for village-level fixed factors (distance to all-season road) and household productive assets (land, livestock and other assets) has a modest effect on the derived income distribution. The income distribution

deviates considerably from the base distribution when one excludes productive assets, but deviates relatively little when one excludes distance to all-season road, the proxy for market access and remoteness. Overall, these results confirm that the effects of participation vary along the income distribution: they are high at the bottom end and decline gradually toward the top end of the income distribution. To better understand the income advantages that are associated with charcoal production, we now examine whether the observed income gap is due to differences in household characteristics or changes in the economic returns to these household characteristics.

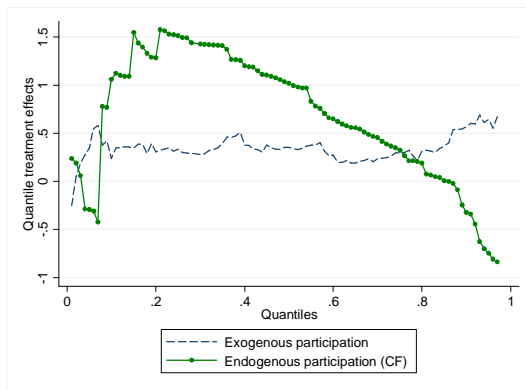


Fig. 2a. Quantile treatment effect (QTE) of participation in charcoal production on income. Endogenous quantiles were obtained by bootstrapping with 500 replications

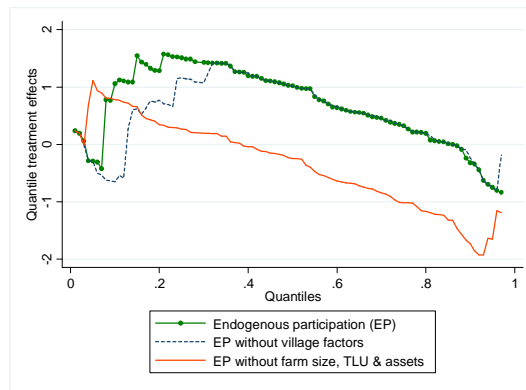
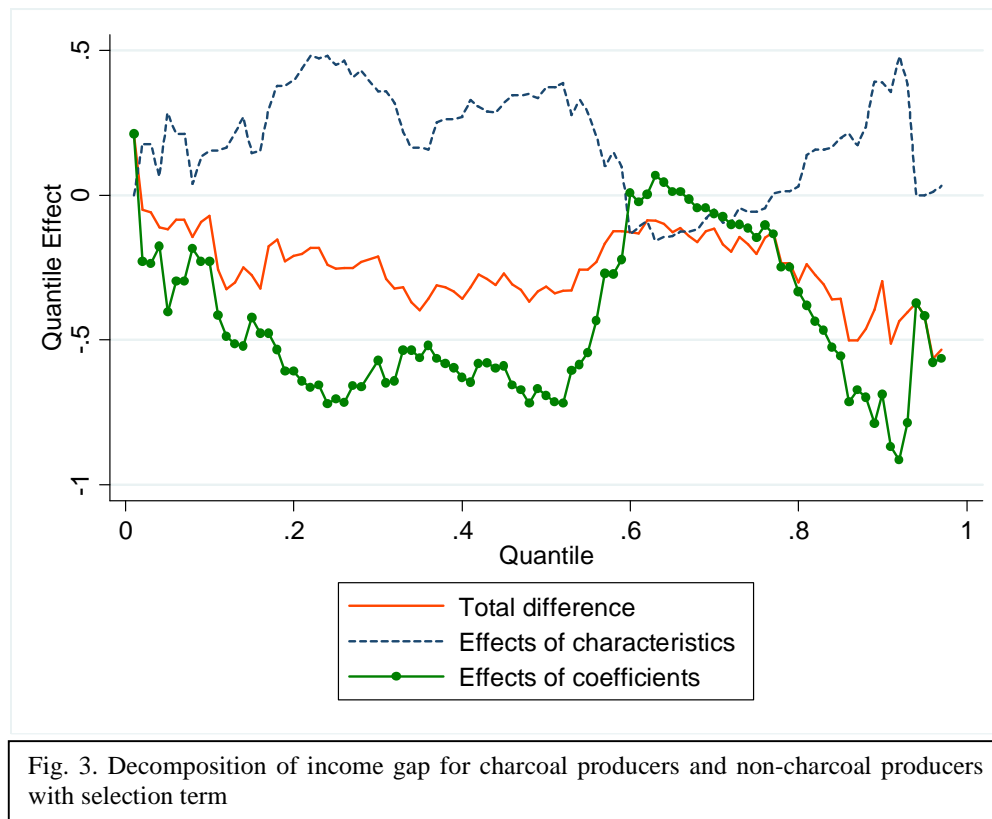


Fig. 2b. QTE of participation in charcoal production on income; the role of village factors, farm size, livestock (TLU) and other assets. Endogenous quantiles were obtained by bootstrapping with 500 replications

### 4.3 Decomposition of changes in the income distribution

Figure 3 reports estimates obtained using equation (12). We interpret Figure 3 with reference to income gap estimates for endogenous participation in Figure 2a. Recall that Figure 2a presents the income gap between charcoal producers and non-producers based on the propensity score weights. Figure 3 shows the income gap after controlling for differences between charcoal producers and non-charcoal producers in terms of observed household characteristics and returns to these characteristics. That is, Figure 3 shows the counterfactual distribution of household income that non-charcoal producers would have obtained, had they possessed the same distribution of household characteristics as the charcoal producers. We use all characteristics considered in Model 5.



Contrary to the negative and positive income gaps we observe in Figure 2a, the total difference curve in Figure 3 shows that the income distribution for non-charcoal producers dominates that of charcoal producers, since the income gap is negative for

nearly all quantiles. This negative income gap reflects differences in returns to household characteristics. The distribution of returns to household characteristics follows a pattern similar to that of the total difference curve. This means that charcoal producers would earn less income upon exiting charcoal production and it would mostly be disadvantageous for individuals close to both the lower and upper ends of income distribution. However, given the changes in household characteristics (as indicated by the curve labeled “effects of characteristics”) in Figure 3, the income advantage for charcoal producers over their counterparts is visible for a large part of the lower end of the income distribution – up to around the 59<sup>th</sup> quantile, after which the income gap is close to zero and largely negative up to 76<sup>th</sup> quantile beyond which the distribution turns to positive again.

What we observe from figures 2a and 3 is that charcoal producers are well-off in terms of income compared with non-charcoal producers, largely due to high returns derived from participating in charcoal production. But charcoal producers appear to be at an income disadvantage given returns to their resource endowments compared to non-charcoal producers. We investigate this further via sensitivity analysis, in which we decompose the changes in the distribution of resource endowments for charcoal producers while controlling for selection into charcoal participation.

## 5 Sensitivity analysis

The analysis that follows builds on the income gap distribution for charcoal producers observed in Figure 2a. If one assumes for the moment that charcoal producers are uniformly poor in terms of assets, then one might reasonably ask why we might observe a large income gap at the lower end of the income distribution that decreases toward the upper end of the income distribution. To answer this question we need to identify which households are stochastically poor (vs. non-poor) and which are structurally poor (vs. non-poor). We follow Carter and May (2001) to construct our categories. We define a household as stochastically poor if it is observed to be poor based on its realized household income ( $H_i$ ), but is nevertheless expected to be non-poor given its assets. In other words, a household is stochastically poor if it is poor based on income, but nevertheless possesses assets that collectively place it in a position above the asset

poverty line. A household is defined as structurally poor if its assets place it below the asset poverty line. The stochastically and structurally non-poor are defined in a similar way as shown below:

<i>Stochastically poor if</i>	$H_i < PL_t; \text{ but } \hat{h}_i(A_i) > PL_t$
<i>Structurally poor if</i>	$H_i < PL_t; \text{ and } \hat{h}_i(A_i) < PL_t$
<i>Stochastically non-poor if</i>	$H_i > PL_t; \text{ but } \hat{h}_i(A_i) < PL_t$
<i>Structurally non-poor if</i>	$H_i > PL_t; \text{ and } \hat{h}_i(A_i) > PL_t$

where  $PL_t$  is the poverty line and  $\hat{h}_i(A_i)$  is expected income given household assets ( $A_i$ ):

$$H_i = \hat{h}(A_i) + \xi_i \quad (13)$$

where  $\xi_i$  is an error term.

The estimate in (13) is obtained by flexible regression methods so that the marginal contribution of each asset depends on the full bundle of productive assets ( $A_i$ ) controlled by the household. We use polynomial regression of order four to control for any non-linearities that might exist between income and the independent variables.<sup>22</sup> Explanatory variables used as polynomials include farm size, aggregated value of farm related assets and the number of adult-equivalent consumers. Other variables included are tropical livestock units and characteristics of the household head, including education, sex and age. We then use an 80% confidence interval of  $\hat{h}_i(A_i)$  to allow for a 10% probability of Type I error, that is, that any household that appears to be stochastically poor (non-poor) is not. For example, a household is identified as stochastically poor only if its income level is less than the poverty line and the confidence interval of the expected income  $\hat{h}_i(A_i)$  given the assets strictly lies above the poverty line.

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<sup>22</sup> We use orthogonal polynomials to avoid multicollinearity (Golub and Van Loan, 1996).

Table 3 reports the summary of classifications of charcoal producers and non-producers based on observed income and expected income given their assets. We consider only those groups for which we had a reasonable number of observations. Each classification in Table 3 is used to construct a counterfactual income distribution. For example, assume that we want to compare the income distribution of structurally non-poor households against that of stochastically non-poor households. Households in both groups are charcoal producers. Denote this classification by  $C_{ss}$ . We let  $C_{ss}$  be the counterfactual random variable controlling for the household income that a randomly selected household would earn if it were structurally non-poor and participated in charcoal production. Thus, the quantile counterfactual distributions of income are computed as those levels of income that stochastically non-poor households would earn at the  $\tau^{\text{th}}$  quantile if the distribution of their characteristics were the same as that of structurally non-poor households. This means that we are decomposing the difference between the structurally non-poor's income ( $H_{structural}$ ) distribution and the stochastically non-poor's income ( $H_{stochastic}$ ) distribution, that is,  $(H_{structural}(\theta) - H_{stochastic}(\theta))$ . For ease of interpretation in the subsequent discussion, we refer to the reference classification as the “base”. For example,  $H_{structural}$  references the “base” category.



Table 3 Classification of households based on income and asset poverty

Participation status	n	%	Participation status	%	Corresponding Figure number
<i>Charcoal producers</i>			<i>Charcoal producers</i>		
Stochastically non-poor	117	33	Structurally non-poor	67	4a & 4b
Structurally poor	112	30	Structurally non-poor	70	5a
Structurally poor	73	47	Stochastically non-poor	53	5b
<i>Charcoal producers</i>			<i>Non-producers</i>		
Structurally poor	70	49	Structurally poor	51	6
Structurally non-poor	122	64	Structurally non-poor	36	7
Stochastically non-poor	65	60	Stochastically non-poor	40	8

### 5.1 Structurally non-poor versus stochastically non-poor charcoal producers

The subsequent figures present decomposition results based on the classification in Table 3. Figures 4a and 4b decompose the income gap between the structurally non-poor charcoal producers (*base*) and the stochastically non-poor charcoal producers. Figure 4a presents results without controlling for selection bias (see section 2.2). Figure 4b controls for selection bias. Figure 4a shows that an analysis that ignores selection into participation in charcoal production slightly underestimates the proportion of the income gap between structurally and stochastically non-poor charcoal producers that can be attributed to differences in levels of household characteristics (effect of characteristics). All subsequent discussion is based on results that correct for selection bias.

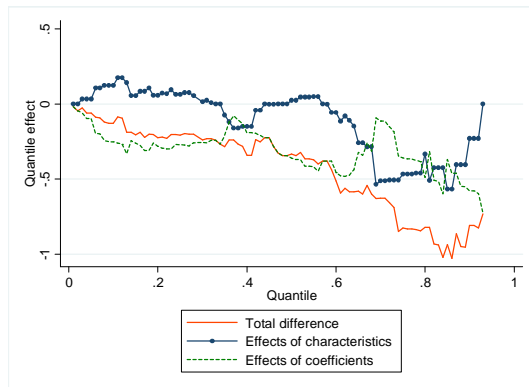


Fig. 4a. Decomposition of income gap for stochastically non-poor and structurally non-poor charcoal producers without selection term

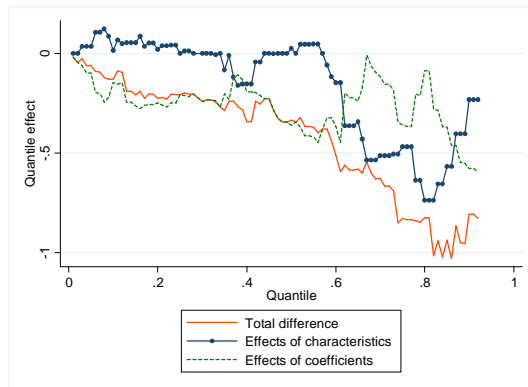


Fig. 4b. Decomposition of income gap for stochastically non-poor and structurally non-poor charcoal producers with selection term

The estimated total differential shows that the income gap between structurally non-poor charcoal producers and stochastically non-poor charcoal producers is small for a sizeable part of the lower end of the distribution up to about the 50<sup>th</sup> quantile, beyond which the gap widens considerably toward the upper end of the distribution. This pattern appears to arise from returns to household characteristics. Returns to household characteristics follow a pattern similar to that of the total differential curve. The effects of characteristics slightly dominate in the lower end of the distribution in favor of structurally non-poor charcoal producers. This means that for the least structurally well-off charcoal producers, differences in household characteristics matter more than differences in returns to those characteristics. In contrast, for the most stochastically well-off charcoal producers, returns to household characteristics matter more than differences in household characteristics.

Figure 4b suggests that charcoal producers that appear to be non-poor but who would be poor given their assets, i.e., the stochastically non-poor, benefit more from charcoal production than their cohorts, i.e., the structurally non-poor. Evidence that stochastically non-poor households benefit more from charcoal production than structurally non-poor households supports the overall descriptive results in Table 1 and the participation results in Table 2, both of which show that charcoal production is a livelihood strategy pursued by relatively young household heads. These young household heads are poor in terms of assets, and charcoal production appears to be a means to

accumulate wealth and/or establish grazing areas for their cattle and open land for agricultural production.<sup>23</sup>

## 5.2 Structurally and stochastically non-poor versus structurally poor charcoal producers

Figures 5a and 5b decompose the income gaps for structurally and stochastically non-poor charcoal producers (*base*) compared to structurally poor charcoal producers. In Figure 5a, differences in distributions of household characteristics appear to play a major role in explaining the income gap for structurally non-poor charcoal producers for a small part of lower income distribution up to about 10<sup>th</sup> quantile, beyond which the observed income gap is nearly zero. An almost identical pattern is observed in Figure 5b. For the stochastically non-poor, differences in household characteristics matter more for explaining the income distribution than difference in returns to these characteristics, at least in the lower-end of the income distribution (say, up to about the 25<sup>th</sup> quantile). In general, the implication is that households in the lower part of income distribution and whose assets place them above the subsistence level have higher incomes than asset-poor households who are also income poor (i.e. the structurally poor).

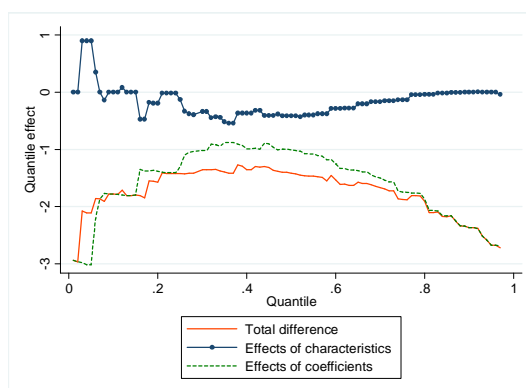


Fig.5a. Decomposition of income gap for structurally poor and structurally non-poor charcoal producers

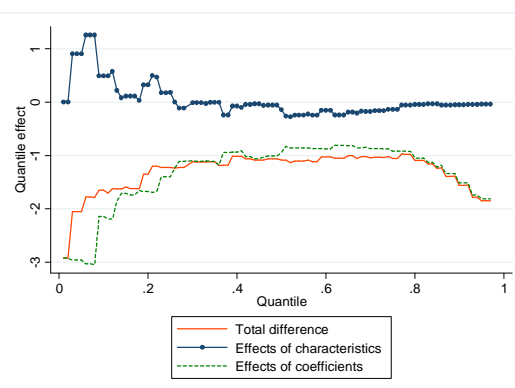


Fig.5b. Decomposition of income gap for structurally poor and stochastically non-poor charcoal producers

<sup>23</sup> Correlations between age and log of farm size, and between age and an index of total tropical livestock holdings (TLU) are 0.15 and 0.16 respectively. Both correlations are significantly different from zero at the 5% test level.

On the other hand, returns to household characteristics play a larger role in explaining the income gap for structurally poor households. Income differentials are larger at the bottom and upper ends of the distribution than in the middle. This means that both the stochastically and structurally non-poor households would earn less income if the distribution of returns to characteristics were same as that of structurally poor households. These results imply that even though both poor and well-off charcoal producers have similar household characteristics, the income gap is mainly widened by the differences in returns to these household characteristics.

### **5.3 Structurally poor charcoal producers and structurally poor non-producers**

Figure 6 shows the income differential between structurally poor charcoal producers (*base*) and structurally poor non-charcoal producers. We find that the structurally poor charcoal producers have a fairly large income advantage over the structurally poor non-charcoal producers in the lower end of the income distribution. Beyond the 63<sup>rd</sup> quantile, the income gap is nearly zero. A large part of this income advantage is explained by differences in household characteristics. However, the opposite effects hold for the structurally poor non-charcoal producers in the same lower half of the income distribution, where the income gap is explained by differences in returns to household characteristics. There are almost no observable differences in household characteristics or their returns, and so the total income differential between these groups is essentially nil in the upper end of the distribution.

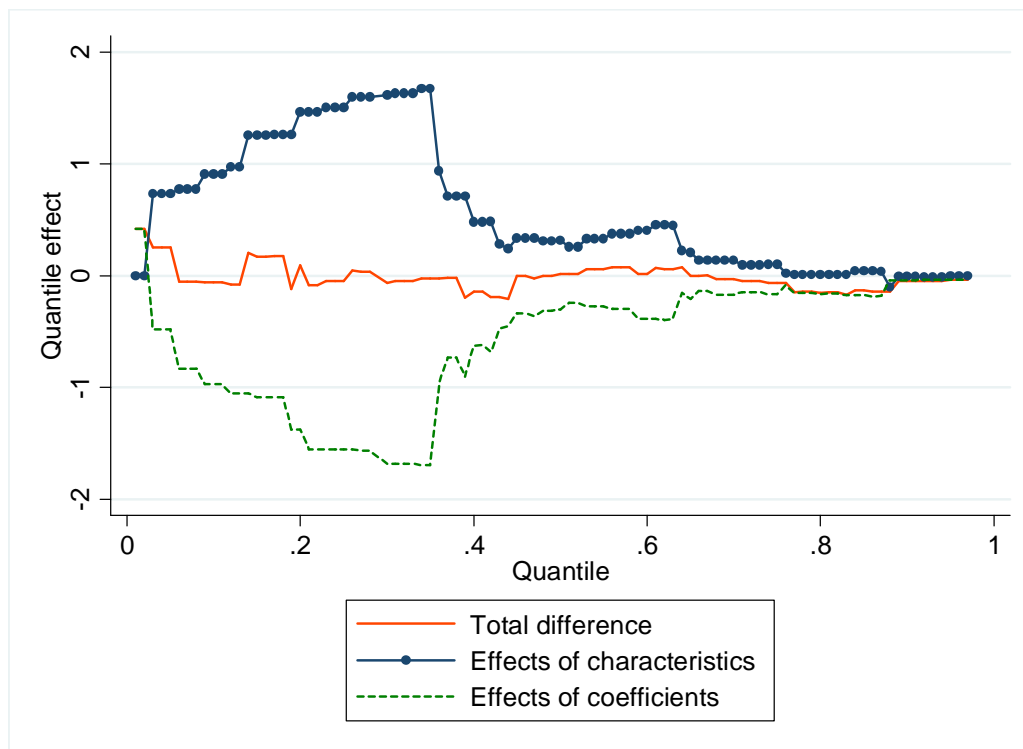


Fig. 6. Decomposition of income gap for structurally poor charcoal producers and structurally poor non-charcoal producers

#### 5.4 Structurally non-poor charcoal producers and structurally non-poor non-producers

Figure 7 shows the income gap of structurally non-poor charcoal producers (*base*) and structurally non-poor non-charcoal producers. The income gap associated with differences in household characteristics is negative for a considerable part of the income distribution, with the exception of the quantiles in neighborhood of the median point (48 to 58<sup>th</sup> quantiles) and those beyond the 73<sup>rd</sup> quantile. The negative difference suggests that the structurally non-poor charcoal producers have smaller income advantages over their counterparts conditional on differences in their household characteristics. That is, the negative difference indicates the structurally non-poor households not engaged in charcoal production would earn less if they switched to producing charcoal. Interestingly, the pattern of income distribution conditional on returns to household characteristics is almost a mirror image of the income distribution based on levels of characteristics. This means that based on returns to household characteristics, the structurally non-poor households not engaged in charcoal production would earn more if they switched to

producing charcoal. This income advantage would largely accrue to households below the mid-point of income distribution. Nevertheless, the overall income gap is stochastic for the most part in the lower half of the income distribution. Beyond the 51<sup>st</sup> quantile the gap widens, with the structurally well-off non-charcoal producers earning more from returns to their household characteristics than the structurally non-poor charcoal producers.

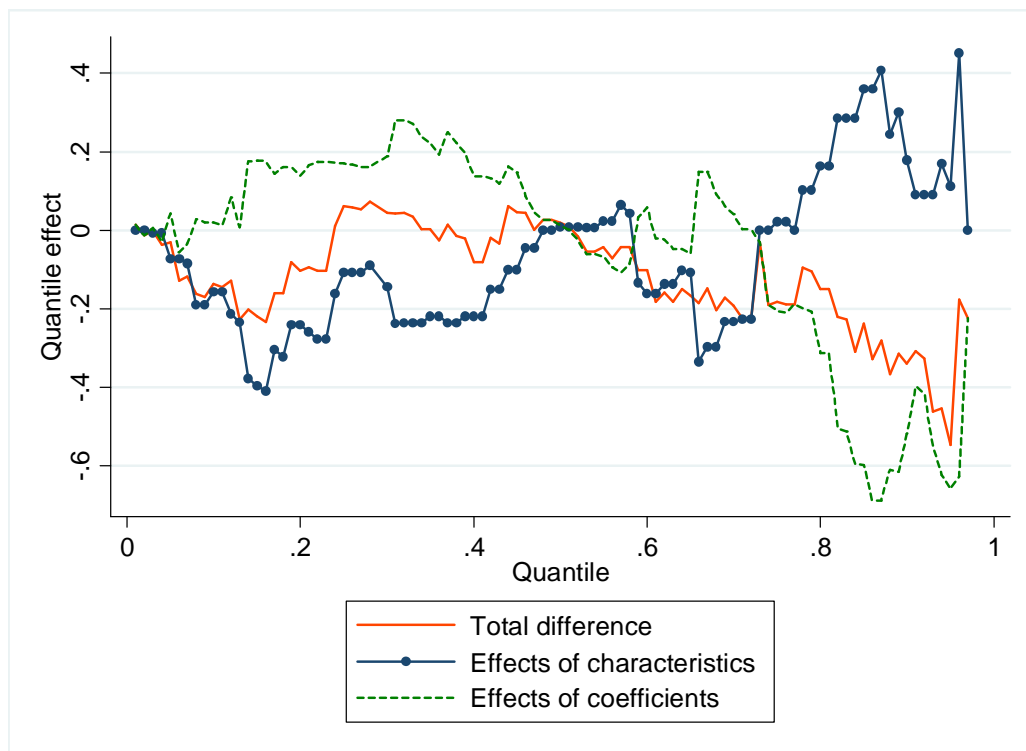


Fig.7. Decomposition of income gap for structurally non-poor charcoal producers and structurally non-poor non-charcoal producers

### 5.5 Stochastically non-poor producers and stochastically non-poor non-producers

Finally, Figure 8 compares the income gap between stochastically non-poor charcoal producers (*base*) and stochastically well-off non-charcoal producers. The stochastically non-poor charcoal producers are slightly better-off in the lower third of the income distribution (up to the 37<sup>th</sup> quantile) and worse-off throughout the remainder of the income distribution, conditional on their household characteristics. Conditional on returns to their household characteristics, the stochastically well-off non-charcoal producers are worse-off in the lower third of the income distribution and better-off beyond this point.

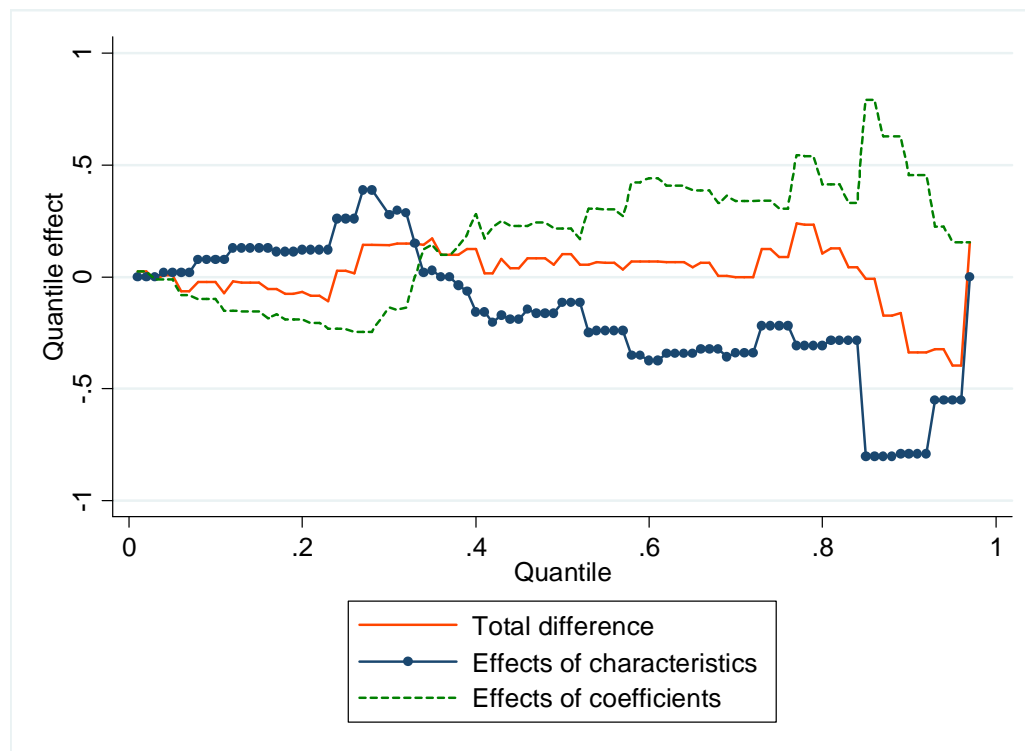


Fig. 8. Decomposition of income gap for stochastically non-poor charcoal producers and stochastically non-poor non-charcoal producers

## 6 Conclusions and policy implications

A range of empirical research continues to support the conjecture that forest utilization is a major livelihood strategy for the rural poor in developing countries, particularly in Africa. Moreover, forests are seen as providing natural insurance in the face of adverse shocks, but perpetuating poverty given the low returns to many non-timber forest products (NTFPs). In this paper, we used data from charcoal producers in Uganda to illustrate that the overall effects of income derived from NTFPs is likely to depend greatly on the characteristics of the households extracting these products. For some households, forest products can function as a means to escape poverty.

On the one hand, our empirical results confirm previous findings suggesting that younger households and those with few productive agricultural assets are more likely to turn to forests to generate income. However, using an approach based on quantile treatment effects we find that participation in charcoal production has a positive effect on household income. Our findings suggest that households may be using charcoal production in a way that alleviates poverty and opens up options beyond forest dependence. Evidence that charcoal producers at the bottom of the income distribution have an income advantage vis-à-vis non-producers suggests this kind of entry and exit strategy may be at work. However, this observed advantage narrows as one moves up the income distribution.

When we decomposed the income gap between charcoal producers and non-producers to ascertain whether the observed positive effects of participation in charcoal production are due to differences in household characteristics or returns to these characteristics we found that the benefits of engaging in charcoal production are explained largely by household characteristics. However, the income distribution of non-charcoal producers dominates the income distribution of charcoal producers across nearly all quantiles. This dominance arises from differences in returns to household characteristics; charcoal producers are better-off in income terms than non-charcoal producers, largely due to high returns derived from participating in charcoal production. Non-producers are better-off than charcoal-producing cohorts, given the observed returns to resource endowments.



In sum, asset-poor households that engaged in charcoal production were better-off in income terms than asset-poor households that did not produce charcoal. Participation in charcoal production appears to be a temporary means to accumulate income, after which exit from forest product extraction is possible. Future research will need to focus on how returns from commercialized NTFPs are utilized, how environmentally sustainable their use might be under site-specific conditions, and at what point the rural poor might be able to exit from an income-earning strategy based on extraction. Our findings indicate that treating NTFPs extraction as a major and continuing livelihood strategy for the rural poor may be misplaced. Where forest product extraction can be commercialized, NTFP may emerge as a temporary and intermediate stage in the process of rural development.

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# PAPER IV



# Do Commercial Forest Plantations Reduce Pressure on Natural Forests? Evidence from Forest Policy Reforms in Uganda\*

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John Herbert Ainembabazi

## **Abstract**

This paper investigates if and how the establishment of private commercial forest plantations in degraded forest reserves can conserve the natural forests in Uganda. It uses difference-in-difference and decomposition analyses on household data collected from intervention and control villages in the neighborhood of forest reserves. I find that the commercial forest plantations are weakly effective in conserving natural forests, and that the reduction in forest use is unevenly distributed across households, depending on location and resource endowments like farmland and livestock. The paper concludes that the conservation effectiveness can be enhanced by complementary interventions that change characteristics that reduce forest use, such as more education.

Key words: Forest policy, commercial forest plantations, extraction, conservation

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## 1 Introduction

Faced with shrinking forest cover and degradation, many countries in Africa, Asia and Latin America have adopted devolution and decentralization policies of forest management (Edmunds and Wollenberg, 2003; Colfer and Capistrano, 2005; German et al., 2010)<sup>24</sup>. In many countries, decentralization and devolution policies have been formulated in a way that deprives the local forest users of their rights or excludes them from decision-making (Sikor et al., 2010). The forest policy reform in Uganda, which is part and parcel of a comprehensive decentralization policy, is an example where conditions of deprivation and exclusion of local forest users exist. In response to severe degradation and deforestation, the government of Uganda in 1998 created local and central forest reserves (Nsita, 2005)<sup>25</sup>. The former was decentralized to local governments, while the latter would later be managed by a semi-autonomous body, the National Forestry Authority (NFA) in 2003 (Nsita, 2003; 2005). Although the NFA mission is to “manage central forest reserves on a sustainable basis ... through expanding partnership arrangements [including private investors] ... to increase the size of the central forest reserves”, NFA is also a for-profit parastatal. Mandated by the forest policy of 2001, NFA raises revenue while at the same time attempts to restore and conserve central forest reserves (CFRs) by, among other activities, leasing parts of CFRs to private investors to establish commercial forest plantations (MWLE, 2001). Whether this form of forest restoration policy that excludes local users is effective in restoring and conserving CFRs is an empirical question that I attempt to answer in this paper: Do commercial private forest plantations reduce pressure exerted by the rural poor on (the remaining) forest reserves?

Studies to answer this question, especially those focusing on individual forest plantations (IFP), remain limited. The current literature deals with drivers of expanding IFP. The practice of IFP has, in part, occurred in densely populated countries in Asia, particularly those undergoing industrialization coupled with rural-urban migration

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<sup>24</sup>*Devolution* refers to the transfer of specific decision-making powers from central authorities to community organizations, whereas *decentralization* refers to the transfer of powers from central authorities to lower levels in administrative and territorial hierarchy (Larson and Soto, 2008).

<sup>25</sup> Central forest reserves in Uganda are defined as forests covering an area of at least 100 hectares, while those covering less than 100 hectares are defined as local forest reserves.

(Mather, 2007; Rudel, 2009). These driving forces are part of the forest transition, where countries enter into a phase of a net increase in forest cover (including plantations), and forest plantations are mainly occurring on abandoned farmland (Rudel et al., 2005). This typical pattern is in contrast with the IFP policy initiative in Uganda, where the establishment of IFP is occurring in forests (CFRs) that have been degraded by the rural poor. The government, through NFA, leases part of the CFRs to wealthy individuals or private companies to establish commercial forest plantations in forest reserves that have been heavily degraded or deforested.

The policy is expected to reduce pressure on natural forests through a number of channels. First, privatizing parts of the forest reserves will increase scarcity of forest products for the people living adjacent to these reserves, which may trigger them to begin on-farm tree planting, in particular for woodfuels. Second, higher scarcity may also induce adoption of measures to increase fuel efficiency or switch to other energy sources. Third, by partitioning out degraded or deforested areas, the government expects to improve the enforcement of forest protection laws and management of remaining forest reserves. Forth, private owners of IFP are expected to provide efficient management and protection of their plantations, and to become suppliers of forest products in the future.

These positive effects cannot, however, be taken for granted. The local people who depend on or extract forest products from these CFRs are in practice excluded from participating in commercial forest plantations due to their limited wealth that denies them a chance to acquire leases. Having been expelled from the new plantation areas, the forest dependent households may shift collection of forest products to distant and intact forests that have previously been conserved by their remoteness (Robinson and Lokina, 2011). Thus, we may experience what is referred to as ‘displaced emissions’ or ‘leakage’ in the climate debate.

Policy initiatives that encourage local communities to participate in forest plantations have been found to reduce pressure on natural forests in other settings (Köhlin and Parks, 2001; Köhlin and Amacher, 2005). Similarly, policies promoting individual on-farm tree plantations for fuelwood production (Webb and Dhakal, 2011) or technological change involving agroforestry (Evans, 1999) have been found to enhance conservation of natural forests. Nevertheless, Angelsen and Kaimowitz (2004) argue that

the effect of agroforestry on forest conservation is conditioned on farmer characteristics, production practices, market and tenure conditions, and hence making broad generalizations difficult.

This paper complements earlier studies (Banana et al., 2007; Turyahabwe et al., 2007; Jagger, 2010) which reveal that decentralization of forest reserves in Uganda has worsened forest quality, and gains from decentralization in form of household income are unevenly distributed due to institutional failures, primarily lack of capacity, funds and mandate in the case of local governments, and due to selective enforcement of rules in the case of NFA managed CFRs. However, these studies have focused on the effects of decentralization of forest management as a comprehensive policy package, but not the individual policy components like the forestry policy of 2001 (MWLE, 2001), which promotes both establishment of profitable and productive forest plantations on CFRs and progressive divestment of management of existing commercial forest plantations on forest reserves to private sector. This study focuses on one component of the forestry policy: establishment of commercial forest plantations on CFRs by private investors, a component that encourages individual rather than communal participation in forest plantations. In addition to focusing on the effectiveness of this policy, the paper goes a step further to identify which households are changing the forest use and why.

The paper is organized as follows. Section two briefly describes the history of forestry policy reforms in Uganda. Section three describes the data sources and sample selection procedure. Data were collected from both households living in communities adjacent to forest reserves with and without establishment of commercial tree plantations. Section four presents the two different project evaluation methods used: difference-in-difference and decomposition. Results are presented and discussed in section five, while section six concludes.

## **2 A brief history and nature of forestry policy reform in Uganda**

Forest policy reforms in Uganda started as early as 1939 when local forest reserves under district administration were established (Turyahabwe et al., 2007). The Forest Department (FD), the overall authority at the time, controlled the central forest reserves (CFRs). The district administration had a mandate to make bylaws to protect local forest reserves (LFRs). A series of policy reforms have occurred since then. In 1967, the LFRs

were centralized under the Forest Department and the services offered by the local administration were abolished (Nsita, 2005; Turyahabwe et al., 2007). The Forest Department was mandated with full control of all government forest reserves and regulation of harvesting of forest products from these reserves.

The government devolved ownership and management of central forest reserves to local governments in 1993, but forest management was later recentralized in 1995 (Nsita, 2005; Banana et al., 2007). In 1997, district and sub-county local governments took over the forest management before being restricted again in 1998 when central and local forest reserves were re-created (Nsita, 2005; Ribot et al., 2006; Banana et al., 2007). CFRs and LFRs are managed and controlled by the central and local governments respectively.

The Forest Sector reform formed in 1999 led to a number of policy changes: abolition of the centralized Forestry Department, creation of the decentralized District Forestry Service (DFS), introduction of a new forest policy in 2001, development of a national forest plan in 2002, and creation of the National Forestry Authority (NFA) under the National Forestry and Tree Planting Act of 2003 (Nsita, 2003; Republic of Uganda, 2003; Turyahabwe and Banana, 2008; Jagger, 2010). DFS is responsible for issuing permits for extraction of forest products, and offering advisory services to owners of private and customary forests (ungazetted forests). NFA manages CFRs and is responsible for the leasing of forest reserves to private investors for establishment of commercial forest plantations among other functions.

### **3 Data sources and sample selection**

The data were collected in 2009 from two districts in western Uganda: Hoima and Kiboga. The districts were purposively selected because they have a high number of CFRs where parts of the reserves have been leased out for commercial oriented IFP. There are 11 and 15 separate CFRs in Hoima and Kiboga districts, respectively. At the time of the study, Hoima had 300 IFP established in its CFRs, whereas Kiboga had 104 IFP. Establishment of these IFP has been going on since 2002 in Hoima and 2005 in Kiboga.

One sub-county in each district was purposively selected based on the presence of CFRs with and without IFP. A sub-county selected in Hoima has two CFRs: one with 108 IFPs established in 2005, and the other CFR had no IFP. Similarly, a sub-county selected in Kiboga has two CFRs: one with the largest IFP in the district also established in 2005, and the other CFR had no IFP.

Twelve villages in Hoima district and six villages in Kiboga district were randomly selected from two randomly selected parishes with CFRs where IFP have been established<sup>26</sup>. Three villages in Hoima and nine villages in Kiboga were also randomly selected from two randomly selected parishes with CFRs where IFP have not been established. From each of the selected villages, a random sample of ten households was selected. In total, the study uses a random sample of 180 households in 18 intervention (IFP) villages and 120 households in 12 control villages. Both village and household level questionnaires were administered. The village level data were collected using focus group discussions. Household information on key variables before and after the introduction of IFP policy initiative was collected using recall methods. The reference time before the introduction of IFP in the study areas is 2004 and the after-IFP time reference is 2009 (as mentioned above, IFP was introduced in 2005 in the study sites).

#### **4 Empirical methods**

The research question concerns whether commercial forest plantations reduce pressure exerted by the rural poor on natural forest reserves. To address this I use the counterfactual analytical approach that follows the *before-after-control-intervention* design (Imbens and Wooldridge, 2009). This approach uses the data collected from both villages around CFRs with IFP establishments (intervention site) and villages around CFRs without IFP (control site). The approach requires the data collected to cover both before and after the introduction of IFP policy initiative in both sites. Then changes in forest outcomes are compared. Households in the control site provide a reference point to what would have been harvested without the policy change (the counterfactual or business-as-usual scenario), and the control site intends to capture changes in forest use

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<sup>26</sup> A village in Uganda is commonly referred to as local council one (LC1). An LC1 is the lowest administrative unit in Uganda. Also note that the terms village and community are used interchangeably.

over time that is not due to the policy change. To examine the changes in forest outcomes due to the policy, I use two methods: difference-in-differences and decomposition analyses.

#### 4.1 Difference-in-differences

In the difference-in-differences (DiD) approach, the before-after difference in the mean of CFRs outcome derived from the households in intervention site is compared with the before-after difference in the mean of CFRs outcome obtained from households in control site. The DiD estimate measures the change in CFRs conservation due to the policy change. The “CFRs outcome” was measured as the sum of forest products extracted by a household in a month. Hereafter, CFRs outcome and forest product harvesting (or forest use) are used interchangeably. In absence of panel data, a recall method was used to collect necessary data on CFRs outcome and household variables before and after the introduction of IFP policy initiative.

The DiD approach to determine the effect of IFP policy initiative follows Imbens and Wooldridge (2009). Let  $T_p$  denote the estimated effect of IFP policy initiative on the households in intervention site. Let  $G_0$  and  $G_1$  be the mean of CFRs outcomes for the households in the intervention site before and after the introduction of IFP policy respectively. Similarly, let  $Y_1$  and  $Y_0$  be CFRs outcomes for households in control site before and after the introduction of IFP policy such that:

$$T_p = (G_1 - G_0) - (Y_1 - Y_0) \quad (1)$$

Equation (1) measures the relative average treatment effect attributed to IFP policy initiative. Although an attempt was made to find comparable control sites, there might be systematic differences between them that may bias the simple comparison of relative outcomes. For example, IFPs are established on largely degraded CFRs, which suggest that the IFP policy initiative is not randomly applied on CFRs. Equation (1) then needs to be modified to control for other factors that might explain the variation in CFRs outcomes (Wooldridge, 2010):

$$T_{it} = \beta_0 + \beta_1 target_{it} + \beta_2 after_{it} + \beta_3 target_{it} * after_{it} + \beta_4 X_{itv} + \varepsilon_i \quad (2)$$

where  $T_{it}$  is the observed outcome for household  $i$  in period  $t$ .  $target$  is the indicator variable = 1 if the household lives in the intervention site, and 0 if the household lives in the control site. The  $target$  dummy isolates the difference in the mean of CFRs outcome between households in intervention and control sites before or after the policy change.  $after$  is the indicator variable = 1 if the household lives in the intervention site and is observed in the after-IFP policy period, and = 0 if before the introduction of IFP policy. The  $after$  dummy controls for the difference common to both households in intervention and control sites after the policy change. The interaction term  $target_{it} * after_{it}$  is an indicator for the households in intervention site, and it measures the percentage change in CFRs outcome associated with the IFP policy initiative. The coefficient on the interaction term ( $\beta_3$ ) yields the difference-in-difference estimate of the treatment effect.  $X_{itv}$  is a vector of the household and village ( $v$ ) level factors that may explain variation in the CFRs outcome.  $\beta_0 - \beta_4$  are parameters to be estimated and  $\varepsilon_i$  is the error term.

## 4.2 Decomposition

The second approach uses the decomposition method developed by Blinder (1973) and Oaxaca (1973). This approach complements the DiD approach by explaining the source of any observed differences in the amount of forest products extracted by different households. The DiD approach yields the difference in CFRs outcome between the control and intervention sites associated with IFP policy, with (equation 2) or without (equation 1) controlling for any differences in household or village characteristics between the two sites.

In the decomposition approach, this difference may be explained by the differences in *returns* to observed (household or village) characteristics in the two sites, or differences in the *level or magnitudes* of these characteristics (e.g., education, landholding, access to markets, population density). For example, households in the intervention site may extract smaller amounts of forest products than their neighbors in control site not only because they have larger land size but also because the impact of land size on forest extraction differs between the two sites.

Thus, decomposition analysis splits any impact of the IFP policy on *magnitudes* and *returns* of observed characteristics. Suppressing the household index, the estimation procedure is developed as follows:

$$m_I = X_I \beta_I + e_I, \quad E(e_I) = 0, \quad \text{Intervention site} \quad (3)$$

$$m_c = X_c \beta_c + e_c, \quad E(e_c) = 0, \quad \text{Control site} \quad (4)$$

where subscripts  $I$  and  $c$  denote intervention site and control site respectively.  $m_g$  (for  $g = I, c$ ) is the amount of forest products extracted by a household in location  $g$ .  $X_g$  is a vector of observed household and village characteristics similar to those in  $X_{iv}$ .  $\beta_g$  is the vector of corresponding parameters to be estimated.  $e_g$  is the error term with zero expectation. The mean CFRs outcome difference ( $\varpi$ ) can be expressed as the difference in the linear prediction at the site-specific means of the regressors as:

$$\varpi = \bar{X}_I \hat{\beta}_I - \bar{X}_c \hat{\beta}_c \quad (5)$$

Following Jann (2008) and Jones and Kelly (1984), the contribution of group differences in magnitudes and returns to characteristics to the overall CFRs outcome difference in (5) is estimated as<sup>27</sup>:

$$\varpi = \underbrace{(\bar{X}_I - \bar{X}_c) \hat{\beta}_c}_{\text{Characteristics level effect}} + \underbrace{\bar{X}_c (\hat{\beta}_I - \hat{\beta}_c)}_{\text{Returns to characteristics effect}} + \underbrace{(\bar{X}_I - \bar{X}_c) (\hat{\beta}_I - \hat{\beta}_c)}_{\text{Interaction of characteristics and returns effect}} \quad (6)$$

The first part on the right hand side of (6) measures the proportion of CFRs outcome differential due to differences in the distribution of characteristics between households in control and intervention sites. Sometimes this first part is called the

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<sup>27</sup> The decomposition approach applied here assumes that errors are homoskedastic since the introduction of IFP is a government policy and the local forest users have no direct influence in deciding which location to apply the policy. In other words, the IFP policy is exogenously given in intervention villages. Melly (2005) discusses other decomposition approaches where errors are heteroskedastic and equation (6) is split into three parts: effect of characteristics, returns to characteristics and effect of errors (residuals).



‘explained’ portion of the outcome difference. This part helps to identify policies (termed as ‘*X-policies*’ in the discussion) which are necessary to cause changes in observed characteristics that will eventually lead to a reduction in CFRs outcome. These ‘*X-policies*’ are identified based on equation (2).

The second part measures the proportion of the CFRs outcome differential due to differences in returns to characteristics. This part is often referred to as ‘unexplained’ portion of the outcome difference and indicates how the CFRs outcome would change if households in the control site had the same rates of returns as the households in the intervention site. In labor economics literature, the second part is sometimes regarded as the measure of discrimination against, for example, female laborers, in which case discrimination is measured in terms of returns to characteristics such as education (Jones and Kelly, 1984). In this study, I regard the second part of (6) as a behavioral measure of a household and instead use the term “self-exclusion” as an alternative to “discrimination”. The second part therefore helps to identify policies (termed as ‘*β-policies*’ in the discussion) which play an important role in changing the behavior relative to observed characteristics. The third part is an interaction term which explains how differences in characteristics and their returns occur simultaneously between households in intervention and control sites.

## 5 Results

### 5.1 Descriptive statistics

Table 1 reports some of the key household and village level characteristics. The majority of the participating households are headed by males, 90% in control site and 82% in intervention site. The average age of household heads is 42 years, and they have about six years of education. The majority of them are monogamously married (65%), with an average household size of about six members of whom more than half are dependants. The dependency ratio was computed as a ratio of the total number of household members aged below 15 years plus those aged above 65 years to the household size.

Table 1 also shows that although the population density in the participating villages increased from 35 to 44 households per square mile in control site and from 41 to 58 households per square mile in intervention site following the introduction of IFP

policy in 2005, the increase did not affect the households' resource endowments (Table 2). The average landholding increased slightly from 2.5 to 2.9 acres in control site and from 5.6 to 6.2 acres in intervention site, while livestock ownership declined slightly from 1.2 to 1.0 tropical livestock units (TLU) in control site and from 3.1 to 2.8 TLU in intervention site<sup>28</sup>.

Table 1. Descriptive statistics of selected key variables

<i>Household characteristics</i> (mean values)	<b>Control site</b>		<b>Intervention site</b>	
	Before (N=120)	After (N=120)	Before (N=180)	After (N=180)
Age of household head		41.7		42.2
Education of household head (years in school)		5.4		6.0
Share of household heads with off-farm employment	0.358	0.525	0.461	0.556
Share of male household heads	0.900	0.900	0.817	0.817
Share of household heads in monogamous marriage	0.650	0.650	0.650	0.650
Share of household heads in polygamous marriage	0.225	0.225	0.156	0.156
Dependency ratio	0.347	0.516	0.400	0.525
Share of household heads that have received agricultural or forestry extension services	0.158	0.400	0.222	0.439
<i>Village level variables</i>				
Number of migrant households in previous five years	13.9	26.6	36.7	63.1
Village population density (households/square mile)	35.4	44.0	41.4	57.8

## 5.2 Extraction of forest products, forest leasing policy and household characteristics

Table 2 shows the source of forest products and the share of households extracting forest products from each source. There were two major sources of forest products: state owned and privately owned forest reserves. Although respondents were able to identify the state and private forest reserves, the owners of private forest reserves do not hold *de jure* but *de facto* rights (NFA, 2005; 2006)<sup>29</sup>. As result, the majority of the private forest reserve owners have no formal land titles except for a few individuals that have acquired lease titles. Given the unclear ownership of forest reserves, apart from the community characteristics in Table 2, the subsequent analysis ignores the source of forest products.

<sup>28</sup> A TLU index was computed as: 1 TLU = 1 cattle = 0.1 goats or sheep = 0.5 donkeys = 0.05 chicken or turkeys or ducks (Jahnke, 1982).

<sup>29</sup> The government has for a long time failed to re-demarcate clear boundaries of state forest reserves. The Government gazetted and demarcated forest reserves in the early 1950s. However, between 1972 and 1986 there was a breakdown in the law, which led to heavy encroachment on forest reserves (NFA, 2005).

Table 2. Household characteristics and forest extraction

	Control site				Intervention site			
	Before (N=120)	After (N=120)	% change	t-value	Before (N=180)	After (N=180)	% change	t-value
Share of households in village extracting products from state forest reserves	0.398	0.246	-38.2	1.013	0.249	0.150	-39.8	1.109
Share of households in village extracting products from private forest reserves	0.364	0.403	10.7	-0.343	0.577	0.613	6.2	-0.519
Number of visits per month	3.1	5.1	64.5	-4.50***	3.7	4.9	32.4	-3.01***
Extraction time (hours per visit)	0.73	1.35	84.9	-4.98***	1.04	1.44	38.5	-3.41***
Amount of forest products extracted per adult equivalent (kg)	805.6	1087.0	34.9	-2.356***	825.8	905.5	9.7	-0.803
Household size	4.4	6.1	38.6	-4.85***	5.0	6.2	24.0	-4.01***
Share of households in village planning to establish on-farm tree planting		0.425				62.8		-3.516***
Farm size owned (acres)	2.5	2.9	16.0	-0.75	5.6	6.2	10.7	-0.50
Livestock ownership (TLU)	1.21	1.03	-14.9	0.36	3.11	2.82	-9.3	0.22
Off-farm income per adult equivalent (US\$) <sup>a</sup>	116.3	133.1	14.4	-0.58	173.1	188.3	8.8	-0.31

<sup>a</sup> Average exchange rate was 1US\$ = 1 930 Uganda shillings (Bank of Uganda, 2009).  
\*\*\*, \*\*, \* are significance levels at 1%, 5%, 10%, respectively.

Forest products considered in the study were timber trees, poles, fuel wood, charcoal, rattans, thatching grass, wild livestock feeds, ropes, vines, forest edible products like fruits, mushrooms among others. For every product extracted, the respondent was asked to estimate the amount extracted in kilograms. The total amount extracted was estimated based on the number of visits made to the forest reserves in a month and whether that month fell in the high harvesting season or low harvesting season, number of harvesting months in each of the two seasons in a year, average number of hours per visit, number of household members per visit and the average total quantity harvested per visit. Information on weights of individual forest products was collected both at household and community levels. In the analysis below, I normalize the total amount of forest extraction by adult equivalent scale to control for differences in forest product consumption by age and sex of household members (Hagenaars et al., 1994).

In focus group discussions, participants were asked to list all forest products commonly extracted by the community members. The participants were asked to estimate the unit weight of a given forest product based on the form in which it is harvested such as bundles of fire wood, bags of charcoal, individual poles and the like. The mean of individual forest product weights collected at community level was fairly comparable to the mean obtained from household level data. In cases where respondents were unable to estimate the unit weight of a given forest product, the median unit weight of that product estimated from all households in a given community was used. Nearly all sample households extracted forest products for home consumption: only four households sold part of the extracted forest products. I was therefore unable to obtain information on market prices for the extracted products. This led to the use of quantities of forest products harvested in kilograms rather than their market values. Interestingly, most (78%) of the forest products extracted were wood products (firewood and poles), making the use of physical units more appropriate. Moreover, from environmental viewpoint and related to the objective of the IFP policy, the amount of biomass harvested is more important than its monetary value.

Table 2 shows that the share of households extracting forest products from forest reserves in intervention site is slightly lower than the share of households in control site in both periods, that is, before and after the introduction of IFP policy. The majority of the households extract forest products from private forest reserves. Before the introduction of IFP policy, about 57% of households in the sub-sample from intervention site extracted from private reserves compared to 25% extracting from state reserves. But the shares of households in control site extracting forest products from both private and state reserves are fairly comparable: 36% (private forest reserves) and 40% (state forest reserves). After the introduction of IFP policy, the share of households extracting forest products from state reserves decreased by 10 percentage points, from 25% to 15% in intervention site, whereas the share of households extracting forest products from private forest reserves increased by only 3%, from 58% to 61% in control site.

Two preliminary results are worth noting. First, the simple descriptive analysis suggests that the introduction of IFP policy is weakly effective in conserving state forest reserves. There is a small reduction in the share of households extracting forest products

from state forest reserves, but matched with a slight increase in extraction from private forest reserves. Thus the results indicate that with establishment of IFP, state forest reserves are increasingly becoming inaccessible to the forest dependent households compared to private reserves.

An alternative explanation, however, is that the policy was introduced in areas where deforestation and forest degradation activities had been occurring for a long time to the extent that extractable products have become scarce and hence households are shifting to private forest reserves that still have adequate extractable products. It should be noted that private forest reserves are owned by few individuals who are either absentee landlords or unable to control encroachers given the vastness of the forest reserves.

Second, the annual change in the average amount of extracted forest products (from state and private forest reserves) per adult equivalent in the intervention site increased less relative to the control site: the amount increased significantly by about 35% in the control site, while the increase was only 10% in the intervention site following the introduction of IFP policy. Correspondingly, the extraction time of forest products along with the number of visits to the forest increased significantly in both control and intervention sites. However, the increase in both extraction time and numbers of visits to forests was greater in control sites than intervention sites. Overall, these figures may suggest that the IFP policy was effective.

In addition to changes in extraction from forest reserves, another indicator of the success of IFP policy is whether more private on-farm tree plantations have been established. Before the introduction of IFP policy, only two households had on-farm tree plantations and the number increased to four households after the introduction of IFP policy in control site. In intervention site, the number of households with on-farm tree plantations increased from two to nine households (i.e. 5% of the sampled households). Even though the majority of households in intervention site (63%) plan to establish on-farm tree plantations compared to 43% in control site, these results suggest that forest reserves are likely to remain the main supplier of woody forest products in the foreseeable future.

Table 2 also compares the household characteristics between the households in control and intervention sites. Households in both sites have had fairly large increases in

household size: 39% (control) and 24% (intervention). This suggests that the population of households in the neighborhood of forest reserves is still in the productive age group. Indeed, Figure 1 reveals that household heads living within 5 km from forest reserves are in their early forties and the dependence ratio of these households within the same distance is substantially increasing. Other household characteristics like farm size holding, ownership of livestock and off-farm income per adult equivalent did not have any significant changes in both control and intervention sites following the introduction of IFP policy.

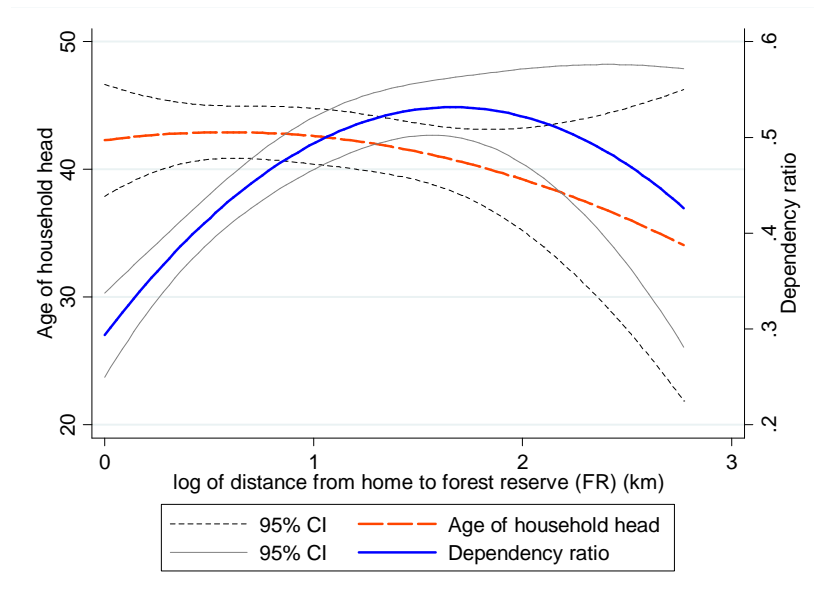


Figure 1. Quadratic predictions for head's age and dependency ratio on distance to CFR

### 5.3 Determinants of forest products extraction

To quantify the relationship between extraction of forest products and the introduction of IFP policy, this sub-section uses the difference-in-difference model presented in equation (2). I estimate equation (2) using random effects (Wooldridge, 2010) instead of fixed effects due to limited variation in some of the variables as evidenced in Table 1. As reported and discussed in relation to Table 2, the dependent variable is the sum of all forest products extracted by a household from forest reserves. The random effects model is estimated with data clustered by both control and intervention sites to control for intra-site correlation. I then run two specifications of the model, one where I assume linearity of all variables and another one where I account for nonlinear relationships among some

variables. The selection of the variables included as nonlinear was based on *a priori* expectations of the relationships between forest extraction and certain explanatory variables. For variables that were not consistent with the *a priori* expectations, their quadratic terms were included. Table 3 reports the final results from a specification where I considered nonlinear relationships among some variables.

Table 3. Determinants of forest products extraction

Dependent variable: log of forest extraction per adult equivalent	Estimates
<i>Policy characteristics</i>	
Presence of IFP (1 = intervention site, 0 = control site)	-0.058*** (0.011)
Time (1 = after introduction of IFP, 0 = before)	0.354*** (0.084)
Interaction of IFP and time dummy	-0.589*** (0.040)
<i>Household assets</i>	
log of livestock (TLU) <sup>a</sup>	0.974 (0.868)
log of livestock squared (TLU)	-0.586* (0.313)
log of farm size (acres) <sup>a</sup>	7.662*** (0.444)
log of farm size squared (acres)	-3.347*** (0.155)
<i>Other household characteristics</i>	
Age of household head (years)	-0.033*** (0.004)
Age of household head squared (years) x 100	0.042*** (0.005)
Household head (1 = male, 0 = female)	-0.052 (0.141)
Education of household head (years in school)	-0.006*** (0.001)
Household size	0.106*** (0.019)
Household head has off-farm employment (1 = yes, 0 = no)	0.211 (0.138)
<i>Village and location characteristics</i>	
log of village population density (households per square mile) <sup>a</sup>	0.162** (0.067)
log of immigrants in previous five years <sup>a</sup>	0.071** (0.030)
Distance from home to nearest output or input market (km)	0.184*** (0.032)
Distance from home to nearest commercial tree plantation (km)	-0.002 (0.008)
log of distance from home to nearest forest reserve (km) <sup>a</sup>	3.625*** (0.373)
log of distance from home to nearest forest reserve squared (km)	-1.976*** (0.199)
Constant	2.048*** (0.334)
Within R <sup>2</sup>	0.630
Number of observations	600

<sup>a</sup>Note that the logarithm transformation was done to correct for skewness.

Figures in parentheses are robust standard errors. \*\*\*, \*\*, \* are significance levels at 1%, 5%, 10% respectively

*IFP policy initiative:* The key result is the interaction term between IFP policy and time dummy that shows the difference-in-difference (DiD) estimate after controlling for differences in household and village level characteristics between households in control and intervention sites before and after the introduction of IFP policy. The coefficient on the interaction term is negative and statistically significant. This finding implies that the introduction of IFP policy reduced the annual business-as-usual increase in forest extraction by about 59% in the intervention site compared to the control site. This finding may be perceived as a contrast to the picture painted by the descriptive statistics which suggested that IFP only weakly reduced forest extraction. I simplify the interpretation here with reference to equation (1) and the descriptive results of forest extraction in Table 2. Equation (1) gives unconditional DiD estimate, which can be computed from Table 2, as -201.7 kg per adult equivalent (i.e., the difference in extraction between ‘after’ and ‘before’ in intervention site less the difference in extraction between ‘after’ and ‘before’ in control site). This means that the increase in the average amount of extracted forest products per adult equivalent in the intervention site was 201.7 kg lower than what it would have been in the absence of the IFP policy:  $(1087.0-805.6) - (905.6-835.8)$ . In other words, the increase was only 79.7 kg instead of 281.4 kg in the control site, which means that the increase was 71.6 %  $(201.7/281.4)$  lower than what it would have been without the IFP policy. Table 3 gives the corresponding *conditional* estimate of -58.9 %, which suggests that the reduction in forest extraction, compared to a without IFP scenario, was 165.7 kg  $(281.4 * 0.589)$ .

Overall, the results suggest that forest product use was reduced by 165.7 kg, compared to a business-as-usual extraction of 1,071.3 kg  $(905.6 + 165.7 \text{ kg})$ . This represents a reduction of about 15.5%. Thus, while establishment of private commercial forest plantations lead to a reduction in forest extraction and a reduction of 15.5% is not to be ignored, it may not be sufficient to conserve natural forests.<sup>30</sup>

*Distance to the nearest forest reserve:* The results show that extraction of forest products increases with the distance from home to the nearest forest reserve at decreasing

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<sup>30</sup> To put these results in perspective, woody biomass is a major source of energy for the rural households in Uganda (NEMA, 2005), and the annual per capita consumption of firewood is estimated at 680 kg (MEMD, 2005). Our estimate represents a share less than 24% (i.e., 166/680) of annual per capita consumption of firewood, since the 166 kg includes both firewood and other forest products.



rate before the extraction decreases at greater distances. This finding is unexpected as one would expect extraction of forest products to decrease continuously with distance from the forest. I further examine this relationship between forest extraction and distance to the forest reserve using bivariate regression. Figure 2 reports the results for both control and intervention sites before and after the introduction of IFP policy. The figure shows a relationship leaning toward a significant inverted-U or bell-shaped curve in both sites before the introduction of IFP, which is consistent with the picture reflected by regression results in Table 3. On the other hand, after the introduction of IFP policy, we observe that forest extraction tends to decrease with the distance from forest reserve as expected. These results imply that the variation in forests extraction is not only explained by the introduction of IFP and observed household and village characteristics, but also that unobserved heterogeneity across households may explain part of this variation in forest extraction. I elaborate on this pattern further in the next sub-section.

*Landholding and livestock ownership:* Differences in productive assets significantly affect the amount of forest products extracted; less extraction is observed in households owning larger herds of livestock and farms. More specifically, I observe an inverted-U relationship between extraction of forest products and productive assets (landholding and livestock ownership), although the relationship is not significant for livestock ownership. From Table 3 (after taking the antilogarithm), the turning point is 3.1 acres of farmland. That is, extraction of forest products among households owning small farmland is high but as the farm size increase, extraction is increasing at a decreasing rate up to 3.1 acres, beyond which extraction declines. Compared to results in Table 1, this turning point of farm size suggests that redistribution of land in control site beyond the average farm size holding (2.9 acre) would reduce forest extraction. However, this turning point is less than the average farm size in intervention site suggesting that large farm size alone may not reduce forest extraction and that other factors are important as I elaborate in detail in section 5.4.

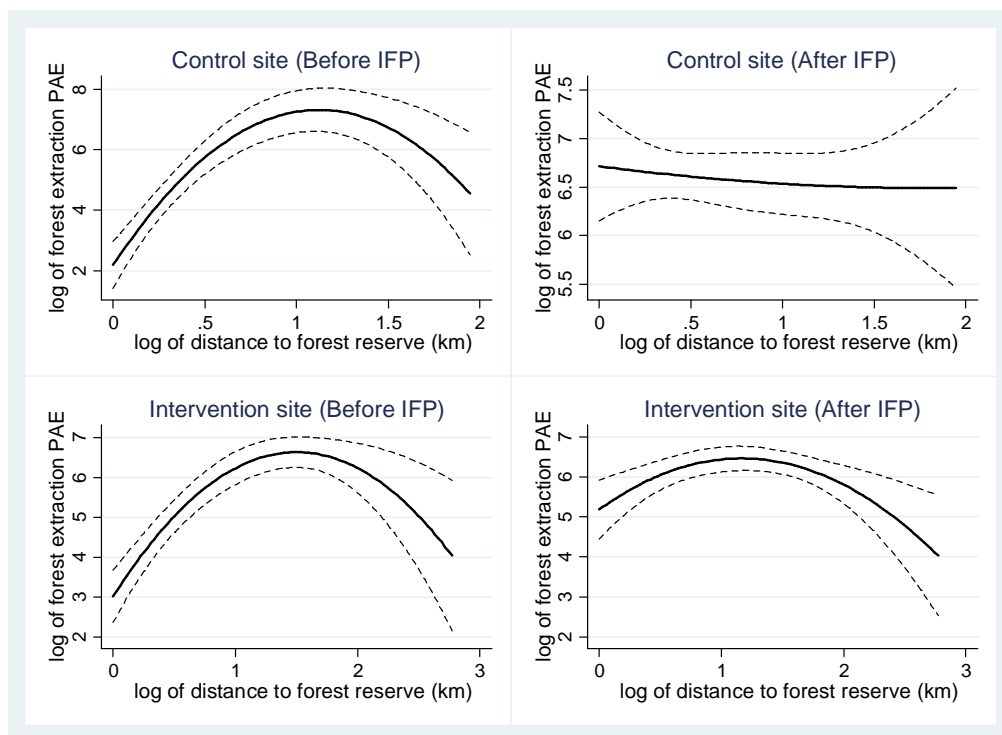


Figure 2. Quadratic prediction of annual forest extraction per adult equivalent (kg) on distance from home to nearest forest reserve (km).

*Other household and village characteristics:* Other than the policy effect, changes in forest extraction are also partly explained by differences in: household demographics – low extraction is common among younger household heads than older ones (as evidenced by the U-shaped relationship) especially those with less education and large household size; location differences – high extraction levels are associated with households farther away from input-output markets; population pressure – increase in number of immigrants in the community and household population density are associated with increased extraction of forest products.

While these results suggest that the success of IFP policy depends on the household characteristics that define household welfare, they also paint a puzzling picture. Households extracting the smallest amounts of forest products live very close to forests and have small stocks of farmland and livestock holdings, but as the distance from forests increases, forest extraction increases along with increases in farm size and livestock holdings before declining at greater distances and larger stocks of landholdings and livestock. These results may appear counterintuitive, but do reflect the reality

reported in government reports. Poor enforcement of forest protection laws and bylaws, and unclear forest boundaries have allowed encroachers to obtain high crop yields from rich and virgin forest soils (NFA, 2005; 2006). More than 80% of encroachers – mainly immigrants from over populated districts of south western Uganda – are smallholder cultivators and cattle keepers (NFA, 2005). This may explain why we observe smaller forest extractions for households nearer to forest reserves compared to larger extractions for households farther away from forest reserves. I explore this interpretation further using decomposition analysis that controls for returns obtained from characteristics.

#### **5.4 Decomposition of forest products extraction**

In this sub-section I seek to establish whether the difference in forest extraction between control and intervention sites is explained by the observed characteristics or the returns to these characteristics. Characteristics reported in Table 3 but without quadratic terms are used. Decomposition equation (6) is used for this purpose. The decomposition analysis is structured in two stages. In stage one, I decompose forest extraction between control and intervention sites before and after the introduction of IFP policy. In stage two, I decompose forests extraction by terciles of distance from home to the nearest forest reserve. This second stage decomposition analysis seeks to explain the observed inverted-U relationship between forest extraction and distance to forest reserves. As in the regression analysis, the logarithms of forest extraction per adult equivalent are used. Table 4 reports the decomposition results.

The results report the mean predictions of forest extraction for households in the control site and in the intervention site and their differences in the first panel. The second panel results indicate how much of the observed difference in forest extraction is due to differences in magnitudes of observed characteristics and how much is due to the differing degrees of “self-exclusion” from forest extraction (difference in returns to characteristics). The results indicate that before the introduction of IFP policy, households in control site would reduce forest extraction if they had similar magnitudes of observed characteristics as those in intervention site. The effect is significant as indicated by the characteristics coefficient of -1.015. This means that the observed difference in forest extraction of -0.682 is largely explained by the differences in magnitudes of characteristics rather than returns to these characteristics.

Table 4. Linear decomposition of log of forest extraction per adult equivalent

	IFP policy effects		Effects by forest distance terciles before IFP policy			Effects by forest distance terciles after IFP policy		
	Before IFP	After IFP	1 <sup>st</sup> tercile	2 <sup>nd</sup> tercile	3 <sup>rd</sup> tercile	1 <sup>st</sup> tercile	2 <sup>nd</sup> tercile	3 <sup>rd</sup> tercile
Mean extraction in control site	4.918*** (0.285)	6.593*** (0.109)	4.034*** (0.427)	5.938*** (0.376)	6.581*** (0.274)	6.654*** (0.120)	6.491*** (0.367)	6.404*** (0.274)
Mean extraction in intervention site	5.600*** (0.184)	6.146*** (0.128)	3.528*** (0.523)	6.585*** (0.189)	6.119*** (0.180)	6.020*** (0.366)	6.263*** (0.195)	6.136*** (0.186)
Mean difference	-0.682** (0.339)	0.448*** (0.168)	0.506 (0.675)	-0.647 (0.421)	0.462 (0.328)	0.634* (0.385)	0.227 (0.416)	0.268 (0.331)
<i>Decomposition estimates</i>								
Observed characteristics	-1.015*** (0.249)	-0.026 (0.205)	0.640 (0.665)	-0.260 (0.256)	-0.339 (0.432)	0.219 (0.457)	-0.233 (0.284)	0.395 (0.372)
Returns to observed characteristics	0.996*** (0.366)	0.435** (0.209)	-0.102 (0.501)	-0.003 (0.476)	2.445*** (0.397)	0.682* (0.408)	1.453* (0.772)	0.407 (1.530)
Interaction	-0.663** (0.338)	0.038 (0.243)	-0.031 (0.510)	-0.384 (0.493)	-1.643*** (0.529)	-0.268 (0.467)	-0.992 (0.863)	-0.534 (1.581)
Number of observations	300	300	113	91	96	124	78	98

\*\*\*, \*\*, \* are significance levels at 1%, 5%, 10% respectively

After the introduction of IFP policy, the weak but negative effect attributed to characteristics is virtually zero as indicated by the characteristics coefficient of -0.026. This is expected as characteristics are likely to remain relatively stable over time, for example, I observe small variation in characteristics reported in Tables 1 and 2. Instead, the results show that relatively less forest extraction is motivated by changes in the “returns” to observed characteristics (self-exclusion), and these play a significant role in explaining the differences in forest extraction.

Table 4 also presents decomposition results of forest extraction based on IFP policy together with distance from home to the forest reserves. The results show that before the introduction of IFP policy, the forest extraction differential between households in the control and intervention sites that lived nearer to the forests (those in the first tercile) was attributed to the differences in observed characteristics. However, the forest extraction differential between households in the control and intervention sites that lived farther away from forests (those in the third tercile) was attributed to the differences in returns to observed characteristics (self-exclusion). But after the introduction of IFP policy, the forest extraction differential between the two sites is largely explained by self-

exclusion regardless of the distance from forest reserves. In general, it is observed in Table 5 that before the introduction of IFP policy, households in the first tercile of forest distance extracted smaller amounts of forest products than those in the third tercile in both sites. After the introduction of IFP policy, we see that the amount of forest extraction is almost similar across terciles and between the sites. The general implication from these results is that self-exclusion as measured in terms of differences in returns to characteristics, rather than differences in magnitudes of characteristics themselves, play a significant role in explaining the variation in forest extraction across households in different locations (IFP policy areas and non-IFP policy areas).

What policy lessons can we draw from these findings? I elaborate this by introducing the terms mentioned earlier in section 4.2: the ' *$\beta$ -policies*' and '*X-policies*'. As earlier defined, the  *$\beta$ -policies* are policies that explain changes in returns to observed characteristics (self-exclusion), that is, the parameter estimates ( $\beta$ ) in equation (6), while the *X-policies* are policies that lead to changes in the levels of observed characteristics. The findings in Table 3 indicate that less forest extraction is associated with a number of factors including: ownership of stocks of farmland and livestock (but with a U-shaped relationship), low population density, easy access to input-output markets, less access to forest reserves, as well as other household factors such as education of household. *X-policies* that would reduce forest extraction include resettling the forest dependent households in non-forested areas with good access to input-output markets, and redistribution of resource endowments, e.g., farmland and livestock. However, a policy promoting redistribution of farmland and livestock would have to take into account the threshold stock of these resources beyond which forest extraction declines, since we find that forest extraction initially increases at a decreasing rate as the stock of resources increases before reaching the turning point. Such *X-policies* may also be costly and politically controversial, and therefore less likely to be implemented by governments of developing countries like Uganda. Others *X-policies* like higher education, which also tend to reduce forest use (Table 3), are more politically acceptable but carry high costs.

The  *$\beta$ -policies* can be interpreted as regulatory policies which change the behavior (forest use) for a given set of characteristics. The IFP policy intends to have impact on the health of the forest reserves by providing alternative sources of wood products and by

changing the access to forest reserves by establishing the private plantations. Thus it can be seen as a typical  $\beta$ -policy within the decomposition framework. The finding suggests that the policy was indeed successful in changing forest users' behavior.

## **6 Conclusion and implications**

Faced with increasing rates of deforestation and forest degradation, the government of Uganda introduced a policy initiative to conserve forest reserves by leasing parts of degraded forest reserves to private investors to establish commercial forest plantations. The policy initiative is premised on the assumption that the establishment of individual forest plantations will reduce pressure exerted by local users on remaining natural forest reserves. This paper examines the impact of this policy initiative by answering the following research question: has establishment of individual forest plantations by private investors reduced extraction of forest products by rural households?

The analysis shows that the establishment of individual forest plantations on forest reserves has led to a slight reduction of forest products extracted. This reduction is unevenly distributed along the forest distance from homesteads and differences in household characteristics such as livestock and farm size holdings. I found that households living close to forests and have small farm size and livestock holdings extract small amounts of forest products. As the forest distance increases and with an increase in farm size and livestock holdings, forest extraction increases before declining at greater forest distances and ownership of large farm size and livestock holdings. In other words, in addition to individual forest plantations having a weak effect on conservation of natural forests, there is a nonlinear relationship between extraction of forest products and distance to forests as well as ownership of productive assets like land and livestock.

To understand how variation in observed characteristics explain the effect of the forest plantations policy on conservation of natural forests, I used decomposition analysis to determine the degree of variation in forest extraction explained by the magnitudes of observed characteristics and self-exclusion measured in terms of the differences in returns to these characteristics. I found that self-exclusion, rather than the differences in magnitudes of observed characteristics, largely explains the effects of the policy initiative of forest plantations on conservation of natural forests. High returns to observed

characteristics, particularly household endowments of livestock, land, human capital indicators such as education of household head, household size among others significantly reduce forest extraction and augment the effectiveness of the policy initiative of individual forest plantations to conserve natural forests.

Overall, the policy seems to have weakly reduced the forest use in the order of 15.5% compared to what it would have been in a business-as-usual scenario in the intervention site. Expected longer term effects, for example, from the supply of forest products from the plantations, have the potential to further enhance the effectiveness of the policy.

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Motivated by a large body of literature that suggests land is a key determinant of livelihood strategies for farm households in developing countries, this thesis offers insights on how the mode of land acquisition at the time of household formation influences household decisions to invest in land, and then examines how landholding determines two other key household decisions: first, the decision to switch from subsistence production to a crop mix of food and cash crop production, following a policy reform of export-crop (coffee) market liberalization, and second, the decision to extract uncultivated products such as forest products.

The thesis uses a diversity of analytical approaches applied on a range of different datasets from Uganda to understand these household decisions. The findings indicate that although inheritance is the main form of land acquisition, inheritance discourages investment in land and encourages land disposal through both sales and bequests. The initially landless or near-landless households accumulate landholding over time and catch up with the initially land rich households, and land markets serve to make the land distribution more equal.

The thesis further finds that households poor in productive assets like land and livestock extract charcoal from natural forests, and that this makes it possible to catch up with more asset-rich neighbors. The extraction continues until they accumulate necessary income to acquire productive assets after which exit is possible. Another paper focuses on extraction of forest products mainly for subsistence use, and the impacts of commercial forest plantations established to reduce the pressure on natural forests. While the thesis finds that this policy has had a modest conservation effect, it concludes that policy initiatives designed to conserve forests can be made more effective if they are introduced with complementary interventions that change characteristics that reduce forest use, including the asset holdings

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